PROCEEDINGS OF 2011 KABARAK UNIVERSITY 1ST ANNUAL INTERNATIONAL RESEARCH CONFERENCE

RESEARCH FOR PROMOTING CREATIVITY, INNOVATION, DEVELOPMENT, AND INDUSTRIALIZATION

12TH TO 14TH OCTOBER 2011

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This book of proceedings is the result of hardwork 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 Research Production and Extension staff for many hours sacrificed to ensure everything went as desired.

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

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FORWORD BY THE VICE CHANCELLOR

On behalf of the Board of Trustees, the Governing Council, the Management Board, the staff and students of Kabarak University, I take this opportunity to welcome all the participants to the 1st Kabarak Annual Conference.

In pursuits of excellence, Kabarak University emphasizes learning, research and community engagement as pillars that contribute to creativity, innovation, development and industrialization for Kenya and the world at large. The University continues to make research a top priority by enhancing the capacity of the faculty and students in their research orientation. This will help to usher Kenya into a knowledge based economic dispensation.

A conference such as this provides an opportunity for researchers to share knowledge and Kabarak University will endeavour to continue facilitating such a forum where researchers can share their ideas and innovations.

The conference is coming at a time when universities must play a major role in national and international research. It brings together scholars, entrepreneurs, bureaucrats and researcher who will share creative ideas, innovative insights and new techniques with a view to forge powerful tools for national Development. The theme of the conference focuses on research for Creativity, Innovation, Development and Industrialization in line with the current local and global challenges. The conference highlights themes in business, science and technology, education and theology, law and ethics.

The success of the developed nations economically and technologically is as a result of their universities playing a critical role in research. The university remains the only institution whose character is defined by its fundamental commitment to the conviction that teaching and research cannot be separated and together they constitute the fundamental mission of the university. A university does not produce research for its own sake but research whose application is carried on largely by industry and government outside the university, on the other hand, industry and government must have university trained scholars to conduct research.

Research is costly affair that entails active involvement of government as well as the private sector in partnership with universities in the provision of necessary resources to enable scholars to do research. It is also essential that individuals and the corporate world establish research foundations to help researchers do their work.

I thank the Institute of Postgraduate Studies and Research as well as the conference organizing committee for playing a crucial role in the organization of this conference. My prayer is that you will find this conference enjoyable and rewarding.

Prof. Dankit Nassiuma
Vice Chancellor
EDITORIAL NOTE

The Editorial Committee of the Kabarak Journal of Research and Innovation is happy to be associated with the publication of the proceedings of the inaugural Kabarak International Research Conference which was held in October 2011. Although these proceedings have only been edited but not peer reviewed, we consider this publication significant in three ways. First, it signifies the commitment and determination of the Kabarak university management and conference organizers to elevating and sustaining the Kabarak International Research Conference to a world-class annual event at Kabarak University. Second, it re-assures past and future participants of and contributors to the conference that their contributions will not only receive utmost and timely attention but also wide dissemination through the web. Third, it provides a database of scholarly papers from which a select few would be peer-reviewed and published in the inaugural issue of the Kabarak Journal of Research and Innovation, to be launched in May 2012. Essentially therefore, these conference proceedings may be viewed as the first fruits of a long tradition that will characterize Kabarak University’s contribution to research and scholarship in the region. We accordingly welcome you to put into best use the various articles in this publication.

Professor Fred Simiyu Barasa

Chief Editor, Kabarak Journal of Research and Innovation

(For and on behalf of the Editorial Team)
KEYNOTE SPEECHES

INTEGRATION OF FAITH AND LEARNING IN HIGHER EDUCATION: THE CASE OF KABARAK UNIVERSITY

Keynote Address Presented by Dr. John N. Ochola, PhD
Registrar (Academic and Research)

Preamble

Chartered in 2008 by the Government of Kenya as a private university and affiliated with the Africa Inland Church, Kabarak University was founded in 2002 by the Second President of Kenya, His Excellency Daniel Toroitich Arap Moi, who continues to serve with distinction as the Chancellor of Kabarak University. His Excellency envisioned Kabarak University as:

- A University that would be committed both to its Christian heritage and to academic excellence.
- A University that would become a world class centre of academic excellence as a Christian institution.
- A University that would provide holistic quality education, practical skills, knowledge, and Christian moral values for the service of God and humanity.
- A University whose members shall “purpose at all times in all places ‘to set apart in our hearts, Jesus Christ as our Lord’ (1 Peter 3:15).
- A University that would offer “Education in biblical perspective.”

Kabarak University seeks to fulfill this mandate through the noble practice in Christian higher education known as the integration of faith and learning in both undergraduate and postgraduate programs.

Integration of faith and learning is a definite and intentional plan in the provision of education to nurture every area of the learner – cognitive, emotional, social, physical, and spiritual – in a Christ-centered community of believers. This is a systematic effort to see that learning in every one of these areas is not fragmented but holistic and interdependent.

The basis for the integration of faith into the university environment can be found in Jesus’ summary of the commandments in Mark 12:30:

“Hear, O Israel, the Lord our God, the Lord is one, and you shall love the Lord your God with all your heart, with all your soul, with your entire mind, and with all your strength.’ This is the first commandment.”
Following its commitment to the biblical injunction in Mark 12:30, Kabarak University intentionally pursues integration of faith in the following areas of the university environment:

- Academics (loving the Lord with all the mind)
- Spiritual (loving the Lord with all the heart)
- Psychological (loving the Lord with all the soul)
- Physical (loving the Lord with all Strength)
- Social (loving neighbor as oneself).

The practice of integrating faith and learning is not a new concept under the sun. From the very beginning Christianity has sought to integrate faith with scholarly disciplines. For instance, the Hebrew system of education incorporated Greek and Roman ideas of education. During the Medieval and the Reformation period, institutions of higher learning emphasized theology as the main subject, while other disciplines were to facilitate human understanding of faith. Theology then was known as “The Queen of the Sciences.”

**Integration of Faith and Learning in Kabarak University**

Through its stated vision, mission, Moral Code, and philosophy of education, Kabarak University cultivates a campus atmosphere in which moral, spiritual, and academic growth can thrive. This is achieved in several ways:

First, Kabarak University exemplifies its commitment to transmit education in biblical perspective to students through a distinctive curriculum comprised of University common courses intended to broaden the academic background of students in their respective professional training and to facilitate a more profound appreciation of life, the society and environment in which the students are a part. Four of the common courses are Bible-based. The *Old Testament Survey* and the *New Testament Survey*, which every student must take within the first two semesters, enable the student to receive lectures on all sixty-six books of the Bible. The third common course, the *Redemption Story*, exposes the student to the theological account of the history of creation, fall, and redemption. The fourth common course, *Christian Ethics*, introduces the student to fundamental contemporary ethical issues, which the student then examines from biblical perspective. The University has established the Department of Theology which carries out the load of all those courses.

Integral to its commitment in integrating faith and learning is Kabarak University’s commitment in appointing administrative and academic staff with high Christian moral standard of life. When prospective staff members are interviewed, officials of the university are always keen to ensure that the interview score sheet includes a screening of both the academic and the Christian background of the candidate. The University also ascertains how the candidate would contribute to the furthering of the University vision and mission, besides a commitment to the traditional criteria of teaching and research.

Another demonstration of Kabarak University’s attentiveness to its commitment to the integration of faith and learning is seen in its highly active campus ministry. Kabarak University is one of the few
universities in Kenya, if not the only one, with a chapel building (not a multi-purpose building) dedicated entirely to prayer and worship services. The Kabarak University Chapel, its cross-topped spire and profound architectural design, conveys a clear message that this is a University connected to Christ. Chapel attendance is part of the student’s spiritual commitment which all students must sign upon admission.

Chapel services are held on Sunday and Wednesday, with focus given to prayer, worship and sharing spiritual challenge and encouragement. Every Wednesday from 11:30 a.m. to 1:00 p.m., all other business in the University comes to a standstill as all offices close and staff and students gather in chapel to worship the Lord. Administrative and academic staff members are often scheduled as chapel speakers. There is also provision for a special chapel led by academic departments and administrative units, as well as the graduating class, in which they minister as groups to the University community. Guest speakers from various professional backgrounds are often invited to share how they integrate faith and daily life. Each academic year, the University selects a biblical theme to which speakers address. For instance, the theme for the year 2011 was taken from John 14:6 “I am the way, and the truth, and the life.” Spiritual emphasis week is scheduled each semester for staff members and students to gather for special messages from guest speakers, to have private meditation, and to meet in small groups for prayer, fellowship and encouragement.

In addition to chapel services, Kabarak University provides opportunity for spiritual growth to students through the mentoring program. One of the criteria for hiring academic and administrative staff at Kabarak University is their willingness and ability to serve as spiritual mentors for the students. Each mentoring group consists of one member of staff and four to six students. Students are encouraged to schedule personal consultations as often as necessary during the semester. The objective of the mentoring program is to handle one-on-one spiritual issues, build accountability among the students, and encourage students on active participation and initiative in Christian programs. Furthermore, students living in residential halls have the advantage of being mentored by the hostel wardens, who function as the parent in the University policy of in loco parentis. This means that the wardens oversee and assist the students to comply with university’s behavioral policy. A morally upright student life in the residential halls and at the University generally is seen to be the university’s responsibility.

Another material demonstration to Kabarak University’s commitment for integration of faith and learning is the appointment of fulltime student counselors in the Office of the Dean of Students to help students with counseling needs. In most cases, students approach the counselors with personal issues. In some cases, counseling may be initiated by the counseling staff when areas of weakness become evident in the life of a student.

No account of Kabarak University’s initiative in the integration of faith and learning would be complete without mentioning the University’s commitment to mission outreach. For one week each year during April, Kabarak University students and members of staff, in conjunction with Moi High School Kabarak, organize a team which travels together to a community where arrangements have been made in collaboration with local churches to conduct an evangelistic mission outreach. In April 2011, the team conducted a successful evangelistic outreach in the once troubled areas of Mount Elgon.
The development of spiritual formation in the University is supplemented by the activities of a number of Christian student-led clubs which thrive on campus. Such clubs include the Christian Union (C.U.), the Fellowship of Christian University Students (FOCUS), SAM Africa, I Choose Life, and Students in Free Enterprise (SIFE), amongst others. In this regard, it should be noted that Kabarak University won the national SIFE competition this year 2011 and represented Kenya in the international competition held in Kuala Lumpur, Malaysia in October 2011. Kabarak University emerged among the best top five universities in the global competition.

To provide leadership and support for Christian nurture, growth, and ministry among students and staff members, Kabarak University has established the position of Deputy Vice-Chancellor/Provost who heads both academic and spiritual affairs in the University. The position will be occupied by a person with outstanding Christian life, distinguished ministry in the church, and impeccable academic record. This is another strong and bold statement of Kabarak University’s commitment to the integration of faith and learning.

Heights to Climb

Although Kabarak University has done quite well in integrating faith and learning, there are still some areas that could be improved. For instance, there is a need to bring the academic staff members to speed in the business of integrating faith and learning in their courses. To this end, the University could provide a mechanism which would ensure that all academic and senior administrative staff members are given the opportunity to read landmark books on the integration of faith and learning. The required reading could include the books listed as further reading at the bottom of this paper.

To prepare the staff members to play effective role in the integration of faith and learning, the University could create a Centre for Faith and Learning to provide funds and opportunity for academic and senior administrative staff to take courses in theology and to construct interdisciplinary courses that incorporate Christian vision. In this regard, the university’s ultimate objective would be to enable its lecturers to move to their highest level in their capacity to integrate faith and learning systematically into their subject areas.

Also, the University could establish endowed professor positions or chairs spread across the University academic programs and recruit professors with a track record of, or potential for, integration of faith in their specialization areas.

Furthermore, integration of faith and learning in the university requires thoughtful reflection and well coordinated framework for action in each academic program. The academic and senior administrative staff members could be required to receive orientation and attend workshops on scholarship and the Christian university at which the interaction of faith and learning are explored. The workshops could be followed by ongoing mentoring process in which staff members are further exposed to the idea and practice of engaging faith and learning.

The outcome from these initiatives would be staff members who not only express their Christianity through prayer and worship, but also in their teaching and research agenda. For instance, the Law program could explore the fundamental impact and contributions Christianity has made to modern law, politics and society. The department of commerce could research on the effect of Christian
standards on modern business life. The department of environmental studies could conduct studies on Christian ecology. The department of computer science could examine the theology or ethics of information technology, amongst others.

On the student side, a significant portion of students are commuters living in privately rented off-campus dwellings. Many of these students rarely participate in the Christian life and ministry of the University. The University, therefore, faces a serious challenge of imparting its Christian ethos to these students. Without doubt, there are many serious Christians among off-campus student population, but there could also be a fair number of rebels against the dominant campus Christian ethos. The University could devise a mechanism for extending its Christian ministry to these students.

Finally, since Theology is historically the queen of sciences and the engine that should drive the engagement of faith and learning in the University, the department could be strengthened to offer both undergraduate and postgraduate programs as the flagship programs in the University.

**Conclusion**

In conclusion, it is evident from the foregoing discussion that Kabarak University has taken a multi-dimensional approach to integration of faith and learning, involving appointment of staff with high Christian moral standard, cultivation of a vibrant campus community in which in-reach and out-reach ministry thrive. The challenge, however, is in the area of integration of faith and learning in the university academic programs and courses. Provision of spiritual ministry to off-campus students is also a challenge. The way forward for addressing these challenges has been proposed in this paper.

**Further Reading**


INTEGRATING FAITH & MANAGEMENT

by Dr. Gideon Muriuki - OGW
Group Managing Director & CEO Co-operative Bank of Kenya Group

We have the great advantage of not having been Adam or Eve; or others who have gone before us. But we can learn from their successes and their failures. The Bible is full of testimonials of great men & women of God and how they integrated their Faith and Management of their ‘businesses’ with very broad outcomes.

**Success Rate**

Adam; Joseph; Daniel; Moses; Joshua; Samson; Esther; Solomon. Below is a key synopsis of each of the above leaders viz a viz Faith & Management!

**Genesis: 41:41-49** 'So Pharaoh said to Joseph, ‘I hereby put you in charge of the whole land of Egypt.’ Then Pharaoh took his signet ring from his finger and put it on Joseph’s finger. He dressed him in robes of fine linen and put a gold chain around his neck. He had him ride in a chariot as his second-in-command, and men shouted before him, ‘Make way! Thus he put him in charge of the whole land of Egypt’.

Then Pharaoh said to Joseph, ‘I am Pharaoh, but without your word no-one will lift hand or foot in all Egypt’. Pharaoh gave Joseph the name Zaphenath-Paneah and gave him Asenath daughter of Potiphera, priest of on, to be his wife. And Joseph went throughout the land of Egypt. Joseph was thirty years old when he entered the service of Pharaoh King of Egypt. And Joseph went out from Pharaoh’s presence and travelled throughout Egypt. During the seven years of abundance the land produced plentifully. Joseph collected all the food produced in those seven years of abundance in Egypt and stored it in the cities. In each city he put the food grown in the fields surrounding it. Joseph stored up huge quantities of gain, like the sand of the sea; it was so much that he stopped keeping records because it was beyond measure.

**Reflections**

Joseph kept his faith under extremely difficult circumstances: slavery, working for Portiphar’s wife. Confronted with the temptation from His master’s wife Joseph replies: Genesis: 39: 9(b) ‘How then could I do such a wicked thing and sin against God’. Prof Ngewa and Assohoto in the ‘African Bible Commentary’ had this to say on this passage. As a mark of his office, Joseph was given Pharaoh’s signet ring. Possession of this ring authorized Joseph to make decisions and place seal and signature on official documents; Power and Authority!

Robes, fine linen and gold chain would serve as constant reminders to others and they were dealing with a man of power. So would the fact that Joseph would be riding in a chariot as Pharaoh’s second-in-command with men shouting, make way before him. What a reversal for Joseph! The Lord had transformed all his past humiliations into great honour. No situation, however, trying and humiliation, can be an obstacle to the to the Lord’s blessings. When God’s presence is with us, the most terrible slavery, the most brutal humiliation or the worst treatment is nothing. God has the last word. Joseph had been about seventeen when he was sold into slavery (37:2) and was thirty when he
was put in charge of Egypt. He collected so much food that he eventually stopped keeping records because it was beyond measure. His well-thought-out strategy was not intended to enrich himself but to save Egypt, and the whole region, from death during the seven years of famine. We have to pray for and elect ‘Josephs’ into office in Africa. When the seven years of famine struck, things happened exactly as Joseph had foretold: there was famine in all the other lands, but in the whole of Egypt there was food.

One good leader can make his or her ‘scope of influence’ appear like paradise while the surrounding ones are like hell. Good planning is critical! This is what many African Institutions need. This is a call to all of us who are owners of the land of Kenya. The famine was severe in the whole land of Egypt, but because of one man they had enough food for themselves and also enough for the citizens of other countries who also flocked to Egypt to buy grain from Joseph.

I was appointed CEO of Cooperative Bank on 1\textsuperscript{st} March 2001; the bank on the verge of collapse with a loss of over Kshs.2.3 Billion. I really had nothing in terms of age, experience, connection etc. Only Faith. From the rock bottom, today Co-op Bank is the 4\textsuperscript{th} largest Bank in terms of asset base and voted Best Bank in Kenya in Year 2010 in the ‘Global Bankers Awards’ by Financial Times of London

Performance Trend in the last 10 years

<table>
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<th>Year 2000</th>
<th>Currently</th>
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<tr>
<td>Branches: 28</td>
<td>90</td>
</tr>
<tr>
<td>Asset Book: Kshs.20B</td>
<td>Kshs.160 B</td>
</tr>
<tr>
<td>Deposits: Kshs.15 B</td>
<td>Kshs.136 B</td>
</tr>
<tr>
<td>Staff : 925</td>
<td>Over 3000</td>
</tr>
<tr>
<td>PBT : Kshs.2.3B Loss</td>
<td>PBT Kshs.4.1 B (Half Year)</td>
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Key Reflections

Running CoOp bank has been a journey of Faith, and looking back I can only testify of God’s faithfulness upon our institution. Its vision is Based on ‘Kingdom’ principles. We believe we can feed the whole Nation of ‘Egypt’ – ‘Egypt’ prospered. We can also feed the whole earth, earn long life – 110 years, save our ‘people’, and honor God.

Kingdom Business

Adds incredible fulfillment when you serve God principally through your job; it is Kingdom Business! Seek vision based on Kingdom principles and make it God’s business. Prov.16:3 ‘Commit to the Lord whatever you do, and your plans will succeed’. James 4:2 ‘You do not have for you do not ask’. Deut.8:18 ‘He is the Lord who teaches us to profit’. Prayer is KEY in the CoOp bank. Prayers were held at the opening of Co-op House branch, official re-opening of the building in 2003. Had Tremendous breakthrough over the years E.g. Debt write-off. IPO success and liability campaign was a result of prayer and fasting. In the Year 2004 CoOp bank was declared the ‘Kingdom Bank’ that will help the people of Kenya by the Board of Directors, and in the Year 2010: The Kingdom Bank was registered as a Trade Mark of Co-op Bank.

Key Performance Standards

Professional recruitment; Exodus 31:2; example of Bazalel and Oholiab (right skills, ability and Knowledge).

Professional procurement systems.

Performance based reward system - 2 Thes.3:10; for even when we were with you, we gave you this rule: ‘If a man will not work, he shall not eat’ and Prov. 28:19: ‘He who works his land will have abundant food, but the one who chases fantasies will have his fill of poverty.’

Sound Ethical standards e.g. staff sacked on pornographic material.

Giving back to community - Co-op Bank Foundation; supports1302 students in secondary education and 112 students in University Education

Policy making – Participated in drafting the Alcohol Bill (Mututho Bill).

Ministry Support - Support ministry e.g. Church financing’ Endowment Funds, Education Programs for needy students, Church based ‘CSR’ Programs

Mentorship - Committed to team work/employer of choice. Attend to 3000 staff members and 2.3 million customers

The result will be Better Nation; Better stewardship (accountability, faithfulness) and like Joseph we can nurture and prosper our institutions, the Nation and the World.
Conclusion

Let’s make it God’s business to conquer new Horizons in our spheres of influence. Joshua 1:3 ‘I will give you every place where you set your foot.............’ Thank you all & God bless.

THE ROLE OF RESEARCH IN INDUSTRIAL DEVELOPMENT

by Dr. Manu Chandaria

Last century since 1901 until 2000 I must say was the most rewarding to mankind. The history that we talk about since five thousand or three thousand years back - majority of those centuries have passed as mediocre centuries. It is only in eighteen hundred that industrial revolution started when people started thinking out of the box and specifically the intelligent ones started thinking that they could change the way life is.

Before the eighteenth century life was drudgery, movement was on horses or in carts, transportation of goods in bullock carts, camel carts etc. As soon as the sun went down it was the little oil lamp or candle light, and for sending messages it took many days.

Middle of nineteen century, around eighteen forty, the first rail road came along and people and goods started moving for the first time at a much faster speed than horses and carts.

Then came the telegrams and telephones in 1876, we got the first incandescent bulb. Let’s look at the twentieth century - we got automobiles to move individually up to the destination, the planes which fly us around the world in the most comfortable manner at reasonable prices. Last month I took a flight from Beijing to Dubai to London and I took a shower in the plane. The first man on the moon was sent during the century.

Television came into our lives from black to colour, from big size to slim size where we can see things happening miles away from us - enjoy entertainment all in our own rooms at our comfort.

Computers changed from huge units to laptops, mobile telephones have changed our lives, and mobiles take more photographs than all cameras put together. The things one can do with the mobiles is unbelievable. Everyday something new comes up and now we have IPADS, generation two, and before long generation three electronics made out life hassle free. Microbiology and genetic studies gave us clues about lots of things we never knew.

I keep wondering, how people lived from five thousand years back till the nineteenth century. It makes me think why it took such a long time to change - what made the change. Inquisitiveness. To find something different better than what you had yesterday - this is what research is all about search for solutions to make life easy.

Universities play an important role in research worldwide. There are institutions created for research like KIRDI in Kenya. Major input in these institutions is also man power - product of the universities.
Research at universities provides local growth and development. University research generates local economic impacts through scientific discoveries. It also provides local industries the case study and show research findings.

The classification case in Silicon Valley connected with Stanford University and electronic clusters around MIT are success stories where universities have placed an important role on doing research and also cultivated human resource for many of the industries.

Similarly there is a recorded case of John Hopkins University in Baltimore which has made very little impact.

The other important issue is if the research can create income for the universities if patents are good and strong - it can bring income and sometimes big income.

Worldwide it has been known that universities with greatest economic impacts are generally those with the highest quality research programmes.

University culture and policy can have an important effect on the extent to which faculty engage in developing commercially relevant research.

Let me give you an example of India and its green revolution. When I was studying in the late forties, we used to eat imported food as we could not produce enough for ourselves. Today India is exporting food, and supporting its bullion plus population.

Kenya has shown great progress in floriculture and horticulture in producing flowers and vegetables as an industry. Not as a little farm output.

TRANSFORMING KENYA THROUGH RESEARCH
by Dr. M. K. Rugutt, PhD, HSC National Council for Science and Technology

Introduction

Globally knowledge economies are known to be driven by well funded research institutions. R&D plays critical role in rapid economic development as evidenced in Korea, Malaysia. Kenya has been establishing S&T institutions in effort to develop research capacity and application of science and technology towards addressing the country’s development priorities. The enactment of the Science and Technology Act, Cap 250 in 1977 which established the National Council for Science and Technology (NCST) as an advisory institution—led to key research institutions: KARI, KEMRI, KIRDI, KEFRI etc.

Harnessing Scientific research potential

Africa accounts for about 0.6% of World gross expenditure on R&D

In Kenya funding level to R&D is about 0.5% GDP as opposed to recommended the 1%
Increased and sustained funding on ST&I for is key to transforming into a competitiveness economy

National research policy and investment frameworks in R&D

Strengthening of National Innovation System (NIS)

Centers of excellence to strengthen R&D capacity

**Promoting Interest and Investment in Scientific Research**

Protecting benefits of R&D and innovations through IPR for Wealth Creation; Commercialization of R&D products - going beyond publications, patents and prototypes; Industrial liaison units to strengthen research - industry links; Establish systems of recognition to award innovators; Favorable framework conditions for commercialization of technologies; Production and use of technologies for economic benefits; Inventions from Laboratories to the market place to add value.

**Transformative Research**

Research that leads to innovations for industrialization, should be demand rather than supply driven, Multi-disciplinary & Multi-institutional vs Single approach in R&D, Publications vs Patenting, transforming Innovations & Inventions into products and commercialisation, should develop problem-solving scientific research, and Fuse economic planning with technology planning

**Role of Key Actors in R&D Promotion: - Researchers**

Research is pivotal addressing region’s challenges to socio-economic development. Researchers collect and analyze information to increase our understanding, with Generation and dissemination for exploitation of new knowledge. Research results should contribute to quality of life and technological change. There should be linkages with Industry for application of research findings.

**Key Actors Promoting R&D:- Government**

Provides enabling environment for socio-economic growth. Enact appropriate legislation to guide R&D activities. Invest in R&D infrastructures, Provide funding for research in Universities and R&D institutions, and facilitating collaboration with Industry and academia.

**Key Actors Promoting R&D:- Private Sector**

Funding of R&D through venture capital as well as Commercializing research finding and innovations. Bridge scientific research and products development for industrial development, and Develop innovativeness for competitiveness.

**Benchmarking Kenya’s ST&I**

Global Competitiveness Report (World Economic Forum)

Knowledge Economy Index (World Bank)

**UNESCO Science Reports**
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**INNOVATION IN KENYA**

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<td>Availability of scientists and engineers</td>
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<td>Utility patents per million population</td>
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*Source: The Global Competitiveness Report 2010-2011*

Challenges facing Research systems

Lack of national research policy, Our research being supply rather than demand-driven, Funding to R&D is small about 0.5% GDP, Brain drain, Weak link between research and the industrial sector

**Reversing the trend**

Increase funding for R&D/GDP; 1% recommended, Improve R&D infrastructure and capacity to develop innovations, Human resource-capacity building, Strengthen IPR regimes, Nurture and sustain home-grown scientific talents, Brain gain through Brain circulation, Promotion of ST&I, Science Parks and innovations incubation Units

**Competitive Higher Education**

Strengthen Postgraduate education in science, engineering and technology (SET) skills, Establish Entrepreneurial Universities, Encourage University/ Industry linkages

**Effective National Innovation System**
Quadruple Helix

The Role of NCST

Advise, Promotion, Coordination

NCST ST&I Grant

Research- (160, Women Scientists/Researchers (46)
Postgraduates - PhD (62) and M.Sc (47)
Research facilities (8)
Support for Conferences/Symposia (31)
Kenya- South Africa (16)
NCST-JSPS (2)
Kenya-DAAD(1)
Innovations – (25)

“No country on earth has developed without deploying, harnessing and utilizing S&T, whether through technology transfer or home grown solutions”

Thank you

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http://www.ncst.go.ke
PAPER PRESENTATIONS

EDUCATION

INSTRUCTIONAL METHODS USED IN TEACHING CONFLICT RESOLUTION IN SOCIAL STUDIES IN PRIMARY SCHOOLS

T. H. Ngetich and Prof. P. Ndege
hiltuimur@yahoo.com
Moi University

Abstract

Education has been seen to play an integral part in the building of the Kenyan nation. Through education primary school children acquire basic skills, attitudes and values for growth in life. It is the paramount duty of education to help the youth acquire their sense of nationhood by removing conflicts through promotion of positive attitudes and mutual respect so as to live in harmony and foster patriotism in order to make a positive contribution to national development. One of the basic skills taught in Social Studies at the primary school level is conflict resolution which is acquired through effective teaching. This entails the use of appropriate instructional methods, materials and the right learning environment. It is against this background that the study investigated the teaching of conflict resolution topic in Social Studies at the primary school level with regard to instructional methods.

The findings of this study showed that many of the primary school social studies teachers had not attended any in-service courses to induct them on how to teach emerging issues in the current primary curriculum like conflict resolution and thus did not use appropriate methods like role play, storytelling and the use of resource persons which are learner centered and enable the learners to become creative. The conclusion drawn from the study was that the current preparation of teachers to teach emerging issues in the society was inadequate with regard to teaching methods. The study recommended the need for Social Studies teachers to be retrained and sensitized on the appropriate instructional methods for teaching conflict resolution. This will enable the learners internalize what is taught and thus be creative in their handling of emerging issues in the society today.

Introduction

Since Kenya’s independence, education has been seen to play an integral part in the building of the Kenyan nation. According to the Kenya Education Commission Report of 1964, education was expected to foster a sense of nationhood and promote national unity (Republic of Kenya 1964:25). It was also to be used as an instrument for the conscious change of attitudes and relationships, preparing children for those changes of outlook required by modern methods of productive organization.

This has also been stressed in the National goals of education where education among others should foster nationalism, patriotism and promote national unity. Kenya’s people belong to different ethnic groups, racial and religious groups, but these differences need not divide
them. The Kenya Institute of Education (KIE) Primary education syllabus (2002) explains that it is a paramount duty of education to help the youth acquire their sense of nationhood by removing conflicts and by promoting positive attitudes of mutual respect, which enable them to live together in harmony and to foster patriotism in order to make a positive contribution to the life of the nation.

Primary education has been recognized as basic education, which should be provided to all Kenyans. It is in the primary school where children acquire basic skills, attitudes and values for life. This forms the basis for future education, training and employment.

The 1988 Presidential Working Party on Education and Manpower Training for the Next Decade and Beyond recommended one of the objectives of primary education as that of developing positive attitudes and values towards society and developing a measure of logical thought and critical judgment (Republic of Kenya 1988:20).

Social Studies as one of the subjects taught in the primary school is supposed to contribute to the development of an all-round personality. The topics taught are aimed at inculcating desirable qualities in an individual such as self-reliance, flexibility of mind, tolerance, initiative, promotion of problem solving skills, clear thinking among others, African Social Studies Programme ASSP (1988). In addition, learners are able to get solutions to their individual and collective temporary social problems and be able to reach responsible judgment in seeking solutions to these problems.

The Social Studies Curriculum has undergone changes since its inception in the primary school in 1985 when its title was Geography, History and Civics. A combined course. Subsequent evaluations of this curriculum included; the 1990 formative evaluation report, the 1995 summative evaluation report and the 1999 National Capital Needs Assessment Survey Report which concluded that the curriculum among others, did not address emerging issues like conflict and conflict resolution, HIV/AIDS and drug abuse.

When the 2002 Primary Social Studies syllabus was introduced, emerging issues like conflict and conflict resolution were included in it. One of the objectives of primary school Social Studies was to make the student willing and able to resolve disputes in and out of the school. This was in line with the objectives of primary education, which is that education should instill respect and love for one’s own country and the need for harmonious co-existence, (KIE 2002). Through effective teaching of this topic, the national goals of education will be achieved since it is likely to bring harmony, national unity as well as critical judgment by learners.

For learners to get maximum benefit from the conflict and conflict resolution topic in Social Studies, teachers had to be careful about the organization of learning experiences so that knowledge could be internalized and retained by the learners and be useful to them. Kochhar (1991:91) had the following to say;

“Even the best curriculum and the most perfect syllabus remains dead unless quickened unto life by the right methods of teaching and the right kind of teachers”.
Were (1982) examined problems relating to the teaching of history in secondary schools in Kenya and found that history was perceived by learners to be dull, boring and uninteresting. Upon further investigation, it was found that this attitude had come up due to the poor quality of the teachers’ inappropriate teaching techniques and inadequate use of varied learning materials. This study focuses on the materials and methods of teaching conflict and conflict resolution in Social Studies in the primary schools. Other Studies that have been undertaken mainly in the teaching of History in secondary schools are those by Muchilwa (1998), Mwaniki (1984), Kiigi (1983) and Were (1982). Their findings attested to the fact that there still existed a gap in the information concerning teaching methods and use of available materials in history and by implication Social Studies in the primary schools. This study attempted to bridge this gap by examining instructional methods in teaching the topic conflict and conflict resolution in Social Studies in primary schools in Kenya.

**Instructional Methods used in the teaching of Social Studies.**

Instructional methods are defined as modes of delivery systems or teaching and learning methods employed in an educational process with the view of facilitating the attainment of the set goals or objectives. Kochhar (1991) explained that the best curriculum and the most perfect syllabus remained dead unless quickened into life by the right methods of teaching and the right kind of teachers. Some of the instructional methods used in teaching Social Studies include; lecture, class discussion, problem solving, role playing, group work, question and answer, use of resource persons, storytelling, field trips, debates, and essay writing. The teacher chooses the instructional method to be used when teaching different topics.

The importance of a good teaching method was summed up by Kochhar (1991) in *characteristics of a good teaching method*, paraphrased; a good teaching method should produce certain changes in terms of knowledge, understanding and habits of students. It should also arouse interests in students rather than passing on facts and figures. It should shift emphasis from verbalism and memorization to learning through purposeful concrete and realistic situations (Kochhar, 1991:93). A Social Studies teacher should be conversant with different Instructional methods. This is because as Joyce, and Weil (1980) said, “No model of teaching is designed to accomplish all types of learning or to work for all learning styles”. This means that no single method of teaching is the best for all situations and with all teachers and pupils.

Kochhar (1991:92) added that the method the teacher adopts should emerge out of the abundance of information and skill of the teacher.

From the above information one realizes that Instructional methods are necessary for effective teaching of conflict and conflict resolution in Social Studies. Social Scientists like Glazer (2004), Bhaskaran (2003), Freeman and Capper (1998) and Armstrong (1995) have highlighted the following as some of the methods of teaching conflict and conflict resolution; class discussion, problem solving, role play, and story telling. They say that these methods are appropriate since they; 

Made learning become student centered while the teacher acts as a facilitator.
Enabled learners to develop action plan to improve their attitude and skills.

Encouraged reflection on the knowledge of a subject.

Helped embed concepts and deeper knowledge in the minds of the learners.

Teachers of Social Studies should be familiar with different methods of teaching and use them for effective teaching. Students have to be exposed to a variety of learning experiences for comprehensive objectives of teaching conflict and conflict resolution in Social Studies to be realized.

An examination of the situation in many schools may show that this is not the case. Farrant (1990) said that many teachers in primary schools taught their pupils what they learnt in college. In his evaluation of a Social Studies programme in Kano state, Nigeria, Guri (1979) cited in Merryfield, and Mutebi, (1991) concluded that the Social Studies teachers did relatively well for recall of information but were unable to teach higher order skills. Salamu (1982) cited in Merryfield and Mutebi, (1991) observed that Social Studies teachers in Secondary Schools in Ibadan, Nigeria relied on rote memorization as their major teaching method.

In Kenya, studies have produced similar results, there seems to be a situation where Social Studies teachers are glued to only one method of teaching; lecturing and giving notes. A survey was done on curriculum, teaching, learning and assessment in Primary Schools in Kenya and Uganda which revealed, among other findings that the teaching of Social Studies \GHC in Kenyan and Ugandan classrooms was dominated by the techniques of questioning (by teachers), lecturing, and giving notes. (ASESP, 1993).

Makumba (1983) carried out a study on the degree of preparedness of Primary schools in Kakamega District to receive and implement the Social Studies Programme. He found out that there was inadequate in-service training of teachers on the implementation of the programme i.e the real teaching and learning situations which became a problem. Other researches done on teaching methods include; Were (1983) on ‘problems relating to the teaching of History in secondary schools in Kenya’, Mwaniki (1984) on ‘methods of teaching History in upper secondary schools in Kenya’ and Kiigi (1983) on an examination of History teaching in Kenyan secondary schools’. What came out clearly from these studies was that learning was mainly teacher centered and the main teaching methods were the lecture method and giving of notes. Nasimiyu (1994) in her study on the strategies used to implement the History and Government curriculum in Bungoma, found out that the teachers were not adequately prepared to teach History and Government curriculum of the 8.4.4. System of education.

The studies of these researchers were centered on the teaching of History and Government and Social Studies before the introduction of the new Social Studies syllabus in 2002. In the new syllabus, emerging issues like conflict and conflict resolution were addressed. One of the objectives of this topic was that the learner should be able to resolve disputes in and out of school (KIE, 2002). Memorization of facts will not lead to the achievement of this objective;
the teacher should select the Instructional Procedures that will enable the learner to internalize as well as retain and practice what has been learned. This study therefore sought to find out the instructional methods Social Studies teachers in Primary schools in Kenya used when teaching conflict and conflict resolution.

**Statement of the problem**

There was increasing criticism on the teaching of Social Studies in primary schools in Kenya especially with regard to the teaching methods. The teaching of Social Studies in Kenyan classrooms was found to be dominated by lecturing and giving notes. (African Social and Environmental Studies Programme ASESP, 1993).

One of the emerging issues in the Social Studies syllabus in the primary schools was conflict and conflict resolution. The objective of teaching this topic was to enable the learners to state the factors that cause disputes and demonstrate the ability and readiness to resolve their own disputes in and out of schools (KIE 2002) For this objective to be achieved, the teacher had to select the instructional methods that would enable the learner to internalize, retain, and apply what had been learnt. Only then could the learner productively implement what had been learnt in everyday life. This study sought answers to the following questions;

Which methods were commonly used in teaching of conflict and conflict resolution in Social Studies?

Which methods were recommended in the primary teachers Social Studies textbooks on the teaching of conflict and conflict resolution?

**Purpose and objective of the study**

The purpose of this study was to investigate the instructional methods used in the teaching of conflict and conflict resolution in Social Studies.

The specific objectives of the study were;

To establish the methods used in the teaching of conflict and conflict resolution in primary Social Studies.

To examine methods recommended in the primary Social Studies teachers textbooks on the teaching of conflict and conflict resolution.

**Methodology**

The research design was a descriptive survey. This kind of research was chosen because it answered questions concerning the current status of the teaching of conflict and conflict resolution in Social Studies at the primary school level with regard to instructional methods.

The study was carried out in Kosirai Division, which is part of Nandi North District, Rift Valley Province, Kenya. This study area was chosen because no other known study of this nature had been conducted in this area before. Kosirai division has forty five (45) primary
schools. The population consisted of primary Social Studies teachers in Kosirai Division. The teachers were distributed in primary schools in three educational zones in the division namely;

a) Mutwot zone with sixteen (16) schools.

b) Lelmokwo zone with fourteen (14) schools.

b) Kosirai zone with fifteen (15) schools.

The sample for the study was drawn from all the standard Seven Social Studies teachers in Kosirai Division. One teacher was picked from each of the 45 schools in the division. Purposive sampling was used to ensure that subjects were picked from class seven Social Studies teachers in Kosirai division since they are the ones who did the actual teaching of conflict and conflict resolution in class. Most of the schools in the division had one stream of standard seven thus the teacher was automatically picked. Therefore 45 teachers who taught social studies in class seven in primary schools in Kosirai division were used for the study.

Data collection Instruments

The instruments used for data collection in this study were questionnaire, document analysis and classroom observation checklist.

a) Questionnaire

A questionnaire was used by the researcher since it gave the respondent adequate time to give well thought answers and is effective when using a large sample (Kerlinger, 1983) The researcher developed a questionnaire which was used to get information from teachers of Social Studies in primary schools and sought to evaluate instructional methods used in the teaching of conflict and conflict resolution in Social Studies.

b) Document Analysis

Document analysis is the systematic examination of relevant documents in order to determine factors that explain a specific phenomena,(Mugenda and Mugenda, 1999).Textbooks, course outlines or school schedules may help researchers determine what is and what is not taught, the grade placement of particular materials and the amount of time devoted to them,(Dalen,1979). In this study, the primary Social Studies syllabus and the teachers guide textbooks for standard seven were analysed.The analysis of these documents assisted in establishing whether the teacher was adequately guided on the instructional methods to be used when teaching conflict and conflict resolution. The books analyzed were those approved by the Ministry of Education, Science and Technology to be used in primary schools in Kenya in 2006.The researcher designed a document analysis schedule which consisted of instructional methods for teaching conflict and conflict resolution. These were derived from the primary Social Studies syllabus. A record of the teaching methods for conflict and conflict resolution was indicated.

c) Classroom observation checklist
In this study the researcher made classroom observations of Social Studies teachers when teaching the topic “conflict and conflict resolution”. This verified the information given by the teachers through questionnaires. Classroom observation is important because of the reliability and range of information it provides (Nachmins and Nachmins, 1992). An observation checklist (appendix B) designed by the researcher was used to record methods used when teaching conflict and conflict resolution in the classroom. The checklist consisted of methods recommended by primary Social Studies syllabus which should be used when teaching conflict and conflict resolution. It enabled the researcher to quickly record different observations and to avoid overlooking relevant evidence as noted by Dalen (1979).

**Validity and Reliability of instruments.**

**a) Validity**

Validity is the extent to which a measuring instrument provides adequate coverage of the topic under study and measures what it is supposed to, Kothari (1992:91). Once developed, the questionnaire, the observation checklist and the document analysis schedule were seen by the staff of Moi University; Department of Curriculum, Instruction and Educational Media and the Department of History, Political Science and Public Administration, where corrections were made, suggestions and advice were used as a basis in modifying the research instruments and making them adequate to the study.

**b) Reliability of Instruments**

Since the topic Conflict and Conflict Resolution was taught during a specific period of the academic year and in class seven, the test retest technique could not be used as earlier planned. The researcher, after receiving the completed questionnaires, subjected them to Cronbuch coefficient alpha. The researcher found 0.80 coefficiency thus making the questionnaire reliable and fit for use in the actual study.

**Procedures for data collection**

Data was collected by means of questionnaire, document analysis and observation checklist developed by the researcher for class seven teachers of Social Studies in the primary schools. The observation checklist as a data collecting instrument was used to determine if the teachers used the methods they indicated in the questionnaires. Document analysis schedule was used in examining the textbooks approved by the Ministry of Education to be used in the instruction of Social Studies. Teachers’ guides and the primary Social Studies syllabus were examined to see whether teachers were guided on teaching methods for teaching conflict and conflict resolution.

**Results and discussion**

**a) Frequency of use of instructional methods in teaching conflict and conflict resolution.**

Table 3 Frequency of use of Instructional Methods in teaching conflict and conflict resolution in Social Studies.
Table 4.5 presents the frequency of use of instructional methods when teaching conflict and conflict resolution. From the study, 24 (60) of the respondents used class discussion method always while 12(30) used it very often and 4(10) used it often. This implies that the method was used by most of the teachers which indicates a change from rote learning as earlier indicated by ASESP in the teaching of Social Studies. Regarding problem solving, 8(20) used it always, 14(35) used it very often while 18(45) used it often. This indicates that learning was learner centered since the pupils participated yet past researches had shown that the teaching of Social Studies was all chalk and talk (ASESP, 1993). There seems to be a change in this. None of the respondents used project method always while a small proportion 6(15) and 10(25) used it very often and often respectively.20 (50) rarely used the method while 4(10) never used it. This may be explained by the fact that only 18(45) had been in-serviced while 22(55) had not as earlier shown in table 4.1. Further analysis revealed that 2(5) used role play always when teaching conflict and conflict resolution while 8(20) very often and 18(45) often. A smaller proportion 10(25) used it rarely while 2(5) never used it. As earlier mentioned in chapter two, role play is one of the most suitable method for teaching conflict and conflict resolution (Bhaskaran, 2003). Teachers should therefore be sensitized on how to

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<tr>
<td>Group work</td>
<td>8(20)</td>
<td>14(35)</td>
<td>18(45)</td>
<td>0(0)</td>
<td>0(0)</td>
<td>40(100)</td>
</tr>
<tr>
<td>Question and answer</td>
<td>30(75)</td>
<td>6(15)</td>
<td>2(5)</td>
<td>2(5)</td>
<td>0(0)</td>
<td>40(100)</td>
</tr>
<tr>
<td>Resource person</td>
<td>0(0)</td>
<td>0(0)</td>
<td>2(5)</td>
<td>36(90)</td>
<td>2(5)</td>
<td>40(100)</td>
</tr>
<tr>
<td>Story telling</td>
<td>0(0)</td>
<td>2(5)</td>
<td>26(65)</td>
<td>12(30)</td>
<td>0(0)</td>
<td>40(100)</td>
</tr>
<tr>
<td>Debate</td>
<td>4(10)</td>
<td>0(0)</td>
<td>16(40)</td>
<td>14(35)</td>
<td>6(15)</td>
<td>40(100)</td>
</tr>
<tr>
<td>Lecture</td>
<td>2(5)</td>
<td>0(0)</td>
<td>12(30)</td>
<td>8(20)</td>
<td>18(45)</td>
<td>40(100)</td>
</tr>
</tbody>
</table>

(Percentages in parentheses)
use this method so as to enable the learners to reflect on the topic. Regarding group work, 8(20) indicated that they used this method always while 14(35) very often, 18(45) often and none of them rarely or never, this implied that the method was favorable to all of them. From Table 4.4 majority of the respondents 30(75) used the question and answer method always while 6(15) and 2(5) used it very often and often respectively and 2(5) rarely used it. From the study, Resource persons were hardly used when teaching conflict and conflict resolution. 2(5) used them often, 36(90) used them rarely while 2(15) did not use them at all. With regard to story telling, a large proportion 26(65) used it often; 2(5) used it very often while 12(30) used it rarely. Debate was used by 4(10) always, 16(40) often and 14(35) rarely. None of them did not use it at all nor used it very often. Lecture method was used by 2(5) always, 12(30) used it often, 8(20) used it rarely while 18(45) never used it.

From the study a variety of methods were used but the teachers should venture further to methods such as resource persons, role play, storytelling and debate which are suitable for teaching conflict and conflict resolution. Bhaskaran(2003).

b) Instructional methods used when teaching conflict and conflict resolution as observed during the Social Studies lesson.

Table 4 Instructional methods used when teaching conflict and conflict resolution as observed during the Social Studies lesson

<table>
<thead>
<tr>
<th>Method</th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>6(100)</td>
<td>0(00)</td>
<td>6(100)</td>
</tr>
<tr>
<td>Discussion</td>
<td>2(33.3)</td>
<td>4(66.7)</td>
<td>6(100)</td>
</tr>
<tr>
<td>Problem Solving</td>
<td>1(16.6)</td>
<td>5(83.4)</td>
<td>6(100)</td>
</tr>
<tr>
<td>Project work</td>
<td>0(00)</td>
<td>6(100)</td>
<td>6(100)</td>
</tr>
<tr>
<td>Role play</td>
<td>1(16.6)</td>
<td>5(83.4)</td>
<td>6(100)</td>
</tr>
<tr>
<td>Question &amp; answer</td>
<td>6(100)</td>
<td>0(00)</td>
<td>6(100)</td>
</tr>
</tbody>
</table>
Table 4.6 presents the use of different methods by teachers of Social Studies when teaching conflict and conflict resolution. This was obtained through classroom observation where a checklist was used (appendix B) where each teacher was observed once. Six lessons were observed and the results were as follows; all the teachers 6(100) used lecture and question and answer methods during the lesson. This confirmed what the teachers indicated in the questionnaire as presented in Table 4.5. A large proportion had indicated that they used question and answer method. With the lecture method it was contrary in that all of them used it yet had stated that they did not. This may have been due to the fact that in actual teaching, several methods were used during the lesson where the lecture method was used shortly in the introduction which was appropriate.

The findings further revealed that none of the teachers used project work, resource persons and debate. A small proportion 2(33.3) used discussion against 4(66.7) who did not use it. Problem solving, role play and group work, were used by a minority 1(16.6) while 5(83.4) did not use them. Role play has been stressed in the teacher’s guides used in Social Studies and by educationists Bhaskaran (2003) as an appropriate method of teaching conflict and conflict resolution. Story telling was used by 2(33.3) while 4(66.7) did not use it.

c) Methods recommended in the Primary Social Studies teachers textbooks on the teaching of conflict and conflict resolution.

Table 5 Instructional methods recommended by primary Social Studies teachers guides (approved by the Ministry of education) on the teaching of conflict and conflict resolution in Social Studies.

<table>
<thead>
<tr>
<th>Method</th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>0(00)</td>
<td>6(100)</td>
<td>6(100)</td>
</tr>
</tbody>
</table>

(Percentages in parentheses)
The analysis of class seven Social Studies teacher’s guides approved by the Ministry of Education revealed that learner centered methods were recommended for the teaching of conflict and conflict resolution. A list of the approved books is found in appendix F. Table 4.9 shows that all the six books analyzed recommended the use of discussion and question and answer methods to teach conflict and conflict resolution. This may have been the reason as to why all the teachers used the question and answer method when teaching as earlier indicated.

<table>
<thead>
<tr>
<th>Method</th>
<th>1st Column</th>
<th>2nd Column</th>
<th>3rd Column</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discussion</td>
<td>6(100)</td>
<td>0(00)</td>
<td>6(100)</td>
</tr>
<tr>
<td>Problem solving</td>
<td>0(00)</td>
<td>6(100)</td>
<td>6(100)</td>
</tr>
<tr>
<td>Project work</td>
<td>2(33.3)</td>
<td>4(66.7)</td>
<td>6(100)</td>
</tr>
<tr>
<td>Role play</td>
<td>3(50)</td>
<td>3(50)</td>
<td>6(100)</td>
</tr>
<tr>
<td>Question &amp; answer</td>
<td>6(100)</td>
<td>0(00)</td>
<td>6(100)</td>
</tr>
<tr>
<td>Resource person</td>
<td>5(83.4)</td>
<td>1(16.6)</td>
<td>6(100)</td>
</tr>
<tr>
<td>Story telling</td>
<td>1(16.6)</td>
<td>5(83.4)</td>
<td>6(100)</td>
</tr>
<tr>
<td>Group work</td>
<td>2(33.3)</td>
<td>4(66.7)</td>
<td>6(100)</td>
</tr>
<tr>
<td>Debates</td>
<td>0(00)</td>
<td>6(100)</td>
<td>6(100)</td>
</tr>
</tbody>
</table>

(Percentages in parentheses)
in Table 4.6. None of the books recommended the use of lecture, problem solving and debate when teaching conflict and conflict resolution. Majority of the books 5(83.4) recommended the use of resource persons while 3(50) the use of role play. Story telling was recommended by 1(16.6) while 2(33.3) recommended the use of project and group work.

Findings

Instructional methods used when teaching conflict and conflict resolution in Social Studies.

When teaching conflict and conflict resolution, majority of the teachers used discussion and the question and answer methods. This implies that the method was used by most of the teachers which indicates a change from rote learning as earlier indicated by ASESP in the teaching of Social Studies. This indicates that learning was learner centered since the pupils participated yet past researches had shown that the teaching of Social Studies was all chalk and talk. (ASESP, 1993). There seems to be a change in this. They did not use resource persons, storytelling, project and role play when teaching the topic yet they were very effective methods. As earlier mentioned in chapter two, role play is one of the most suitable method for teaching conflict and conflict resolution (Bhaskaran, 2003). Teachers should therefore be sensitized on how to use this method so as to enable the learners to reflect on the topic. Lessons were observed and the results were as follows; all the teachers used lecture and question and answer methods during the lesson. This confirmed what the teachers indicated in the questionnaire as presented in Table 4.5. A large proportion had indicated that they used question and answer method. With the lecture method it was contrary in that all of them used it yet had stated that they did not. This may have been due to the fact that in actual teaching, several methods were used during the lesson where the lecture method was used shortly in the introduction which was appropriate. The findings further revealed that none of the teachers used project work, resource persons and debate.

Conclusion and recommendations.

Most of the teachers did not use the appropriate methods of teaching conflict and conflict resolution which are learner centered; they avoided methods they were not conversant with. This may be explained by the fact that most of them were not in- serviced on the teaching of conflict and conflict resolution.

From the findings and the conclusions, the following recommendations were made;

1. Teachers should be in serviced on the teaching of conflict and conflict resolution so as to adequately prepare them to handle the topic.

2. The methods to be used when teaching the topic conflict and conflict resolution should be clearly indicated in the teachers’ textbooks and the syllabus too.

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Abstract

This paper makes the claim that technology is a key agent for any cultural transformation. Looking back into history it is possible to see the part played by technology in shaping cultures. Kenya has recognized this and has rolled out a plan for technological development called the vision 2030. Science and technology as any human endeavor relies on language for communication. Science has its own language- English, which poses challenges for Kenyans as it is not only a foreign language but also a technological discourse. The paper examines technological trends and technological discourse which has developed over the last century and points out challenges that are posed to the envisioned technological transformation in Kenya. The paper uses a sociolinguistic-semantic study which employed an ethnographic methods to examine how ordinary Kenyans handle the challenges occasioned by this discourse in simple functions such as using the mobile phone. The study examines different terminologies and concepts translated by lay people as a way of dealing with linguistic challenges. The study shows that ordinary folks’ conceptualization and adaptation of scientific concepts is patterned on cultural concepts which are based on Mother tongue and proposes a revisit to the debates on the languages to use for education and science. Mother tongues are key to people’s understanding of issues. Therefore as a way forward, this paper puts in a case for modification and use of MT in education and in sciences. Mother tongues are used widely in rural Kenya and can amplify positive effects and reduce negative impacts of trends in Kenya’s technological development and economy occasioned by the use of a foreign language.

Introduction

‘For me, I have concluded that technology is a major agent of social change, contributing significantly to the creation of all of the other "tsunamis" (demographics, global environmental change, political-economic instabilities, cultural transformation, etc.) upon which we all must "surf" (or drown). While it is too long a story for me to fully explicate here, my understanding is captured best by the aphorism of Marshall McLuhan: We shape our tools and thereafter our tools shape us’ (Jim Dator 1998:1).

The tone of this paper is in agreement with the arguments outlined in the words of Jim Dator (1998) found in the quote above. Technology has been an agent of most cultural transformations in the world. The paper examines present trends of science and technologies and more so in relation to the challenge of using English the language of science for the Kenyan vision 2030.

Language is key in all human endeavors. Only human beings in all God’s creation can use language. Language is used to learn, to develop communication capabilities and for thought processes. Science as most human endeavor relies on language for communication. Over the years Science has developed its own form of language. In the world today for one to practice science s/he must know the language of science- English. The challenge for Kenya is that
many people do not know the language of science to meaningfully participate in the envisioned technological development. The language of science poses challenges for the initiatives being undertaken in the vision 2030. It is with this background that a small study was carried out to investigate how ordinary wananchi deal with this linguistic challenge as they use the mobile phone. The study unearthed mwanaanchi’s efforts of translating and adapting terminologies and concepts when using the mobile phone and recommends more research to be done to examine and develop MTs as a way of getting more citizens involved in technological and cultural transformation.

This paper starts by defining the following terms as used in the paper: Science and technology, cultural transformation, language of science (or science discourse) and mother tongue/African languages. Next, the paper will discuss the said study carried out among Taita languages speakers in Taita- Taveta county.

Definition of terms

Science and Technology

The term technology is used here to mean the use of tools, machines, materials, techniques, and sources of power to make work easier and more productive. Technology can be understood as man’s ingenuity to create for himself or extend himself in form of tools. For example, while human beings can walk, cars give them extra powerful ‘legs’ with more speed. The Aero plane gives them wings to fly, which they do not have naturally. The computer for human beings today has become a great ‘extra brain’ to help them calculate and store information among many other functions. Technology deals with making things happen. The term science on the other hand is used here to refer to the concerns with how and why things happen.

Mother tongue

Mother Tongue also called first language refers to a language in which the child first meets the world, forms concepts, learns to expand and deepen thinking, feels and imagines (Neville 2011). Such a language is normally learnt at home before any other. Usually, unlike what has been said for most children in Kenya such a language is an African language. Ideally, such a language(s) should be the first the child comes in contact with in school and does all creative works

Importance of MTs

UNESCO (1953) recognized the importance of MTs as the most important factor in the learning process. ADEA 2004 also indicated that MTs are most important for quality education and knowledge creation. MTs develop as they are used.

African language:
An African language is any language that is a mother Tongue to an established group of citizens in an African state. It is indigenous. The European languages are not part of this definition, except for creoles which are based on them.

**Cultural transformation**

The term cultural transformation in most literature is used to refer to transformations in areas such as, work, business, health, religion and the military. Here, I use the term to refer to general cultural or societal change, evolution or growth.

Johnson and Earle (1987:16), argue that ‘the primary motor for cultural evolution is population growth’. They say further that the shift from mobility (hunting and gathering) to settlement (husbanding and cultivating) as the primary mode of subsisting is born of such evolution. The changeover from mobility to settlement further brought about significant changes in the course of human history such as the technological revolution of the Iron Age and the scientific revolution. These cultural changes were not universal. For some reason, it is the populations that settled down (may be with more population growth) which evolved from agrarian to technological, scientific and to the present industrial stages.

The role of technology, how it has aided cultural transformations in different Societies and progress over the years can be summed up as in table 1. Technology helped humanity to gain control over nature and so build a civilized world. Communities that did not develop certain forms of technology did not surmount problems in their environments. In most African countries, technology has not been adequately used to deal with the various socio-economic, political and environmental problems faced.

**Table 1: Technology and cultural transformation in the world over the years.**

<table>
<thead>
<tr>
<th>Period in human history</th>
<th>Mode</th>
<th>Technology</th>
<th>Economy</th>
<th>Cultural practices and outlook</th>
<th>Political ideologies</th>
<th>Percentages of human population in the mode today</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earliest</td>
<td>Agricultural</td>
<td>Simple tools i.e. the hoe and use of body muscle</td>
<td>Plots, Soil, communal land ownership</td>
<td>Traditional values i.e. of the tribe, blood relations</td>
<td>Tribal /clan boundaries, fiefdoms</td>
<td>75%</td>
</tr>
<tr>
<td>Modern</td>
<td>Industrial</td>
<td>Mechanical, engines i.e. cars and tractors</td>
<td>Machine and oil, ownership paper title deeds</td>
<td>Modern, i.e. of the nation-patriotism</td>
<td>National, boundaries, state control and policing</td>
<td>20%</td>
</tr>
<tr>
<td>Present &amp; Digital</td>
<td>Digital</td>
<td>Digital, i.e. the use of Terminal, mind. In use</td>
<td>Post modern, no absolute</td>
<td>Global, no boundaries,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Future</td>
<td>computer, wireless, ICTs</td>
<td>ATMs, Credit economy, ideas</td>
<td>truths, cognizance of diversities</td>
<td>more democracy, transparenc, critical tolerance of others</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>---------------------------</td>
<td>-----------------------------</td>
<td>----------------------------------</td>
<td>--------------------------------------------------------</td>
<td>----</td>
<td></td>
</tr>
</tbody>
</table>

Table 1 shows the modes and forms of technologies from the earliest times to the present and how they connect with the economy, the political ideologies and the values of a given society. Humanity first relied on the soil. In such agrarian economies, land was and for some societies still is, communal and needs the use of muscle and basic tools. In most African countries the idea of communal land and mobile populations is still very prevalent. Some African Governments such as Kenya give title deeds to individuals for parcels of land. In other modern societies, which are thought to be industrialized, technology has moved to reliance on machines, and oil. In such states, politics have moved from tribal affairs to National politics. The post modern societies are those who have moved to the new forms of technology which are not bound by boundaries. They are digital. According to Miki Gal (2005) only 5% of the world’s populations belong to the digital mode, while 20% belong to the modern and 75% to the Agricultural/traditional mode. African communities tend to lie on the later. It should be noted that, boundaries between these modes of cultural transformations can be fuzzy. The boundary between mechanical and digital stage are unclear for many nations and this is good because it means any nation can progress without being bound by its present economic, technological or political stage.

A lot of present cultural transformations are related directly to the growth of information technology. Presently, cultural transformations are becoming faster and faster. It took the human race thousands of years to move from gathering fruits and picking roots and seeds to settling down, cultivating the land and becoming farmers. Agrarian transformation has lasted thousands of years. The industrial transformation lasted hundreds of years and in its last phase: the transfer from heavy mechanical industry to hi tech technology based on information has lasted about 50 years. In the transportation industry it has taken more than a hundred years to go from steam engine driven coach to more or less what we have today. Presently, the computer industry technologic generation is being measured in few years and sometimes in months.

**Present Trends: Information and Communication Technologies**

The world is witnessing today more than just a cultural transformation brought about by technological transformation, it is also an ideological transformation which touches on how and what people think. Dr. Uzi Melamed (in Miki Gal 2005 also Miki Gal-video ltd 2005) points out that presently humanity is grappling with at least three major revolutions all rolled up in one; a multi-revolution. These are; the post modern, the post industrial and the digital. The Post modern revolution relates ideologically to the death of absolute truth, universality
and scientific decisiveness. It focuses on subjective reasoning, interpretations and perspectives. In post industrial revolution knowledge is the main production factor/asset. Economy of ideas replaces the economy of capital, so that companies can sell ideas and not necessarily tangible goods. The digital revolution is multi-faceted, it draws on the characteristics of several revolutions: the industrial revolution, the print revolution of Gutenberg, the communication revolution and some political revolutions as well.

Digital revolution gives the opportunity for Kenya to leapfrog and catch up technologically with the rest of humanity. As Higgins (1995) says, it is now a question of ‘innovate or evaporate’.

**Language and Technology**

Cultural transformation brings about an ideological transformation which touches on how and what people think. There is no room here to unpack the notions of language and thought and how cultural changes are construed in language (Lucy 1985), suffice it only to say, Language is part and parcel of cultural change and general human history. Human experience is construed; analyzed, interpreted and translated through language as societies evolve. Such construal is not only a necessary condition for their evolution—it is also an integral part of it. English language is the Language of science accompanying the above mentioned evolutions. English language shapes our world view and is today the dominant mode for interpreting human existence.

**English the Language of Technology**

Fast-paced changes brought by technological developments and which have enhanced globalization and the new economic order, place a premium on the ability to communicate in a lingua franca. English language has claimed this niche, becoming the language of the world and technology. According to information gathered by Crystal (1997), 85% of international organizations in the world make official use of English and some 90% of published academic articles are written in English. Many transnational firms use English for international communication and national communication. English is posing itself in information technology as the medium of the latest revolution; the human communication and cognition. The present imperatives are that English is shared among many groups of non-native speakers rather than dominated by the British or Americans. What is becoming obvious is the emphasis on communicative approach on functional interaction rather than achieving native-like perfection. Increasingly numbers of people around the world, for example, Nigeria, Philippines, Malasia, and Singapore are turning to English for international communication, but they emphasis their own local varieties of English. This communicative English spoken with all types of mother tongue interference is not the language of science as I will show shortly. In fact most of these nations are using the said brand of English for sales only. For innovation and creation they use mother tongue.

**Language of science**
The language of science is Technical English, a specialised discourse used in specific social situations- it is a linguistic semiotic practice developed in order to do specialised kinds of theoretical and practical work. It is the language of literacy and does not follow folk wisdom. Science discourse has its own methods of inquiry and imagery. It is special because of its content, its written and spoken genres, its structures and style. For example science language uses impersonal passive voice. People disappear as actors and agents. Colloquial language, personifications, figurative language, irony, humour and exaggeration are avoided (Kitetu 1998). Science language ends up becoming ‘a mystique’– it sets up a pervasive and false opposition between the world of science – objective, authoritative, impersonal and the ordinary world of human uncertainties, judgements, values and interests (Lemke 1990)

Lemke argues that,

‘ it is not surprising that those who succeed in science tend to be like those who define the ‘appropriate’ way to talk science: male rather than female, white rather than black, middle- upper class native English speakers committed to the values of North Europe middle class culture (emotional control, orderliness, rationalism, achievements, punctuality, social hierarchy, etc)”

Given the above scenario, the question is whether in fact English is the right language to use solely to teach science to Kenyan children?

**Linguistic challenges for technological development in Kenya**

Challenges to technological advancement in Africa include such factors as, education (there are many illiterate people), poverty (most cannot afford the costs of technological training and tools), conflicts (wars and refugee problem), gender issues (specifically the marginalization of women in all spheres of life practically and ideologically) but more important language.

English the language of technology is foreign to nearly all people in Africa. In Kenya the estimates of the number of English-speakers vary wildly. The lowest estimate, admitted as conservative is 714,000, (i.e. four percent of the country's population) in 1985. The Cambridge Encyclopedia of the English Language estimates English-speakers in Kenya to constitute 9 percent of the population of 25 million, (that is 2.24 million people) while the BBC World Service estimates 3.4 million adult English speakers. ([http://www.cis.org/articles/1996/back 496.html](http://www.cis.org/articles/1996/back 496.html)).

These statistics do not show the proficiency levels of the speakers. People know English with diverse proficiencies. The majority of Kenyan school drop outs do not have a good grasp of English which is the language of education, but more importantly the language used in technological research is too technical and foreign to most folks in Kenya even those who have a working knowledge of English as a foreign language. There is therefore a real danger of leaving out a whole bulk of citizens from the envisioned industrialisation and science discourse. It is no wonder that sciences subjects are termed as hard. The ideal situation would be to use Mother Tongue (here after MT) the language most known to children when they
get to school and the language they think with and is good for cognitive development. This does not happen.

As a result of this grave picture in as far as technology is concerned in Africa, two false prophecies have emerged; these are techno-infatuation and techno-cynicism (Mark Warschauer 2000). The first argues that computers are the panacea of all troubles in Africa. The later argue we should not bother with digital technology but concentrate on more immediate concern for example, look into education and poverty alleviation. Both are wrong, because computers may not be the panacea of all troubles in Africa, but neither are computers benign optional tools to ignore.

Additionally, both techno-infatuation and techno-cynicism stem from the same problem: down playing the significance of human agency in shaping the use of technology. People seem to have realized that they do not always need to use or own the fastest and most powerful computer for their everyday tasks, so, they invest instead in cellular phones, and communicate by SMS (short message system). Where internet communication is required there are several private cyber cafes where one can pay a fee to browse. But more important is how they manipulate language which leads us to the study.

The study

The Taita speech community

The first language speakers used in this study belong to the Taita group also called ‘Dawida’ and ‘Teita’. They are part of the Bantu group called Watani. The watani languages are some of Africa’s forgotten languages due to the small number of speakers. The Taita speakers are estimated to number approximately 312,000 (Ethnologue encyclopedia). Modern day speakers of Taita language are getting fewer and fewer as more and more are opting to speak Swahili Kenya’s national language instead of their Mother Tongue. However, the few that still speak are creating lexicon related to ICT in very creative ways.

The mobile phone phenomena in Kenya:

“How did we survive before without mobile phones?”

(Mr. Mwatika Mganga interviewee- March 2011)

Statistics show that in Kenya there were over 11.5 million mobile by 2008 and by 2009 the registered mobile users reached 17.6 million (Adero 2009). From the look of things it is as if Kenyans never lived without mobile phones. The ICT revolution has taken the country by storm. Mobile phone use is no longer a preserve of the educated and the rich. The mobile phone is not only used for communication but also for banking! It is in this scenario that ordinary folks are finding ways of naming the different parts and function of this gadget in their MT. The whole scenario causes one to rethink the wisdom of intellectuals in inhibiting the use of mother tongue in education by citing lack of linguistic resources and personnel.

Study design
This was a sociolinguistic-semantic study on languages in contact – Taita and English languages

**General objective**

One general concern was to find out how MT users handle languages in contact - specifically when using the mobile phone. Secondly, there was need to gauge whether the adaptations can be used in education and technological innovation.

**Specific objectives**

The Examination of the Taita coinage and borrowing and translation of ICT terminologies was guided by the following specific objectives:

To understand how taita MT handled intercultural contact and communication when using the mobile phone

To establish how widely the adaptations are used in the Taita speech community;

To show if the adaptations can be used for teaching and publishing of materials for education purposes and for innovations

**Data Collection**

Data used was elicited through interviews and observation/listening (and note taking) with Taita native speakers. The participants were ten - four men and six women aged between thirty and eighty years. Rather than tape record naturally-occurring discourse and later doing lengthy transcriptions, (this may not have been productive as regards the naming conventions looked for), questions were asked directly for names and referents and their meanings as related to the use of the mobile phone. Questions included the following:

What is the name of this gadget (mobile phone)

What do you call the act of charging the phone in Taita

What is a battery called in Taita?

What do you call the act of using the short service message?

The participants were talked and listened to and observed as they conversed with the eighty years old man Mr. Mwatika Mganga (a retired civil servant) at his house home for seven separate days. Normally they come to his home to help in various activities for example to run errands for him but importantly charge their phones. His home was the only one with electricity in this rural setting. The key issues were noted on paper.

**Data**

The data comprised a long list of terms and concepts translated or adopted into Taita language
Discussion

How do ordinary folks deal with new scientific and technological concepts?

In dealing with new scientific terms and concepts the ordinary folks mainly did translations and borrowings. However, these folks hardly knew why, when and by who an item was given its name. From the lay persons view the question of what motivates the translations is a hard one. To understand what motivated their adaptations of the terms in use we needed to draw on the understanding of languages in contact and natural language growth. One of the known results of intercultural contact and communication is the process of loaning that takes place. According to Hockett 1958, the speakers of a language have various options when confronted with a new item and ideas in another language. First is the adaptation of an item or idea. The borrowed word adopts the plural and possessive form from the receiving language. Verbs and adjectives receive native morphemes. Secondly, the loaning could take the form of loan shift where a native word is adopted to new meaning. Thirdly, there can be a loan transfer. The native language uses item- for -item native version of the original loanword as will be shown below. Fourthly, loaning could take the form of loan blend where one element is loan while the other is native as in the case of priest + hood in English. Hockett’s elaboration is used here to analyse the terms collected.

Adaptation

Hockett 1958 mentions the first option when languages are in contact is to adapt an item or idea from the SL. The item being borrowed adopts the plural and possessive forms from the TL. Verbs and adjectives receive native morphemes. There are several such examples in the Taita language as in example 1 and 2.

Example 1:

To have ‘the phone charged’ by someone else is *ku*chajilwa simu. *Ku* is the morpheme for the act of doing, while *lwa* is the morpheme for ‘done on behalf of someone else’.

Example 2:

The term ‘send email’ in Taita becomes ‘*kuduma imeili*’

This is a case of adopting the idea and term of sending a message electronically.

Loan shift

Hockett 1958 shows that Loaning could take the form of loan shift where a native word is adopted to new meaning. This is seen in the Taita language as shown in example 3.

Example 3:

‘Simu ndeine mode’‘Modo’ is a cultural idea which refers to anything that gives energy. The actual meaning of *modo*’ is ‘fire.’ Here it is used to refer to energising the phone.
Loan transfer

Thirdly, there can be a loan transfer. Hockett explains that this is where the native language uses item-for-item native version of the original loanword as in example 4 from the Taita language

Example 4:

Battery becomes betri

SMS is literally borrowed and pronounced as ‘esemwesi’.

Loan Blend

Hockett also talks of loaning taking the form of a loan blend where one element is a loan while the other is native

Example 5:

In the term ‘M-pesa’ ‘M’ stands for mobile and is borrowed whole while pesa stands for money and is blended with the ‘M’ to form M-pesa. Kenyan English and Swahili also use

The term as M-pesa. Taita language has borrowed the loan blend as it is.

Can the adaptations can be used for teaching and publishing of materials for education purposes and for innovations

To answer this question one needs to examine and differentiate languages of science and Taita adaptation by ordinary folks as in the following table.

Characteristics of the language of science and Taita language adaptations

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Language of science</th>
<th>Taita translations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain of use</td>
<td>theoretical and practical work</td>
<td>Home/informal situations</td>
</tr>
<tr>
<td>Argumentation</td>
<td>language of literacy</td>
<td>folk wisdom</td>
</tr>
<tr>
<td>Methods</td>
<td>inquiry and imagery</td>
<td>Functional interaction</td>
</tr>
<tr>
<td>Language use: Content</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Written form</td>
<td>Abstract</td>
<td>Colloquial language, personifications, figurative language, irony, humour and exaggeration</td>
</tr>
<tr>
<td>Spoken form</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subjects/Agents</td>
<td>None</td>
<td>actors and agents.</td>
</tr>
<tr>
<td>Subjectivity/objectivity</td>
<td>Objective/impersonal/Authoritative</td>
<td>Subjective/personal</td>
</tr>
</tbody>
</table>
According the differences noted above between the language of science and the language of ordinary folks even when they make translations is that they stand for different values. The language of science is thorough and objective. The language of lay is interposed when *Formal equivalents or metaphorical* apply as in the following example 6 where text is rendered literally or "word for word", Also in example 7 where *Dynamic equivalence or paraphrase* sometimes also called *functional* equivalence applies. The essential *thought* expressed in a SL is conveyed without regard of literality or original sememe, word order, the active/ passive *voice* and other elements of the grammar, but even more without the actual scientific import.

**Example 6:**

Phone has no credit – *simu ndeine kirediti*

SMS (short message service) - *esemwesi*

M-pesa - *M-pesa*

Screen- *skirini*

**Example 7:**

*Simu ndeine modo.*

There is reason to believe that these terminologies could be used in science education and they are a step forward as they help in communication based on functional interaction rather than achieving native-like perfection, yet, this is where the challenge is. The folk translations do not unpack the science behind the mobile phone and they need quite some work to capture the science behind the terms. Ordinary Folks cannot create science and technology with a foreign tongue for obvious reasons. MT is the language for innovation and cognitive development.

**Suggestions for Way forward**

Kenya is clear regarding the issues of technological development- that industrialization is long overdue. What has raised debates is the language best suited to be the vehicle of the envisioned industrialization. Since independence MTs have been relegated to the back while English language has been the language of choice in official domains. Internationally, Fast-paced changes brought by technological developments and the new economic order, place a premium on the ability to communicate in a lingua franca. English language has claimed this niche, becoming the language of the world and technology. In Kenya only a small percentage of the population are fluent in English much less the technological English. More evidence
coming from research shows that MTs are beneficial for cognitive development and generally an individual’s creativity. There is therefore the need to deal once and for all with the contentious issue and debates regarding the use of African languages in education and the said inability of these languages to modernize themselves, to develop or be developed. There is need to reconsider the thinking that they are inferior to the ex-colonial languages and that they are not equipped to serve as medium of instruction at tertiary level or serve as vehicles of science and technology. There is evidence from rural folks and users of these languages that African languages can be developed to meet the demands of technology as shown by ordinary folks in the study cited above. However, for these languages to be used in science and technology trained linguists must take an active role in unpacking the science behind the terminologies. More research needs to be undertaken to bring at per these adaptations to the language of science.

The call here is not to get rid of English language per se but the idea is to get rid of monolingualism whether presented in English or mother tongue.

**Conclusion**

Linguistic challenges abound as far as making African languages capable of handling Science and technology. Our study showed that Taita grass root users of mobile phones create, translate and borrow terminology from English and use these to communicate. These findings are a small window into what is possible to do to these languages to prepare them for science and technology. The only concern though is that this creation of terminologies by ‘grass root expert’ does not reflect the language of science. This study has shown that grass root experts borrow lexicon in the natural way in which languages grow. While the translations by these rural folks are also patterned on cultural concepts which make the terms to be easily understood by all they do not meet the demands of science of objectivity. Lay people’s translations are an important only as a first step towards availing citizens with a language with which to make scientific and technological innovations.

**References**


*Language is used to communicate the simplest to the most complex thoughts. Language is used to learn, to develop skills and to develop thinking capacity.*

**EFFECTS OF LEVEL OF EDUCATION ON PERCEPTIONS OF ALTERNATIVE RITE OF PASSAGE OF THE MARAKWET OF KENYA**

**G. J. KIPTIONY, M. W. KARIUKI & N. KATHURI**

**Abstract**

The Alternative Rite of Passage (ARP) is an intervention programme sponsored by NGOs as an alternative to female circumcision (FGM). ARP mimics the traditional rites aspect by putting the initiates in seclusion and counselling them while avoiding the physical operation of the genitals. There is a gap in the analysis of the Marakwets’ perception of ARP and their level of awareness of effects of FGM as it has not been empirically investigated. The aim of this study was to determine whether level of education influenced perceptions of ARP. This study focused on the Marakwet people of Kenya who have interacted with ARP from the year 2000. The study employed the *ex post facto research* design. Two purposively chosen locations were used in the study. A sample of 415 males and females from different age brackets were identified through quota sampling. Quantitative data was collected through a questionnaire while qualitative data was collected through interviews conducted among Marakwet Elders and ARP Graduates. Validity and reliability of the instruments, in a pilot study, were established through expert opinion and Cronbach reliability test, respectively. The data obtained was analysed by use of descriptive and inferential statistics using the SAS System. The analysis of variance tests were done at 0.05 alpha level of significance. The content analysis for the qualitative data was done by identifying the key points. The results showed that differences in level of education influenced perceptions of ARP. However, Qualitative data on experiences of ARP Graduates indicated that the mechanisms that ensure women undergo FGM are still firmly rooted in the culture. This study is significant in that the outcome will guide the expansion of existing approaches to FGM eradication. One of the recommendations is that ARP proponents should ensure that ARP Graduates are given enough support to sustain their resistance to FGM pressure and that the community should not hold onto myths about un-circumcision.

**Background of the Study**

Female Circumcision, the partial or total cutting away of the female genitalia, has been practiced for centuries in parts of Africa as one element of a rite of passage. This practice has been cherished since time immemorial as a period of acquisition of knowledge, which is otherwise not accessible to those who have not been initiated (Mbiti, 1969; Orchardson, 1961; Kenyatta, 1938). Female circumcision defines reproduction, sexuality, adulthood, womanhood, power, religion, and diverse kinds of identity (Kratz, 1994). However, under the conditions in which most procedures take place, female circumcision constitutes a health hazard with short and long term physical complications as well as
psychological effects (WHO, 1996). From the perspective of public health, female circumcision is much more damaging than male circumcision. The mildest form, clitoridectomy, is anatomically equivalent to amputation of the penis (Toubia, 1994). Most circumcisions are still being carried out among a populace without anaesthesia or antibiotics, with rudimentary, unsterile instruments such as razors, scissors or kitchen knives (Lightfoot-Klein, 1991). The term Female Genital Mutilation (FGM) has been adopted by human rights activists to clearly indicate the harm caused by the practice (Rahman & Toubia, 2000).

Bringing an end to this practice is described by WHO (1999) as a long and arduous process, requiring long term commitment and establishment of a foundation that will support successful and sustainable behaviour change. It is clear that the people who practice FGM share a similar “mental map” that presents compelling reasons why the clitoris and other external genitalia should be removed (Mohamud, 1997). Historically, efforts at ending FGM go back to the late 1800’s. Africa Inland Mission (AIM) began work in Kenya in 1895 and by the year 1914, the Mission was offering systematic teaching on the effects of female circumcision to all patients who came to Kijabe Hospital. As a result, female circumcision became the centre of controversy in Kikuyu areas in the 1920’s and 30’s (Kibor, 1998).

One of the oldest and most widely used anti-FGM strategy to date is the “health risk” or harmful traditional practice approach but little evidence exist to show that it has reduced the incidence of FGM, instead, it has led to the medicalization of FGM (Population Council, 2002). In addition, this approach does not address the core values, the myths, or the enforcement of mechanisms that support the practice (WHO, 1999). In the 1990s, with population based surveys and large studies on the types of FGM practiced, there came a clear shift from a focus on medical consequences to one on human rights. Amnesty International (1998) observed that eradicating the practice must be presented as a question not of eliminating rites of passage, but of redefining or replacing those rites in a way that promotes positive traditional values while removing the danger of physical and psychological harm. Intervention strategies that led to the creation of a cultural vacuum were avoided and alternative rites of passage for young girls were encouraged (WHO, 1996).

Programme for Appropriate Health Technologies (PATH) introduced the concept of an Alternative Rite of Passage (ARP) in Kenya in 1996. Maendeleo Ya Wanawake Organization (MYWO), a Kenyan national women’s body with the objective of improving the living standards of families and communities, worked with PATH to develop and introduce the first Alternative Rite of Passage in Tharaka Nithi in Meru in August 1996, with 29 girls participating. It was called “Ntanira Na Mugambo” in the Meru language which means “Excision by Words.” The initiates go through one week of intensive instruction through guidance and counselling on various issues but do not undergo the mutilating FGM operation. They also obtain all the information and privileges associated with the traditional coming of age ceremonies which includes dancing, feasting and gift giving. Moreover, they are presented with graduation certificates (WHO, 1999).

However, FGM is one of those cultural elements which exhibit enormous resistance to change (Chebet & Dietz, 2000). In spite of over 60 years of FGM discouragement, female
circumcision is still going on in Marakwet District (Kibor, 1998). Since the year 2000, World Vision-Kenya has sponsored ARP for Marakwet girls, but over 300 underage girls including secondary school students were forcibly circumcised in Marakwet District in December 2004. Some of them had graduated from ARP (“Rite: Parents Defy,” 2004). In 2003, 23 ARP graduates were forcibly circumcised by their parents (“Twenty three Girls,” 2003). It is against this background that this study is undertaken to evaluate the effectiveness of ARP by examining the perception of ARP and the factors affecting it among a people who cherish female circumcision: the Marakwet of Kenya.

**Statement of the Problem**

Girls were being forcibly circumcised while others had ran away from home to live in rescue centres to avoid circumcision in Marakwet. Chebet (2005) observes that the current ARP is viewed as alien and does not reflect the culture of the communities concerned, hence, lack of adaptability and sustainability. Such reports on ARP need to be verified empirically in order to ascertain its effectiveness. An investigation of the role played by level of education in shaping perception of ARP in Marakwet was necessary. Moreover, there was a gap in the analysis of the Marakwet’s perception of ARP and the influence of level of education as it had not been empirically investigated.

**Purpose of the Study**

The purpose of this study was to investigate the perceptions of the Marakwet of Kenya on ARP and the role played by level of education in influencing their perceptions. How ARP is perceived as a replacement of FGM in its roles as a rite of passage, training and sexual control method were examined.

**Objectives of the Study**

The study attempted to achieve the following objectives:

To determine the influence of level of education of the Marakwet of Kenya on their perception of ARP as a rite of passage.

To determine the influence of level of education of the Marakwet of Kenya on their perceptions of ARP as a training method.

To determine the influence of level of education of the Marakwet of Kenya on their perceptions of ARP as a sex control method.

**Research Question**

The following research question was investigated:

Does level of education of the Marakwet significantly influence their perceptions of ARP in its role as a rite of passage, training method and sex control method?

Hypotheses
The following research hypotheses was tested.

Ho$_1$ The level of education of the Marakwet of Kenya does not significantly influence their perception of ARP as a rite of passage.

Ho$_2$ The level of education of the Marakwet of Kenya does not significantly influence their perception of ARP as a training method.

Ho$_3$ The level of education of the Marakwet of Kenya does not significantly influence their perception of ARP as a sex control method.

Significance of the Study
The recommendations from the results of this study will give suggestions regarding the eradication of FGM in Marakwet.

Types of FGM
The term Female Genital Mutilation is used to refer to the removal of all or part of the female genitalia. It consists of excision, clitoridectomy, infibulation, and other unclassified variations. Kibor (1998) found that the older Marakwet women went through the most severe form of FGM; the clitoris, labia majora and labia minora were cut and the women held their legs tightly together for many days before the wound healed. The middle aged and the younger women lost the clitoris and most of the labium (clitoridectomy).

Health Consequences of FGM
WHO (1996) lists immediate complications as haemorrhage, shock, infection, urine retention, and injury to adjacent tissues. Long term effects are bleeding, recurrent urinary tract infections, incontinence, chronic pelvic infections, infertility, vulval abscesses, fistulae, sexual dysfunction, difficulties in menstruation, problems in pregnancy and childbirth, and the risk of HIV transmission.

In infibulation, part or all of the labia majora may be removed and the two sides fastened together with catgut, thorns, or a paste of gum arabic, sugar and egg. Where the two sides are not fastened together, the same effect can be achieved by tying the girl’s legs together until the two sides have adhered to each other in the healing process. When these wounds finally heal, the introitus of the vagina is almost completely blocked. A very small opening is maintained by inserting a small piece of wood or bamboo (Nyangweso, 2002). Interestingly, the Marakwet do not associate such suffering with FGM. The effects are attributed to unconfessed sins such as adultery, lack of respect for elders and parents, stealing or a host of other problems (Kibor, 1998).

Roles of Circumcision:

Rite of Passage
circumcision transforms the Marakwet girl into a woman, eligible for marriage. The terminology which the Marakwets use reflects this process. A young girl is chepto (girl), then she becomes chemeryan (girl during initiation period) and then Murar or cheros (marriageable girl). A mark that distinguished Marakwet women from “children” (the uncircumcised) was siman (a special earring). All circumcised women from the oldest to the youngest wore this earring (Kibor, 1998). Indeed, it is not birth, but initiation that makes a man or a woman a Marakwet (Kipkorir & Welbourn, 1973).

**Training during Seclusion Period**

Kibor, (1998) notes that in Marakwet initiation, much of the teaching in Kapkore (seclusion house) is about the power of female equality, the difficulties of being a wife, the strength of women as a group and the respect that is owed to older women. Most of the instructions were not formalized, with the exception of dances, songs and ritualized sign systems. The initiates were taught midwifery, (but not allowed to deliver the child of a “child,” if they did so, they had to circumcise her or let the child be aborted). They learnt to gather wild vegetables, collect firewood, carry water, prepare food and feed their families. This training lasted for about three months. Many young men chose circumcised women because they had been taught that such women would be loyal to their husbands. It is considered a failure and a great shame especially to the tutors if a woman was found to be ignorant of her marital duties after initiation. Such a neophyte was promptly returned to her parents for training.

**Women’s Sexual Control**

Circumcision, and specifically infibulation, is believed to reduce the sexual drive, and to protect women not only from aggressive males but also from their own sexuality. It is believed in Marakwet that extramarital affairs are the result of uncircumcision. In Marakwet, female circumcision is an essential genital alteration to reduce female aggressiveness in sexual relations. The smaller the vaginal opening, the bigger the gift the husband gave to his new bride. The majority of Marakwet men support female circumcision. They want their daughters or wives circumcised for fear of losing face and for their own pleasure. However, in spite of circumcision, promiscuity has risen greatly in the Marakwet society in recent years (Kibor, 1998). In support of this finding, a study in Nigeria found that FGM neither lowers sexual feelings nor reduces the level of promiscuity among women (Kyuli & Akoko, 2003).

Including an isolated message about the fact that FGM reduces sexual enjoyment is not likely to change people’s practice. In fact, many people, men and women alike, want to reduce
women’s sexuality, something of which they are uncertain and afraid. Supporters of the practice still hold the beliefs that an unexcised woman will “run wild”, “rape men”, or “be unfaithful to her husband” (Yoder, P.S., Abderrahim, N. & ZhuZhuni, A. (2004). In a survey of 55 health care providers in Kenya, the notion that “FGM reduces a woman’s libido” was given as a reason for supporting the practice as well as a reason to stop the practice (Abwao, Mohamud & Omwenga, 1996).

Theoretical Framework

Albert Bandura’s Social Learning Theory states that social behaviour is learnt mainly through observation and the mental processing of information. This is a process in which an individual learns a behaviour by observing others (models) perform it.

Methodology

This study employed ex post facto research design. The location of Study was Marakwet District in the Rift Valley Province of Kenya. Two divisions were purposively chosen for the study, namely; Kapsowar Division, and Tirap Division. This district was chosen because of the high prevalence of FGM and ARP programmes. The target population of this study was the Marakwet people of Kenya in Marakwet District. Quota sampling was used in selecting participants. Kathuri and Pals’ (1993) table for determining the sample size indicated a sample of 380 corresponding to a finite population of 40,000 and was used to determine the sample size. One questionnaire and two structured interview schedules were used to collect data. The questionnaire was used to collect data from the respondents grouped in 12-22, 23-40, 41-60 and 61+ age brackets. The interview schedules were used to gather responses in depth from Community Elders and ARP Graduates for qualitative data. The instruments were piloted in Kapyego Division in East Marakwet. The questionnaire was tested for reliability by using Cronbach Alpha method reliability test. Prior to collection of data, research assistants were trained on how to administer the questionnaires. The interviews were solely conducted by the researcher on a one to one basis. The quantitative data obtained was analysed by use of descriptive statistics such as frequency distributions and results presented in graphs and tables. Inferential statistics such as ANOVA and Post Hoc tests were also carried out. The data was analysed by using the SAS System.

Results and Discussion

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The distribution of the Marakwet’s level of literacy showed that only 15% (n=61) had no formal education at all, while 16% (n=66) had college or university education, 35% (n=145) had primary school education and 34.5% (n= 143) had secondary level education.

![Figure One: Marakwet’s levels of literacy](image)

**Influence of Level of Education on the Perceptions of the Marakwet of Kenya on ARP as a Rite of Passage.**

One objective of this study was to determine the influence that the level of education has on perception on ARP as a rite of passage. Descriptive statistics for mean perception index towards ARP as a rite of passage by level of education of the respondent is displayed in Table One. An examination of the means for the four subgroups revealed that those who have primary, secondary and university education had higher perception means; 3.7, 3.9 and 4.0, respectively, as compared to 3.1 for those who had not been to school. The ANOVA calculation revealed existence of statistically significant differences in means of ARP as a rite of passage. This showed that level of education influenced perceptions of ARP as a rite of passage. To determine which means were statistically different from others, post-hoc tests based on Duncan’s Multiple Range Tests at 5% level were computed and presented in column two of Table One which also presents means for ARP as a method of training and as a sex control method which will be discussed in subsequent sections.
Table One: Duncan’s Range Test for Perceptions of ARP as a Rite of Passage, as a Training Method, and as a Sex Control Method, According to Level of Education

<table>
<thead>
<tr>
<th>Level of Education</th>
<th>Mean Scores of Perception towards ARP as...</th>
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<tbody>
<tr>
<td></td>
<td>A Rite of Passage</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Not been to school</td>
<td>2.9508 b</td>
</tr>
<tr>
<td>Primary School</td>
<td>3.7931 a</td>
</tr>
<tr>
<td>Secondary school</td>
<td>4.0629 a</td>
</tr>
<tr>
<td>College/University</td>
<td>3.9091 a</td>
</tr>
</tbody>
</table>

*Means followed by the same letter are not significantly different at 5% level.

The ANOVA results; F = 18.150; df = 3, 411; p < 0.05 revealed that there are significant differences in perception of ARP as a rite of passage relative to level of education. The hypothesis (Ho) suggesting that the level of education does not influence one’s perception of ARP as a rite of passage was therefore rejected. To determine which pairs of means were significantly different, post hoc tests were done and results showed that the only pair whose perception mean scores were not significantly different is the secondary and college/university pair. All the other comparisons revealed significant differences. This gave the impression that those who have attained higher levels of education have favourable perceptions towards ARP and can take part in ARP activities while those who have no formal education and those with only primary school level may still practice FGM. One can therefore, conclude in the first place, that higher levels of education influences perception of ARP as an acceptable rite of passage and therefore, its adoption. Secondly, illiteracy contributes to the continuation of FGM practice. This is because education enables one to look at other options positively and critique what is being practiced as a result of becoming more knowledgeable.

Surveys on FGM practice support this finding, for instance, Kenya Demographic and Health Survey (2003) results; show that FGM practice is strongly related to education. FGM practice was found to be five times more prevalent among uneducated women than among those with higher educational levels. In addition, Snow et al. (2002) in a study done in
Nigeria, also found that the highest proportion of FGM (66.6%) was found among women with the least education (primary or less schooling).

This finding also agrees with an Adolescent and Social Change Research carried out in Egypt in 1999 which revealed that mothers who had only been to primary or preparatory school were just as likely to circumcise their daughters as mothers who had not been to school at all. On the other hand, mothers who had attended secondary school, or higher, were substantially less likely to circumcise their daughters (Population Council, 1999). Yoder et al. (2004) have noted that there is a close relationship between a woman’s level of education and the probability of having a daughter circumcised. They reached the conclusion that prevalence of FGC is lower among educated women after analysing results of DHS survey from 9 countries. They also found that the amount of education a woman had was also paramount in determining discontinuation of FGM. Those with primary or less education were more likely to have been cut than those who had received secondary level of instruction.

**Influence of Level of education on the perception of the Marakwet of Kenya on ARP as a Method of Training**

Gitau (1994) explains that the whole process of initiation is a school of instruction where initiates are not only taught how to follow tribal laws regarding sex and marriage but also societal morals and secrets with emphasis on marital duties and homemaking skills. One of the objectives of this study was to determine the influence that the level of education has on perception of ARP as a method of training. Descriptive statistics for mean perception index towards ARP by level of education of the respondent reveal that the lower the level of the respondent’s education, the lower their mean perception of ARP as a method of training. For instance, those who never went to school attained a mean score of 3.1 while those with primary level scored 3.7 and those with secondary education and above all obtained a score of 3.9. In addition, The ANOVA results revealed existence of significant differences in perception means for different levels of education \( (F = 18.262; \text{df} = 3,411; p < 0.05) \). The null hypothesis \( (\text{Ho}) \) that suggested that level of education does not influence perception of ARP was therefore rejected at the .05 level of significance.

It is evident that one’s level of education influences one’s perception of ARP as a method of training. To establish the pairs whose mean scores were significantly different in the four subpopulations, post hoc tests were carried out and results showed that the mean score of the
‘not been to school’ was significantly different from the mean score of ‘primary’, ‘secondary’ and ‘college/university’ levels of education. This can be said to divide the sample into two in terms of different perspectives: those with a formal education and those without it.

This finding implies that having a formal education influences the perceptions of ARP as a training method and consequently, the practice of FGM. Those who have an education, despite the level, have an appreciation of ARP’s method of training probably because they can relate to the process of classroom learning and guidance and counselling. Those who have not been to school may think that formal education has little to offer in terms of teaching or training of girls to be responsible Marakwet women and may hold on to what they know best: training through the pain of FGM. This finding corresponds with the results of a survey done by Magiel et al., (2003) in the Sudan among secondary school girls. They found that education is a major factor that would influence positive change of attitude towards the practice of FGM.

The influence education has on FGM practice can further be illustrated by a study by Olenja & Kamau (2001). They carried out a study in Koibatek District of Kenya and found that while FGM prevalence among the mothers was 67 percent, it was 2.2 percent among the young girls. They attributed this difference to an attitudinal change within the community where a new value system priced formal education more than female circumcision. This finding also tallies with findings of a study carried out in the State of Ebonyi in Eastern Nigeria done by Babalola and Amazuou (2000). They found that perception of the benefits of FGM increased with age and decreased with education. However, in the State of Enugu, the respondent’s approval of FGM increased with education and this was attributed to ethnicity.

The implication for this finding is that illiteracy contributes to unfavourable perceptions of ARP on the one hand and the continuation of FGM practice on the other. Therefore, ARP proponents need to target the illiterate population with carefully designed and culturally appropriate messages and activities in order to slowly change their views on the role of ARP as training method.

**Influence of Level of Education on the Perception of the Marakwet of Kenya on ARP as a Sex Control Method**
The belief that uncircumcised women are apt to be promiscuous is prevalent in all societies that practice female circumcision (Giorgis, 1981). Babalola and Amauzou (2000) found that one of the most frequently mentioned benefit of FGM by the respondents was prevention of sexual promiscuity and that favourable attitudes towards the continuation of FGM increased significantly with education. Dorkenoo (1994) explains that in traditional societies, if a woman does not play her part, in terms of FGM, she is ultimately breaking the family and cultural norms of chastity, cleanliness, marriageability and preserving family honour. For this, she can be killed. Indeed, the preservation of virginity was taken so seriously among the Nandi of Kenya that its loss could earn a girl death by a spear (Nyangweso, 2002).

In this study, the third objective was to determine the influence of level of education on perception of ARP as a method of sexual control of women. Descriptive statistics for mean perception index towards ARP by level of education of the respondent shown in Table One reveal that respondents doubt ARP’s ability to ‘sexually control.’ While the overall perception mean for role of ARP as a rite of passage and training method stood at 3.6, the mean for role as sexual control method stood at 3.2. Furthermore, those who had not been to school scored a low of 2.6 while primary level scored 3.1, secondary 3.3 and college/university 3.5.

ANOVA computation results revealed that mean scores were significantly different (F = 21.525; df 3,411; p < 0.05). The null hypothesis (Ho3) suggesting that level of education does not influence perception of ARP as a method of sexually controlling women was therefore rejected at the .05 level of significance. It is evident that one’s level of education influences perception of ARP as a method of training. To determine the pairs whose mean scores were significantly different in the four subpopulations, post hoc tests were carried out. The tests established that the only pair whose mean scores were not significantly different was the secondary and college/university pair. This gives the impression that higher level of education is important in positively influencing one’s perception of ARP as a sex control method. The cutting off of the erogenous zones as a cure for sexual urges may have influenced the response to the questionnaire statement “ARP graduates make better wives because they have not been cut” as 46.6% of the respondents in this study disagreed, 21.7% indicated ‘uncertain’ while 31.8% were in agreement. It is worth noting that those who practice FGM have beliefs that may need to be addressed if ARP is to be considered an
option by them. It is important to recognize that although seemingly preposterous, these notions are ingrained in the culture and accepted by the entire community (Dorkenoo, 1994).

Strategies to raise levels of education need to be established and implemented. ARP proponents can also carry out outreach programmes through seminars targeting those who have not been to school and those with primary level education. Proponents of ARP also need to understand the mental map. This map refers to the range of enforcement mechanisms that ensure that the majority of women comply with FGM which include fear of punishment from God, men’s unwillingness to marry uncircumcised women and lack of respect and denial of opportunities to engage in adult social functions (WHO, 1997).

Similar findings from DHS data from Eritrea, Kenya, Central African Republic and Burkina Faso show that 80% to 90% of women with secondary education are opposed to the practice of FGM. Elsewhere, a 1995 Health Survey in Egypt reported that women whose mothers had no formal education reported a 99.4 percent rate of FGM while women whose mothers completed secondary or higher education reported a 89.6 percent rate (Dillon, 2002). UNICEF (2006) explains the 30 percent of reduction of FGM practice in Kenya according to the DHS 2003 survey as largely due to education. As a result, UNICEF is working with the Ministry of Education and Office of the President to increase access to education through support for mobile schools, boarding schools, improved water and sanitation facilities in schools and better quality teaching in girls centred, girl friendly classrooms. The same can be done by ARP proponents in Marakwet for both boys and girls.

Qualitative data from the ARP graduates did not tally with the impressive perception means posted by those who are in high school. The myths that surround the external genitalia of women shaped their negative perception towards their uncircumcised sisters as shown in Except One. The statement ‘uncircumcised women pose no danger to their husband’s manhood,’ had 33% of the respondents (137) indicate ‘uncertain’. This implies that the myth about the clitoris causing impotence upon contact with male genitalia still holds sway in Marakwet. Myths, beliefs, values, and codes of conduct that cause the whole community to view women’s external genitalia as a potentially dangerous, that if not eliminated, has the power to affect uncircumcised women, their families and their communities (WHO, 1999). The myths and the corresponding enforcement mechanisms that support the practice need to be addressed. Programme activities should be designed to correct these false beliefs. This will
require that consistent information be disseminated persistently through a variety of media and that dialogue focus on understanding, dismantling and dispelling these beliefs.

<table>
<thead>
<tr>
<th>Excerpt One</th>
</tr>
</thead>
</table>

**Qualitative data from ARP graduates on their acceptance by the community**

**Researcher:** Are there ARP graduates who have opted for circumcision so as to be accepted by colleagues and society?

**Respondent:** Yes, the peer pressure is very powerful. Many people, even the educated, say that it is our culture and FGM is a must. Moreover, most ARP graduates are not serious, they believe in culture.

**Researcher:** Would you say that ARP has been accepted in Marakwet?

**Respondent:** Maybe 40 percent acceptance. We still have a long way to go.

From Excerpt One, it is clear that ethnicity plays a bigger role in perpetuation of ARP and the seeming acceptance of ARP is far fetched. Level of education does not matter. ARP graduates need to be followed up, given counselling and possibly protected from ‘forcing’ their parents to circumcise them as explained in Excerpt 2.
Excerpt Two

Qualitative Data from ARP Graduates on their Acceptance by the Community

Researcher: How does the community at large regard you as ARP graduates?

Respondent: The community and especially our colleagues in school (High school) make life difficult for us. They treat us like outcasts.

The following points are a summary of the graduates’ narration (N = 8) of what they experience in the hands of their colleagues in high school. They are told they:

- Smell very badly
- Don’t know how to speak in front of men
- Have no self control sexually
- Are outcasts
- Use a lot of perfume to ward off bad odours from their genitalia
- Jump over the fence to look for men
- Are not mature women but are just children
- Will have their clitoris grow until it touches and drags on the ground
- Spend lots of money buying many panties as the clitoris pokes holes in them
- Are shy and cowardly
- Should seek advise from the circumcised
- Do not have any secret language as the circumcised
- Received ARP training that was empty
- Will never get husbands to marry them
- Will never be respected in society

To add on to this, Excerpt Three reveals what the Marakwets perceive of an uncircumcised woman as illustrated in the definition of a child:

Excerpt Three

Qualitative data from the Marakwet elders on status of ARP Graduates

Researcher: ARP graduates are not children anymore. Explain your response.

Respondent: The community views the ARP graduates as children. In Marakwet circumcision involves sealing the virginal opening. The initiate is infibulated. A child
Abusharaf (2004) explains in reference to ARP that pain and suffering are appropriated and employed as techniques for creating social cohesion and gender solidarity. Following the ritual, girls become adults, while those who are uncircumcised may not be vested with this rank whatever their age. As far as adherents of the practice are concerned, an uncircumcised female is not a woman. Because of the nature of this belief, its effects on consciousness cannot be underestimated.

Conclusion

Education plays a very important role in eradication of FGM. As seen in this study, those who have high rating of the Alternative Rite of Passage are those who have high level of education. It is clear that illiteracy has a hand in the continuation of FGM. On the other hand, the fact that ARP as a training method did not show any differences according to level of education puts weight on the aspect of training. There is a similar mindset that requires ARP proponents to satisfy in order to gain respect and acceptance. In addition, those who really hold on to the culture and fight for it are mostly illiterate people. This implies that if levels of literacy can be raised, then incidences of FGM can be lowered as education can challenge the myths that ensure women are circumcised.

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ASSESSING STUDENTS’ ATTITUDE TOWARDS COMPUTER TECHNOLOGY

K. O. Njagi1*, W. L. Havice2, C. Isbell3, R. Smith4

Abstract

Recent advances, especially in the area of computer technology, have heralded the development and implementation of new and innovative teaching strategies. The purpose of this study was to assess students’ attitude towards computer technology in a history class. Specifically, the study assessed differences in attitude change, towards computer technology for students instructed using web-based resources and those using traditional textbook; and if level of computer literacy predicted students’ attitudes toward computer technology.

Thirty eight students from Bridgewater State College, 70 from Massachusetts Maritime Academy, and 54 from Clemson University participated in this study and a pre-test-post-test; non-equivalent control group design was used. The treatment group was instructed using Web-based electronic textbook while the control group was instructed utilizing traditional textbook. A Likert-type scale was developed to measure the attitude towards computer technology and attitude towards the history class. ANOVA was used to assess differences in attitude-change. Alpha was set at .05. Results of the study indicated that students from both groups had good attitude towards computer technology, although Students with high computer literacy skills showed better attitude. There was a positive significant relationship between computer literacy and attitude towards computer technology. The results of this study should help educators in curriculum planning appreciate the importance of computer literacy skills immediately first year students report to the university. The faculty too should be prepared to use modern technologies in order to build classrooms where students are engaged and motivated.

Key words: Computer technology, student attitudes, History, Web based, computer literacy

Introduction

The teaching and learning process has been dramatically altered by the convergence of a variety of technological, instructional, and pedagogical developments in recent times (Bonk & King, 1998; Marina, 2001; Smith, 2002). Garmer & Firestone (1996) concur that technology is challenging the boundaries of the educational structures that have traditionally facilitated and supported learning. Recent advances, especially in the area of computer technology, have heralded the development and implementation of new and innovative teaching strategies. Profound changes have been brought about by the Internet revolution which has significantly impacted the economy and has been hailed as the technological revolution of our time; providing innovative network and information access capabilities (O’Driscoll, 2003).

The availability of instant global communication systems has also changed the way written documents for learning are viewed. In the past ten years, the World Wide Web (WWW) has
gained general popularity among the education community because of its low cost and ease of accessibility. The WWW has brought to everyone with Internet accessibility, the availability of on-line resources, allowing users to experience real personal interaction. Learning experiences involving more complex interactions between learners and instructional content can now be designed because of increased multimedia capabilities in computer technology (Reiser, 2001). The increasing numbers of search engines ease searching the WWW. Information can be easily retrieved through simple word searches. Information professionals have also created directories, in nearly all subjects, of what is viewed as the most useful and appropriate in their respective disciplines (Barnard, 1997). The WWW also allows non-sequential linking of documents across the Internet resulting in a large pool of information (Macaulay, 2003). All this was made possible by the introduction in growth in computer technologies. Using of the computers in learning opens a wide array of possibilities.

It has become increasingly apparent in instructional technology research, that one of the major, and possibly unique, consequences of instructional situations involving media is the possibility of the development of positive attitudes in students (Simonson & Maushak, 1996). The assumption is that positive attitude towards computer technology; may influence attitude toward learning. Hovland, Janis & Kelley (1953) underscored the importance of exposing learners to new methods of instruction in order to influence their behavior towards learning. It is important to find out why it is important to leave the traditional methods of delivery to adopt use of computer technology. Compeau & Higgins, (1995) maintain the proposition that individuals will use media if they know it will contribute to a positive outcome in learning. In other words, the expected outcome of the behavior will influence an increase in liking or disliking the performance of the behavior.

The purpose of this study was to assess differences in attitude change, towards computer technology for students using web-based resources and those using traditional textbooks, and whether level of computer literacy was a predictor of attitude towards computer technology.

Research Hypothesis 1

There is a statistically significant difference in attitude change towards computer technology, between students instructed using the web-based learning resources and students instructed using the traditional textbook.

Research Hypothesis 2

Computer literacy is a predictor of attitude towards Western Civilization class and towards computer technology?

**Importance of Learner Attitudes**

An important aspect of using instructional technology is the ability to compare the actual and anticipated impact it has on learning (Reiser, 2001; Chickering & Ehrmann, 1996). Instruction is geared towards two major goals: cognitive and attitude change in the learner. Understanding attitudes is crucial in our being able to interpret our surroundings, guide
behavior and organize experiences in a meaningful way (Erwin, 2001). Henerson, Morris & Fitz-Gibbon (1978). Erwin (2001) acknowledged the complexity of measuring attitudes but also insists attitude is an important construct and must be measured because of its usefulness in prediction of behavior.

Ajzen & Fishbein, (1977) assert that attitudes and beliefs play an important role in predicting human behavior. Apart from the fact that a positive attitude may impact learner achievement, Simonson & Maushak (1996) discuss four reasons why it is important to promote attitudinal positions among learners. First, there are times when learners must accept the truth of certain ideas. Second, students are more likely to remember what they learn, seek new ideas, and be motivated to study, when they develop positive attitudes towards an instructional situation. Third, the educator’s awareness of which techniques affect attitude is important because there are times when it is not desirable to influence a student’s attitude. Finally, the teacher can learn a great deal about how a particular situation impacts the learning process by measuring student attitude. With the proliferation of technology, educators in higher education must seek to understand the evolution taking place in the learning arena so that they may: (1) appreciate the tools that are available to them, (2) learn how to use these tools to maximize learner outcomes; and (3) how to transform the learning environment to facilitate the use of the tools.

Defining Instructional Technology

For centuries, teachers have used objects, tools, and books to promote learning. Today, learning about and understanding the usefulness of the objects, tools and books, is termed instructional technology (Hains, Belland, Conceicao-Runlee, Santos, & Rothenberg, 2000). Collier et al. (as cited in Gentry, 1995) offer a broader definition of instructional technology and states that instructional technology involves

“…the applications of systems, techniques, and aids to improve the processes of human learning…It is characterized by the four features in particular; the definition of objectives to be achieved by the learner; the application of principles of learning to the analysis and structuring of the subject matter to be learned; the selection and use of appropriate media for presenting material; and the use of the appropriate methods of assessing student performance to evaluate the effectiveness of the courses and materials (p. 16).”

Methods of instruction and instructional tools can be traced to the earliest civilizations (Saettler, 1968). While current instructional technology practices are scientific and research driven, the earliest methods were unscientific and depended on the educational theory and culture of the particular people involved. Saettler (1968) cites the years of 1918 to 1924 as the period of the emergence of audiovisual instruction, with visual instruction credited to the development of still and motion pictures. Development of instructional technology slowed down but picked up speed again during World War II. With the urgent need to speedily train a large number of soldiers, the government responded by creating and distributing training films and other mediated learning materials (Shrock, 1995). Saettler (1968) suggests that the greatest contribution to instructional technology during that time was the “development of the
operator’s viewpoint and the first person commentary” (p.162). Post-World War II saw the evolution and development of educational radio and television (Raiser, 1987). Media has since played an important role in the teaching and learning process. The 1980’s witnessed the development of the microcomputers, personal computers, and the rapid adoption of more sophisticated instructional technology methods (Shrock, 1995).

**Instructional Technology and the Paradigm Shift in Learning**

Paradigm is defined as a “systematic set of beliefs, and their accompanying methods, which provide a view of the nature of reality” (Savenye & Robinson, 1996, p. 1172). In the past, learning relied largely on pedagogical theories that focused on teacher directed approaches. This was based on the assumption that learners need to know only what the teacher teaches them, resulting in a teaching and learning situation that actively promotes dependency on the instructor (Knowles, 1984). Learning implied the transfer of knowledge from the teacher to passive students. The teacher was viewed as the content expert providing answers to all the learning needs of the students by taking complete control of the learning process. Actually, the teacher possessed full responsibility for making decisions about what was learned, how it was learned, when it would be learned, and how it would be assessed. Today, the paradigm has shifted and the teacher viewed as supporter and facilitator in a learner-centered environment. Learners are active participants constructing knowledge rather than just acquiring it. Students actively research the needed information by participating as expert/knowledge providers. The teacher is viewed as a coach and supporter who actively encourage students to use their personal knowledge and skills to create unique solutions to problems (Newby, Stepich, Lehman & Russell, 2000). The shift favors the philosophy of constructivism.

Constructivism, unlike the old school of thought that held that knowledge exists independently of the individual, subscribes to the fact that learners can construct their own knowledge based on past knowledge and experiences. Knowledge is constructed by enrichment procedures of the mind. This is evidenced by how well an individual reflects on his or her thinking, ponders questions, seeks answers to them, and uses the opportunity to experiment on the knowledge acquired (Ropnarine & Johnson, 1987). Rather than dictating how students are going to learn, the teacher as facilitator instills a desire to learn by acting as a guide by encouraging students to exercise higher order thinking skills such as problem solving, reasoning, and reflection. Students therefore develop the ability to learn in cooperative and collaborative learning environments (McKeown & Beck, 1999). In essence, students become enthused about learning when given an opportunity to think problems through, ask questions and find answers. Education, therefore, should move beyond the learner solely acquiring and integrating specialized knowledge. Learning should be vibrant, relevant, and exciting for the student, building environments where learners are actively engaged and participate in hands on involvement. Instructional technology is an enrichment factor, which can have a great influence on how students learn, construct their own knowledge, and eventually become citizens who participate in life-long learning. Instructional design is a very important component of instructional technology (Raiser,
A definition and discussion of instructional technology would not be complete without pointing out the role of design.

**Importance of Instructional Technology in the Learning Process**

The amount of technology in schools has increased significantly in the last ten years, (Reiser, 2001). Shelly, Cashman, Gunter, & Gunter, (1999) allude to the supposition that using technology in the classroom motivates and encourages students to become problem solvers (Shelly, Cashman, Gunter, & Gunter, 1999). In a study exploring the use of multimedia examination formats in undergraduate teaching, students embraced the interactive technology, and felt the incorporation of rich media in assessment could provide additional support for their learning and teaching (Liu, Papathanasiou & Hao, 2001). The study supports the definition of authentic and active learning. “Authentic learning experiences are instructional activities that demonstrate real-live connections by associating the concept being taught with a real life activity or event.” (Shelly, Cashman, Gunter, & Gunter, 1999, p. 6.11). These same authors state:

"Active learning provides students with the opportunity to be involved and interested in their own learning and gives them ownership of the information with which they are presented because they are actively involved in the learning process” (Shelly, Cashman, Gunter, & Gunter, 1999, p. 6.11).

Instructional technology offers this unique aspect of learning, wherein students are engaged in multiple learning contexts incorporating visual, auditory, and kinesthetic learning processes. In such contexts, a variety of learning styles and individual needs are addressed making it easier to reach and benefit diverse groups of students. The learner is engaged in an active process that fosters the use of what is learned in other contexts and situations. At the same time the learner develops problem-solving skills that can be used in real-world situations (Lowe, 2002). Additionally, interactive technologies are engaging and can capture and hold learner attention thus giving students control of the flow of information. This enables them to review concepts, practice skills, and do in depth research. Well-implemented instructional technology programs engage learners and create excitement in the learning process. It can be a powerful tool for improving motivations and incentives for learning (Garmer & Firestone, 1996). Reiser (2001) suggests that the adoption of sophisticated technology offers diverse instructional capabilities and the ability to present information in a wide variety of forms. This allows learners to easily link to various content.

Since it is important to establish attitudinal positions among learners in a changing technological environment, the understanding of learner attitude towards instructional technology is vital.

**Student Attitude towards Instructional Technology**

An important aspect in successfully implementing instructional technology is user acceptance, which may be influenced a great deal by users’ attitude (Koohang, 1989). Actual contact, direct experience and more exposure to a stimuli object have a great impact on
attitude (Erwin, 2001). Various studies have addressed the issue of student attitude toward instructional technology and specifically toward computer technology and technologically enriched learning environments. A study by Mitra & Steffensmeier (2000) indicates that the students' attitude towards computers, their role in learning and their ability to facilitate communication improved when exposed to computer enriched environments. A longitudinal study of student attitudes toward computers found that when computer utilization increased, attitude and motivation improved which led to better performance on examinations (McKinnon, Nolan & Sinclair, 2000). Another study by Rothman (2000) on the impact of computer-based versus traditional textbook science instruction on selected student learning outcomes concluded that the use of instructional technology significantly improved student attitude toward science learning and English language development. A study evaluating college students' attitudes toward computers before and after taking a computer literacy course found that prior computer literacy helped improve student attitudes towards use of technology and learning (Taghavi, 2001). With more exposure to computers, students developed a more positive attitude and wanted to continue using the tool, resulting in creativity and a desire to take control of the personal learning process (Hopson, Simms & Knezek, 2002). Furthermore, computer enrichment was likely to contribute to a series of positive outcomes on their attitudes towards the process of learning, which could in turn have a positive outcome on learning itself. The findings of this study reflect on Compeau & Higgins (1995) statement that outcome expectations have a significant influence on individuals’ reactions to technology.

Summary

The literature presented in this chapter addressed students’ attitudes towards instructional technology and specifically web-based learning resources. In an era of constant change, technology adoption is taking top priority in higher education. For example, interactive technologies can be engaging and able to capture and hold learner attention. Well-implemented instructional technology programs will not only engage learners but also create excitement in the learning process, becoming a powerful tool for improving motivations and incentives for learning (Garmer & Firestone, 1996). Consequently, development of positive learning outcomes, and in this study, positive attitude in students must be a goal in adopting instructional technology.

Attitude is an important psychological construct that is indispensable in the learning process. As integration of instructional technology becomes a priority in higher education, more demands in its use are placed upon learners. An important aspect in successfully implementing instructional technology is user acceptance, which may be influenced a great deal by users’ attitude. Finally, it appears that certain demographic learner characteristics influence attitudes towards the use of instructional technology.

Methodology

Experimental Design
A pretest-posttest, non-equivalent control group design was used in addressing this question. Such a design, popularly used in education and psychology studies, is appropriate for naturally assembled classrooms (Trochim, and Donnelly, 2006; Campbell & Stanley, 1963).

**Subjects in the Study**

Students in the study were drawn from the group that was enrolled in a Western Civilization class and using the same text book from three different universities: 38 from Bridgewater State College, Bridgewater, Massachusetts - USA, 70 from Massachusetts Maritime Academy, Buzzards Bay, Massachusetts - USA and 54 students from Clemson University, Clemson, South Carolina - USA. The treatment group was instructed using Web-based learning resources, whereas the contrast group was instructed utilizing traditional print textbook. There were 108 students instructed using Web-based support materials: 38 from Bridgewater State College, and 70 from Massachusetts Maritime Academy. The Web resources used by this group were published by the Interactive Learning Resource Network (iLrn), a division of Digital Learning Interactive.  ILrn was a content management and delivery system that comprised multimedia-rich learning resources and course management tools within a robust online learning community. The control group consisted of 54 students from Clemson University. These students were instructed utilizing the traditional or print textbooks (Noble et al., 1998). Cases that did not include both pre-test and post-test measures were omitted from the study. A total of 126 (78%) completed copies of the questionnaire out of the 162 that were initially given out provided the final data set analyzed.

**Instrumentation**

A scale was developed to assess the attitude of students toward computer technology. The scale was developed using items from the Texas Center for Educational Technology's Attitude towards Information Technology Survey (TAT), (Knezek & Christensen, 1997). Survey instrument was validated by four experts in the area on instructional technology. Cronbach’s alpha reliability coefficient was 0.91.

Participants’ attitudes’ towards computer technology were measured by having the respondents indicate the level of importance they gave to selected questions and statements on a Likert-type scale. The response categories were (1) Strongly disagree, (2) Disagree, (3) undecided/unsure, (4) Agree and (5) Strongly agree. Differences in pretest and posttest attitude change, between the Web-based group and the traditional textbook group were assessed. The pretest survey instrument was distributed and administered to students in the beginning of the semester while the posttest survey instrument was distributed to students towards the end of the semester.

**Data Analysis**
All data analysis were performed using SPSS version 10 (1999). Frequencies, percentages and step-wise regression analysis procedure (Mogull, 2004) were used at \( \alpha = 0.05 \). To test for significant differences among the means, Analysis of Variance (ANOVA) for non-equivalent groups was used. Differences in means between the groups and within groups for the pretest and posttest were assessed for difference in significance. The F test using Analysis of Variance was used to determine if the differences were significant.

**Results**

The First Research Hypothesis tested differences in attitude change, towards computer technology, for students using web-based resources and those using traditional textbooks. A pretest-posttest, non-equivalent control group design was used in addressing this question. Differences in posttest attitude change, between the web-based group and the traditional textbook group were assessed. The F test using Analysis of Variance was used to determine if the differences were significant. Alpha was set at .05. Summary statistics for difference in pretest attitude towards computer technology are presented in Table below.

Summary Statistics for Difference in Pretest Attitude towards Computer Technology

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Means</th>
<th>Standard Error</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web-Based</td>
<td>84</td>
<td>3.492</td>
<td>0.031</td>
<td>.209</td>
</tr>
<tr>
<td>Traditional</td>
<td>42</td>
<td>3.424</td>
<td>0.045</td>
<td></td>
</tr>
</tbody>
</table>

N=126  
Frequency Missing = 1

Results of the analysis for differences in pretest between groups indicated no statistically significant difference at .05 levels between the web-based and traditional groups. The mean of the web-based group was 3.492 with a standard error of 0.031, while the mean of the traditional group was 3.424 with a standard error of 0.448. Summary statistics for difference in posttest attitude towards computer technology is presented in Table below.

Summary Statistics for Difference in Posttest Attitude towards Computer Technology

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Means</th>
<th>Standard Error</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web-Based</td>
<td>84</td>
<td>3.548</td>
<td>0.032</td>
<td>.150</td>
</tr>
<tr>
<td>Traditional</td>
<td>42</td>
<td>3.468</td>
<td>0.045</td>
<td></td>
</tr>
</tbody>
</table>
Results of the analysis for differences in posttest between groups indicated no statistically significant difference at the .05 level between the web-based and traditional groups. The mean of the web-based group was 3.548 with a standard error of .038; while the mean of the traditional group was 3.468 with a standard error of .045. Summary statistics for difference in attitude change towards computer technology is presented in Table below.

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Means</th>
<th>Standard Error</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web-Based</td>
<td>84</td>
<td>0.055</td>
<td>0.033</td>
<td>.851</td>
</tr>
<tr>
<td>Traditional</td>
<td>42</td>
<td>0.044</td>
<td>0.047</td>
<td></td>
</tr>
</tbody>
</table>

N=126

Frequency Missing = 1
Results of the analysis for differences in attitude change between groups indicated no statistically significant difference at the .05 level between the web-based and traditional groups. The mean of the web-based group was 0.055 with a standard error of 0.033, while the mean of the traditional group was 0.044 with a standard error of .047.

Is computer literacy a predictor of student attitude towards computer technology?

Research Hypothesis 2 tested if computer literacy was a predictor of attitude towards computer technology. Regression analysis was used to address this question. Attitude towards class and attitude towards computer technology were the criteria variables and computer literacy was the predictor variable. Alpha was set at .05. When the two criteria variables were entered into the regression model, only attitude towards computer technology was retained. Summary of Regression of attitudes towards class on computer literacy is presented in the table below.

Summary of Regression of Attitudes towards Computer Technology on Computer Literacy (N= 119)

<table>
<thead>
<tr>
<th>Variable</th>
<th>β</th>
<th>SE B</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>3.141</td>
<td>.158</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Computer Literacy</td>
<td>.152</td>
<td>.062</td>
<td>.016*</td>
</tr>
</tbody>
</table>

*p = .05

Results reveal a significance at \( p = 0.05 \) level of computer literacy as a predictor of attitude toward computer technology.

Discussion and Conclusion

The purpose of this study was to assess differences in attitude change, towards computer technology for students using web-based resources and those using traditional textbooks, and whether level of computer literacy was a predictor of attitude towards computer technology. Findings in this study indicate no difference in change of attitude towards computer technology between students instructed using Web-based resources and students instructed using traditional print textbook.

The findings are supported by studies of (Macaulay, 2003; Gee, 1990; and Mayes, 1995). Lack of significant increase in attitude could have resulted from computer related anxieties and more specifically Internet related anxiety as reported by (Powers and Mitchell, 1997; Macaulay (2003) suggest that design principles, which will make computer technology and especially the World Wide Web more machine-human friendly need to be examined. Powers and Mitchell (1997) reported that student’s perception was affected by the fact they found the Internet to be time consuming, Gee (1990) also reported that students found the Internet to be distracting. Further, added pressure is imposed on students when class outcomes are linked to
These findings did not agree with those from other studies (Taghavi, 2001; Hopson, Simms & Knezek, 2002; Mitra & Steffensmeier, 2000; McKinnon, Nolan & Sinclair, 2000) who found a significant change in student attitude towards computer technology. It should be noted that the students in some of those studies were computer literate. A limitation in interpreting the results of this study was that it was unclear whether or not the students were trained in the specifics of using the technology. This could account for the difference in the findings of this study compared to the findings of others. In addition, the majority of students in both Web-based and the traditional textbook groups owned personal computers and had Internet accessibility at their residence. It is therefore possible that the students using the traditional textbook utilized computers for some class work just as much as the students in the Web-resources group, a reason that could have accounted for the results obtained.

There was a relationship between computer literacy skills and computer technology. Students with higher literacy skills posted high attitude towards computers. These findings support those of Busch, 1995; Koohang, 1989; Wishart, 2002; Levin & Gordon, 1989; Hall & Cooper, 1991; Liu, Papanasiou & Hao, 2001. Based on the frequent occurrence of findings such as these, one may conclude that students who are going to participate in courses that require the use of instructional technology would benefit if offered technology literacy courses prior to enrolling in courses that require computer use. One may also conclude that these courses would increase computer literacy, consequently improving attitude towards learning.

In conclusion, the purpose of the study was to determine whether there was difference in attitude change towards computer technology between students using the web based learning resources and students using the traditional textbook; and if computer literacy was a predictor of student attitude towards computer technology. The result of the study show no significant change in attitude towards computer technology between students using web based learning resources and the traditional textbook. Computer literacy was however found to predict student attitude towards computer technology.

The implications of these findings are such that higher education curriculums must consider computer literacy as an important component for students enrolling in all the programs in the universities. The technological revolution affecting how higher education is delivering learning both within the classroom walls and in distance learning cannot be ignored. In an era of constant technological changes, the information from this study will be useful to educators in higher education as they move towards technology integration in the learning process. Further research should be conducted to assess the impact of various methods of teaching effectively using computer technology in all disciplines in order to prepare students to participate fully in the changing learning environments. Research should be done on how instructors are incorporating technology in the classrooms, document success stories and best practices in order to encourage more usage and integration.
Reference


**CHALLENGES FACING GUIDANCE AND COUNSELLING TEACHERS IN SECONDARY SCHOOLS IN KENYA: A CASE OF NANDI NORTH DISTRICT**

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**Abstract**

This study investigated the challenges facing guidance and counselling teachers in secondary schools, Nandi North District, Nandi County. The methodology employed was ex-post facto technique, with the use of stratified random sampling approach to identify schools and participants in the sampled schools. Interviews, questionnaires, document and resources study were used for data collection. Findings revealed that a majority of the teacher-counsellors are not trained in guidance and counselling, most of the teachers do not keep any records and the few who kept have students’ attendance files and personal/background information files only. Other than the teacher-counsellors, parents, students, chaplains, peer counsellors, teachers, head teachers and their deputies play a significant role in guidance and counselling services, and harmonising all their activities pose a great challenge. The study further established that students’ attitude towards guidance and counselling is negative and that time for counselling students was inadequate. Recommendations were made to the Ministry of Education, head teachers, other administrators and the teacher-counsellors on the need to put in place workable schedules based on the conceptual framework to improve the level of professionalism and consequently effectiveness of guidance and counselling in secondary schools.

**Key words:** Challenges, Professionalism, Effectiveness, Teacher Counsellor, Guidance and Counselling

**Introduction**

The Government of Kenya through legal notice 56/2001 banned the use of the cane, as a means of disciplining students, in the year 2001. In its place, Guidance and Counselling was
introduced. However mechanisms for training teachers to effectively provide guidance and counselling services were not immediately provided for and it was the Christian Religious Education teachers who were mainly appointed to provide these services. However, serious cases of indiscipline are still reported in schools raising concerns as to whether real guidance and counselling takes place and in the right way.

**Statement of the Problem**

In September 2001, the Ministry of Education Science and Technology constituted a task force to gather views and information from all stakeholders in education, on causes of unrest and indiscipline in secondary schools, and make recommendations on actions to be taken to address the emerging issues. The task force carried out a country-wide research to establish causes of unrest, and some of the heinous acts committed by students were among others, the Kyanguli incident in Machakos where 68 students were burnt to death, St. Kizito in Embu where 19 girls died and Nyeri high school where 4 prefects were burnt to death, (Republic of Kenya 2001).

Education Act (1980), Legal Notice number (40/1972) and the head teachers’ manual (1975), clearly emphasize that students’ discipline and behaviour must conform to societal norms and expectations. Their conduct must be commensurate with their status as students. However teacher-counsellors have to deal with many people from very diverse backgrounds and in addition, challenges in the modern society such as, HIV and Aids, drug abuse, career muddle unemployment, heterosexuality and delinquency. All these issues pose great challenges to the department of Guidance and Counselling in Kenyan Secondary Schools.

The study sought to find out the challenges facing guidance and counselling teachers in discharging their duties.

**Purpose of the study**

The purpose of this study was to establish the challenges facing Guidance and Counselling in Secondary schools in Nandi North District and recommend workable solutions to be able to enhance its effectiveness.

**CONCEPTUAL FRAMEWORK**
A professional teacher-counsellor needs to go through rigorous training over a period of time. The right personality is essential and so is motivation to do their job. The success of Guidance and Counselling programmes requires the collaborative participation of the parents, teachers, students, school administration and the professional community.

**Methodology**

The study utilized ex-post facto design. The respondents were purposively selected for the study. They included the head teachers, teacher counsellors, teachers and students. Questionnaires, interviews, document and resource studies were used to collect data. Descriptive statistics were used to analyse data.

Data Analysis, Presentation and Discussion

This is conducted under following

1. The level of professional training of the teacher-counsellor in Guidance and Counselling and effects on performance of Guidance and Counselling tasks.

2. Types of Guidance and Counselling services offered in secondary schools by teacher-counsellors.

3. Challenges faced by teacher-counsellors in Guidance and Counselling.

The level of professional training of the teacher-counsellor in Guidance and Counselling and effects on performance of Guidance and Counselling tasks.

**Table1. Qualifications of the teacher-counsellors in Guidance and Counselling**

<table>
<thead>
<tr>
<th>Qualifications / training in Guidance and Counselling</th>
<th>F</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graduate</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Diploma</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 1 depicting qualifications of the teacher-counsellors in Guidance and Counselling above, reveals that 3 (16.7) teacher-counsellors have been trained by KESI through a two-week induction course in Guidance and Counselling. 7 (38.9) have attended 1 – 5 day seminar courses on issues pertaining to Guidance and Counselling and 8 (44.4) have never attended any course in Guidance and Counselling. It is evident that most 15 (83.3) of the teacher-counsellors are untrained in Guidance and Counselling. The reasons given by teachers for not having attended any training ranged from head teachers not getting information on time to lack of money to send the teacher-counsellors for seminars.

From the interview, the teachers also revealed that from the onset of free primary education, KESI which is charged with the responsibility of training teachers had concentrated on training head teachers on school management, especially in school finances, therefore, temporarily leaving out other areas which include Guidance and Counselling.

Table2. Teacher-counsellors experience as Head of Department.

<table>
<thead>
<tr>
<th>Length of service (years)</th>
<th>F</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 2</td>
<td>9</td>
<td>50</td>
</tr>
<tr>
<td>2 – 4</td>
<td>6</td>
<td>33.3</td>
</tr>
<tr>
<td>4 – 6</td>
<td>3</td>
<td>16.7</td>
</tr>
<tr>
<td>6 – 8</td>
<td>0</td>
<td>00</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>100</td>
</tr>
</tbody>
</table>

In response to the interview questions on the length of service of the teacher-counsellor as Head of Department, Table 2 shows that 3 (16.7) teachers-counsellors have been H.O.Ds, Guidance and Counselling for more than 4 years and 9 (50) have served for less than 2 years, indicating that the majority 15 (83.3) have worked for less than 4 years. This could be because the emphasis on Guidance and Counselling was put in place after the government banned corporal punishment in Kenyan schools in 2001 through legal notice number 56/2001. This was also in line with the task force on student discipline and unrest in secondary schools’ (2001) recommendations that all secondary schools were expected to establish and sustain viable Guidance and Counselling programmes and a teacher appointed to coordinate the programmes in school. These teachers are designated as Heads of Departments and are appointed by the T.S.C, or internally by the B.O.G.
Types of Guidance and Counselling services are offered in secondary schools

Table 3. Student responses on Guidance and Counselling services offered in secondary schools.

<table>
<thead>
<tr>
<th>Guidance and Counselling services offered</th>
<th>f</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choice of subjects for future careers</td>
<td>649</td>
<td>22.6</td>
</tr>
<tr>
<td>Social problems</td>
<td>593</td>
<td>20.7</td>
</tr>
<tr>
<td>Academics</td>
<td>1356</td>
<td>47.3</td>
</tr>
<tr>
<td>None</td>
<td>257</td>
<td>9.0</td>
</tr>
<tr>
<td>Others: spiritual, health</td>
<td>318</td>
<td>11.1</td>
</tr>
</tbody>
</table>

Table 4. Teachers’ responses on Guidance and Counselling Services offered in secondary schools.

<table>
<thead>
<tr>
<th>Guidance and Counselling services</th>
<th>f</th>
<th>Percentage</th>
<th>T. f</th>
<th>T. Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocational</td>
<td>30</td>
<td>18.40</td>
<td>163</td>
<td>100</td>
</tr>
<tr>
<td>Academic</td>
<td>160</td>
<td>98.16</td>
<td>163</td>
<td>100</td>
</tr>
<tr>
<td>Social</td>
<td>104</td>
<td>63.80</td>
<td>163</td>
<td>100</td>
</tr>
<tr>
<td>Personal</td>
<td>99</td>
<td>62.74</td>
<td>163</td>
<td>100</td>
</tr>
<tr>
<td>Others: spiritual, health (medical)</td>
<td>60</td>
<td>36.81</td>
<td>163</td>
<td>100</td>
</tr>
</tbody>
</table>

Tables 3 and 4 reveal that academic guidance takes the lead in the services offered to students by Guidance and Counseling teachers in secondary schools. 1356 (47.3) of the students and 160 (98.16) of the teachers ranked academic Guidance and Counseling as the highest service offered.

From the students’ responses in table 3, choice of subjects for future careers came second 649 (22.6) followed by social problems 592 (20.7), spiritual and health 318 (11.1) respectively. While 257 (9.0) of the students indicated that they have never attended any type of Counseling.

According to the teachers’ response in table 4, the reason why vocational Counseling takes the least 30 (18.40) in relation to academic 160(98.16) is because in most schools it was revealed that the teacher in charge of careers is also a member of Counseling committee hence can do both concurrently.

Reasons attributed to the high score in academic Counseling 160 (98.16) and 1356 (47.3) are as follows.
Academic Guidance and Counseling is in line with the core function of the school being academic.

The professional qualification of the teachers who are masters in their subject areas overrides their new responsibility of Guidance and Counseling and

The current emphasis placed on the performance has made teachers take a keen interest in their subject areas.

Whereas academic Counseling takes the lead, medical (health) and spiritual Counseling as indicated by 318 (11.1) students and 60 (36.81) teachers respectively, ranks lower because the teacher-counselors have no training in the medical field, and therefore, limited in medical Counseling. Some schools have nurses and chaplains or priests to help in spiritual matters.

**Table 5. Teacher-counselors responses on services offered in secondary schools.**

<table>
<thead>
<tr>
<th>Services</th>
<th>F</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academics</td>
<td>18</td>
<td>100</td>
</tr>
<tr>
<td>Careers</td>
<td>10</td>
<td>55.6</td>
</tr>
<tr>
<td>Social</td>
<td>8</td>
<td>44.4</td>
</tr>
<tr>
<td>Medical / health</td>
<td>5</td>
<td>28.0</td>
</tr>
</tbody>
</table>

From the interviews conducted on teacher-counselors, Table 5 reveals that 18 (100) offered academic Guidance and Counseling as a priority, whereas most 13 (72.2) could not deal with psychological or health issues. This is because teachers have no training linking them to the health (medical) field hence teacher-counselors have no experience. However the following were established

1. Academic, career, spiritual, social and health Guidance and Counseling services were offered by the teacher-counselors in secondary schools in Nandi North District.

2. Academic Guidance and Counseling appeared the most emphasized type in all the sampled schools.

3. Two reasons were given by the teachers on the emphasis on academic counseling.

   a). Teachers have very limited time for Guidance and Counseling hence provision of academic Guidance and Counseling is in line with the teaching that goes on.

   b). Emphasis on excellence in academic performance drive teachers to emphasize academic Guidance and Counseling.

4. Health (psychological) Counseling is rarely provided and the reason given was that teachers have no knowledge in medical field.

From the findings stated above
a). Teacher-counselors are charged with the provision of several services in Guidance and Counseling.

b). Other than the teacher-counselor, other persons are actively involved in the provision of the services listed above. For instance, careers, spiritual or health are provided by careers teacher, priest or the nurse respectively.

c). Academic guidance takes the lead because all the teachers are involved in their subject areas.

d). Teacher-counselors are not professionally qualified in Guidance and Counseling

**Table 6 Document and Resources studied.**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>AVAILABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Documents / Resources</strong></td>
<td>Available</td>
</tr>
<tr>
<td><strong>No/Percentage</strong></td>
<td></td>
</tr>
<tr>
<td>Offices (Rooms / Guidance and Counseling Centre)</td>
<td>11 (61.1)</td>
</tr>
<tr>
<td>Reference books</td>
<td>2 (11.1)</td>
</tr>
<tr>
<td>Section in the library for Guidance and Counseling literature</td>
<td>00 (00)</td>
</tr>
<tr>
<td>Notice board for Guidance and Counseling announcements</td>
<td>00 (00)</td>
</tr>
<tr>
<td>Good general organisation of guidance and Counseling department</td>
<td>3 (16.7)</td>
</tr>
<tr>
<td>Students personal information files</td>
<td>2 (11.1)</td>
</tr>
<tr>
<td>Programmes (correspondence, time tables etc.)</td>
<td>2 (11.1)</td>
</tr>
</tbody>
</table>

From the document and resources, the study conducted in the 18 sampled schools, Table 6. reveals that majority 11 (61.1) of the schools have offices or rooms from where Guidance and Counselling activities are conducted. A slightly smaller proportion 7 (38.9) lacks this important facility. The slightly higher percentage of schools having the rooms or offices are in line with the MOEST recommendations, Republic of Kenya (2000) that the Headteacher has to recognize the importance of privacy and respect for confidentiality of Counselling relationships by providing a room or office.

Almost all the schools 16 (88.9) have no reference materials or books and only 2 (11.1) have a few references, which are usually kept by the teacher-counsellor in Guidance and Counselling office. All the schools under study had not reserved section in their school.
library for Guidance and Counselling materials or career literature for career counselling which students could refer to. This shows that students are not exposed to Guidance and Counselling materials and career literature apart from the face-to-face Counselling they receive from their teacher-counsellors. It is necessary to have Guidance and Counselling centres stocked with newspapers, magazines, books, films and other relevant materials that can help students (Mutie and Ndambuki 1999).

On related issues all the 18 (100) schools checked, had no notice boards set aside for Guidance and counselling materials and announcements. However, teacher-counsellors revealed that they utilize the schools’ assemblies to pass information to both the teachers and students. This shows that schools neglect the issue of placing Guidance and Counselling materials and announcements on the notice boards and yet issues and concerns about Guidance and Counselling are raised even in the print media very often.

In almost all the schools 16(88.9), Teacher-counsellors kept no records on students, for example, personal information files, academic records or health records while a small proportion 2(11.1) indicated that the departments kept students’ information records.

On the general organization of the department, 3(16.7) of the schools had well organized offices, strategically placed, always opened with good filing, shelving and posters in place while 15(83.3) which include the 7(38.9) that had no offices or rooms and were operating from the staff rooms, which in most cases are congested, and lacked organization, therefore, no privacy and confidentiality.

Regarding whether the Guidance and Counselling programmes had a timetable or not, majority 16(8.9) had no programmes organized and put on timetable. In any case, both teachers and students indicated that Guidance and Counselling takes place when a need arises. This reveals that Guidance and Counselling is done haphazardly in most schools. This really affects the effectiveness of the programmes or teacher-counsellor as MOEST (1977) noted that lack of specific time set aside for Guidance and Counselling was hampering the success of the programmes. It, therefore, advocated for specific times set aside for school timetable for Guidance and Counselling programmes.

Drawing from Table 6, it can be concluded that the provision and organization of resources in Guidance and Counselling departments are still wanting, and therefore, there is a need for schools to implement the MOEST recommendations of the Wangai report (Republic of Kenya 2001), that required the head teachers to provide material, equipment and facilities such as an office, filing space, forms for securing data from the learners, folders to contain counselling notes, shelves for books, filing cabinets, notice boards, desks and chairs. Mutie and Ndambuki (1999) add that the provision of the guidance programmes must be made in the school time table as well as in the budget to facilitate guidance activities such as maintenance of cumulative records, arranging for career and orientation talks, screening of films or plant tours.

Drawing from the documents and resources studied, the following findings were highlighted:-
a). Almost all the schools (88.9) have no reference material or books.

b). Majority (88.9) of the teacher-counsellors kept no records on student’s personal information.

c). On Guidance and Counselling programmes, 2(11.1) of the teachers had correspondence and timetable records whereas 16(88.9) had no programmes, correspondence and timetables on records.

Findings therefore indicate that:-

a). Majority of the teacher-counsellors in Nandi North District kept no records on students in their offices.

b). 16 (88.9) of the teacher-counsellors had no reference materials or books in that area.

c). The general organization of Guidance and Counselling departments are waiting for even the available offices or rooms, quite a good proportion 15(83.3) had no files, shelves and even posters.

d). However, most 11(61.1) of the schools in the districts had Guidance and Counselling services.

**Table 7 Teachers response on persons offering Guidance and Counselling services in schools**

<table>
<thead>
<tr>
<th>Response</th>
<th>f</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher in charge of guiding and Counselling</td>
<td>55</td>
<td>33.742</td>
</tr>
<tr>
<td>Class teacher</td>
<td>44</td>
<td>26.994</td>
</tr>
<tr>
<td>Head teacher, Deputy head teacher</td>
<td>20</td>
<td>12.27</td>
</tr>
<tr>
<td>Others: priest, chaplain, peer counsellors</td>
<td>44</td>
<td>26.994</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>163</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

When teachers were asked to give the most appropriate person to offer Guidance and Counselling in schools as reflected in Table 7, majority 55 (33.7) indicated the teacher in charge of Guidance and Counselling, 44 (27) indicated class teachers, 20(12.27) indicated head teacher and the deputy head teacher, while another high proportion 44 (27) included the chaplain, priest and the peer counsellors. This is an indication that peer counsellors would function effectively and would go along way in helping solve some problems that students may not be free to “open up” to their teachers. It also reveals that the head teachers and the deputies, who are in charge of discipline in the school, play a crucial role in Guidance and Counselling. Therefore, it can be concluded that co-ordination between parents, teachers, students, teacher-counsellors, head teacher and deputy head teacher are necessary if the students were to be helped in Guidance and Counselling services.
From the interviews administered to the teacher counsellors, it was revealed that all the 18(100) schools do have a teacher in charge of careers.

It was revealed that the following persons take an active part in Guidance and Counselling in secondary schools other than the teacher-counsellors.

a). ● Parents
● Class teachers
● Chaplains
● Peer counsellors
● Teachers in Guidance and Counselling committee
● Students’ own friends (both Students and none students)
● Other teachers in school

b). It was also discovered that the head teachers and the deputy head teachers who are known to be in charge of discipline in schools played a crucial role as Guidance and Counselling providers.

c). Guidance and Counselling committees are in existence but not functional in most schools.

It is clear from the findings indicated above that both the school and the parent community were involved in Guidance and Counselling programmes in school.

**Challenges faced by the teacher-counsellors in their departments.**

The teacher-counsellors (H.O.Ds) and the rest of the teachers, head teachers included, were asked to give the major problems that make Guidance and Counselling ineffective in their schools and the most common problems were listed as follows;

1. Lack of Guidance and Counselling facilities and resources (office, literature etc.)
2. Lack of adequate time for Counselling students.
3. Incompetence of the teacher-counsellor.
4. Students negative attitude towards Guidance and Counselling (students do not seek for Guidance and Counselling services)
5. Lack of cooperation from the parents.
6. Head teachers not supportive
7. Lack of confidentiality of the teacher-counsellor (teacher-counsellor do not keep information private).
According to the teachers, majority 60(36.8) of the students are positive towards Guidance and Counselling programmes. 48(29.5) showed that students are negative and 22(14.72) could not tell, while 33(19.0) indicated they could either be positive or negative depending on the type and form of Guidance and Counselling offered. The negative attitude toward Guidance and Counselling especially, in relation to personal problems, could be attributed to the lack of confidentiality, whereas they could be positive if it is academic or if the Guidance and Counselling is in the form of career talks, plant tours or watching a film or video tapes which are more entertaining.

### Table 9 Workload for the teacher-counsellor

<table>
<thead>
<tr>
<th>Lessons per week</th>
<th>f</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>13-18</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>20-22</td>
<td>4</td>
<td>22.2</td>
</tr>
<tr>
<td>22-24</td>
<td>2</td>
<td>11.1</td>
</tr>
<tr>
<td>24-29</td>
<td>10</td>
<td>55.6</td>
</tr>
<tr>
<td>29-32</td>
<td>2</td>
<td>11.1</td>
</tr>
</tbody>
</table>

According to Table 9, it is revealed that majority 12(66.7) of the teacher-counsellors had lessons between 24-32 per week which gives little room for sufficient time for Guidance and Counselling.
Counseling in schools, whereas 4 (33.3) had between 22-24 lessons and at the same time one is supposed to attend to students even at individual level, which is still uncomfortable for a Head of Department.

Table 10 shows that a majority 1148(40) of the students said they are rarely given enough time to air their problems to the teacher-counsellor and 406 (14.2) strongly put it that they are never given enough time at all. However, a good proportion indicated that they are sometimes given time and a slightly small proportion indicated that they get enough time always.

From the two tables it is clear that heavy workload, on the part of the teacher-counsellor is a hindrance to effective Guidance and Counselling.

**Table 11 Specific timetables set aside for Guidance and Counselling programmes.**

<table>
<thead>
<tr>
<th>Responses</th>
<th>F</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programmes time tabled</td>
<td>13</td>
<td>16.7</td>
</tr>
<tr>
<td>Programmes not time tabled</td>
<td>15</td>
<td>83.3</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>100</td>
</tr>
</tbody>
</table>

Teacher-counsellors were asked if Guidance and Counselling sessions were timetabled, and from the findings in Table 11, shows that 3(16.7) had their programmes timetabled whereas 15(83.3) had no time tables, meaning Guidance and Counselling programmes were haphazardly conducted depending on the need and availability of time.

**Table 12 Adequacy of Guidance and Counselling facilities**

<table>
<thead>
<tr>
<th>Facilities</th>
<th>F</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Not Adequate</td>
<td>18</td>
<td>100</td>
</tr>
</tbody>
</table>

From the interview, all 18(100) teacher-counsellors admitted that facilities for Guidance and Counselling in their schools were not adequate hence making them ineffective in their work.

**Table 13 confidentiality of the teacher-counsellor**

<table>
<thead>
<tr>
<th>Response</th>
<th>F</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Always</td>
<td>22</td>
<td>13.50</td>
</tr>
<tr>
<td>Most times</td>
<td>26</td>
<td>16.0</td>
</tr>
<tr>
<td>Rarely</td>
<td>87</td>
<td>53.4</td>
</tr>
<tr>
<td>Not at all</td>
<td>28</td>
<td>17.18</td>
</tr>
<tr>
<td>Total</td>
<td>163</td>
<td>100</td>
</tr>
</tbody>
</table>
The teachers were asked to indicate the extent to which the teacher-counsellor in their schools keep information on clients confidential and as shown in the Table 13, majority 115(70.6) showed that there is no confidentiality, 22 (13.5) indicated there is good standard of confidentiality and 36(16.0) shows that in most times, they keep the information confidential. This could be the reason why students have a negative attitude towards Guidance and Counselling services.

**Table 14 Communication with the parents of the counselled students**

<table>
<thead>
<tr>
<th>Response</th>
<th>F</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Always</td>
<td>10</td>
<td>6.13</td>
</tr>
<tr>
<td>Most times</td>
<td>20</td>
<td>12.27</td>
</tr>
<tr>
<td>Rarely</td>
<td>81</td>
<td>49.7</td>
</tr>
<tr>
<td>Not at all</td>
<td>52</td>
<td>31.90</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>163</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 14 shows the responses from the teachers on communication between the teacher-counsellor and the parents of the counselled students, 81(49.7) said they rarely communicate unless it is very crucial like when a student cannot improve completely and may be on discipline cases that require suspension or expulsion. In most cases that are extreme, communication is done by either the head teacher or the deputy head teacher. 52(31.9) said there is no communication attempt made at all. From these findings it can be concluded that teacher-counsellors are not effective in their work.

**CONCLUSIONS**

From the findings and discussions the following conclusions were made from the study:-

1. There is a significant relationship between the level of professionalism and effectiveness of the teacher-counsellors in student Guidance and Counselling.

2. Majority of the teacher-counsellors are not trained in Guidance and Counselling.

3. Relatively a good number of Guidance and Counselling services are offered by teacher-counsellors in secondary schools that are in line with the needs of individual students.

4. Majority of the teacher-counsellors kept no records on the students.

5. Other than the teacher-counsellors, parents, peer counsellors, chaplains, students’ body, teachers, head teachers and their deputies play a crucial role in Guidance and Counselling programmes.

6. Students’ negative attitudes towards Guidance and Counselling.
Inadequate time for Guidance and Counselling activities

Lack of facilities

Lack of support from the parents and school administration because it’s not a priority as compared to academics

7. The general provision and management of facilities and resources is still wanting and the provision of an empty room is not enough to effectively run Guidance and Counselling activities in secondary schools.

RECOMMENDATIONS

The findings and conclusions of this study are useful to the Ministry of Education, secondary schools head teachers and all people that they head other educational institutions and all teacher-counsellors. Some recommendations are made below for them to possibly adopt in order to improve the performance of the teacher-counsellors and the Guidance and Counselling departments.

1. Students should be educated and encouraged on the advantages of seeking Guidance and Counselling services.

2. There should be specified times and days when students are supposed to see their teacher-counsellors for Guidance and Counselling and be referred to on the school timetable.

3. The government (MOEST) should train teachers on Guidance and Counselling and deploy them to schools.

4. Already appointed teacher-counsellors should be trained and refresher courses be provided more frequently so as to inject new knowledge consistently to the teacher-counsellors.

5. Teacher-counsellors’ workload should be reduced to give room for Guidance and Counselling programmes and activities.

6. Parents and the entire school community are sensitized on the importance and role of Guidance and Counselling programmes in schools.

7. Schools should provide well equipped Guidance and Counselling offices as Guidance and Counselling activities can be effectively coordinated and provided to the students in such an environment.

8. Peer counsellors should be trained and their activities be monitored by teacher-counsellors.

9. The university and teacher training colleges should offer guidance and Counselling as one of the core study subjects.

REFERENCES

Co-Occurrence of Current Alcohol Use and Mental Health of Adolescents Among Secondary School Students of Nakuru County, Kenya

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1 Kenyatta University, 2 Egerton University

Abstract

Adolescents engage in behaviors that compromise their health and future potentials. However, these behaviors are preventable. The current study was designed to establish association of current alcohol use and mental health state of secondary school students of Nakuru County, Kenya. Multi-stage cluster, stratified proportionate and simple random sampling methods were used to select participating divisions (n=6), schools (n=14) and students (n=1000). Global School based Health Survey (GSHS) was used to collect data on health risk behaviors between February to March, 2009. Sixteen percent (n=161) of students reported use of alcohol 30 days prior to the survey and of these 23.6 (n=38) and
32.9% (n=53) reported low state of mental health and seriously considered attempting suicide respectively. The study established that alcohol drinker was 1.3 (95% C.I: 1.282-1.878) times likely to report low state of mental health than alcohol abstainer. A co-occurrence between adolescents’ mental health and alcohol use provide an opportunity to draw together separate areas of research in designing comprehensive approach that may promote better health and education outcomes in secondary schools.

**Key words:** Adolescents, co-occurrence, current alcohol use, mental health and health risk behavior.

**INTRODUCTION**

Most individuals with alcohol problems initiate drinking during adolescence, a period when not only the body is changing dramatically, but behavioral, cognitive, emotional, and attitudinal changes also take place (Dawson, 2000; Grant et al., 2006; Maggs and Schulenberg, 2005; Semlitz & Gold, 1986). Repeatedly using alcohol (frequency or quantity) at such a critical stage in life may result in detrimental effects on brain development. For example, alcohol exposure has been associated with a greater risk of disrupted hippocampus functions, including memory, in animal models (Spear, 2002; Spear and Varlinskaya, 2005; & White and Swartzwelder, 2005). These alcohol-related cognitive, emotional, and behavioral impairments may then furthermore exert a cascading effect on subsequent health and adjustment (National Research Council, 2004).

Globally, up to 20% of children and adolescents suffer from a disabling mental illness and suicide is the third leading cause of death (12%) among adolescents after homicides (14%) and accidents (37%) (WHO, 2003). With world-wide crises involving children impacted by war, exploited for labor and sex, orphaned by AIDS, and forced to migrate for economic and political reasons, the dimensions of the burden of compromised mental health and mental disorders are increasingly evident. The lack of attention to the mental health of children and adolescents may lead to mental disorders with lifelong consequences that reduce the capacity of societies to be safe and productive (WHO, 2003). Substance abuse is the second most common risk factor for suicide after mood disorders with adolescents and the figure is higher with alcohol or drug misuse playing a role in up to 70% of suicides (Frank et al, 2001; Fadem, 2003).

**Adolescent mental health**

At any given time, about 10% of the adult population globally and about one in three adults attending a primary health center suffers from a mental disorder (Lopez et al. 2006). It is also noted that depression and anxiety (the “common mental disorders”) and alcohol and drug abuse (the “substance abuse disorders”) are the most frequent of all mental disorders. Psychotic disorders, such as schizophrenia and bipolar disorder, although relatively less common, have been documented as profoundly disabling (Kessler, et al, 2005). According to this source, it is no surprise that mental disorders figure prominently in the list of leading global causes of disability. The burden is the greatest during the most productive years of life (young adulthood) when about 75% of all mental disorders seen in adults begin (Kessler, et
al, 2005). It is further noted that among people aged 10 to 59 years in developing countries, four conditions linked to mental health and alcohol abuse can be found in the 10 leading causes of death (road traffic accidents, self-inflicted injuries, violence, and cirrhosis of the liver) (Lopez et al.2006). Furthermore, the same reiterates that if disease burden is measured through the number of years lived with disability (YLD), then unipolar depressive disorders is the leading contributor to disease burden in developing countries; schizophrenia and alcohol abuse disorders also figure in the leading 10 causes of YLD. Altogether, neuropsychiatric disorders account for 9.1% of disability-adjusted life years (DALYs) in low-income countries and 17.7% of DALYs in middle-income countries.

It has also been documented by Wasserman (2005) that global suicide rates among adolescents in the 15-19 age group was 7.4/100,000. Suicide rates were higher in males (10.5) than in females (4.1). This applies in almost all 90 countries studied. The exceptions are China, Cuba, Ecuador, El Salvador and Sri Lanka, where the female suicide rate was higher than the male. Although data on suicides is not readily available in Kenya, according to the 2008 Kenya Police crime report, in 2006 there were 362 suicide cases reported compared to 221 in 2007, a decrease of 34 per cent. But what seemed like a declining trend in 2007 rose to 266 people, in 2008. This averages 20 suicides per month, which are only the reported cases (Wanja, 2010).

Youth with better mental health are physically healthier, demonstrate more socially positive behaviors and engage in fewer risky behaviors (Resnick, 2000). Conversely, youth with mental health problems, such as depression, are more likely to engage in health risk behaviors (Brooks et al. 2002). Furthermore, youths’ mental health problems pose a significant financial and social burden on families and society in terms of distress, cost of treatment, and disability (Busch & Barry, 2007). Most mental health problems diagnosed in adulthood begin in adolescence. Half of lifetime diagnosable mental health disorders start by age 14; this number increases to three fourths by age 24 (Kessler, et al. 2005). The ability to manage mental health problems, including substance use issues and learning disorders, can affect adult functioning in areas such as social relationships and participation in the workforce.

Adolescent alcohol use

Alcohol is most commonly used drug in world and even in Kenya. In USA, alcohol remains widespread with 72% of students indicated to have consumed alcohol (more than a few sips) by the end of high school and 38% had done so by 8th grade. In fact, 55% of 12th graders and 18% of 8th graders in 2008 report indicated that they had drunk at least once in their life (Johnston, O’Malley & Bachman, 2008). According to NACADA Rapid Situation Assessment of Drug and Substance Abuse in Kenya (2007) 8% (n=75) of children aged 10-14 indicated that they have ever used alcohol. Of these, 56 and 44% were male and female respectively. The same children in urban areas are more likely to use packaged legal alcohol (4.1%) than those in rural areas (1.6%). Conversely, the traditional liquor is likely to be consumed by rural children (6.4%) than urban ones (1%). People aged 15-65, 39% were using any type of alcohol; of these 2.6 and 11.7% were in ages 15-17 and 18-24 years
respectively. In Rift Valley where Nakuru District falls, 12.5% respondents indicated that they had ever used alcohol in their life.

Besides the direct effects of intoxication and addiction, alcohol use has been associated with about 20% to 30% of each of oesophageal cancer, liver disease, homicide and other intentional injuries, epilepsy, and motor vehicle accidents worldwide (WHO, 2002). Unintentional injuries are the leading cause of death among 15- to 25-year-olds and many of these injuries are related to alcohol use (Facy 2000). Young people who drink are more likely to use tobacco and other drugs and engage in risk sexual behaviour, than those who do not drink (Hibell et al.; 2000; Bonomo et al., 2001.). Adults who began to use alcohol before age 15 are five times more likely to report previous-year alcohol dependence or abuse than those who began alcohol use at age 21 or older (NSDUH,2004).

**Association of adolescent mental health and alcohol use**

Substance abuse is the second most common risk factor for suicide after mood disorders (Frank et al, 2001). Both chronic substance misuse as well as acute substance abuse is associated with suicide. This is attributed to the intoxicating and disinhibiting effects of many psychoactive substances; when combined with personal grief such as bereavement the risk of suicide is greatly increased (Fadem, 2003). More than 50% of suicides are related to alcohol or drug use. Up to 25% of drug addicts and alcoholics commit suicide. In the United States 16.5% of suicides are related to alcohol (CDC, 2006). Alcoholics are 5 to 20 times more likely to kill themselves while the misuse of other drugs increases the risk 10 to 20 times. About 15% of alcoholics commit suicide, and about 33% of suicides in the under 35’s have a primary diagnosis of alcohol or other substance misuse; over 50% of all suicides are related to alcohol or drug dependence.

In adolescent’s alcohol or drug misuse plays a role in up to 70% of suicide. Adolescents who are intoxicated are at high risk of successful suicide and of hurting others through accidents or violence (Mack & Frances, 2003). While intoxicated, an adolescent who has just broken up with a romantic partner or who has failed an examination may act against herself or himself or others in a way he or she would not when unimpaired. Furthermore, this argument is consistent with the results of past studies that reiterate that adolescents with more alcohol experiences were more likely to experience problems within the attention, thoughts and somatic syndromes as compared with their alcohol naïve counterparts (Spear, 2002; Spear and Varlinskaya, 2005 & White and Swartzwelder, 2005).

**Objectives of the study**

The study aimed to achieve the following objectives:

To determine prevalence of adolescent alcohol use among secondary school students of Nakuru district, Kenya

To establish association of adolescent alcohol use and mental health among secondary school students of Nakuru district, Kenya
METHODOLOGY

Study Design

The study was a cross sectional descriptive survey as data was collected once to establish co-occurrence of adolescent alcohol with their mental health in both public and private secondary schools in Nakuru District, Kenya.

Study Population, Sample Size and Sampling Procedures

The study was carried out in Nakuru District, Kenya. Nakuru District consists of 45 public and 40 private secondary schools with a total student population of 23,404 as at July, 2008. The study focused on 14 schools with enrolment of 6450. A total of 1000 students from 14 secondary schools between ages 13 to 19 were sampled to participate in the study. Of these students, a majority were from public schools (71%) while the remaining were from private schools (29%). The male students were 67% as compared to female who were 37%. The participants were dispersed among all the forms with 19.9, 25.6, 25.2 and 28.8% in the forms 1-4 respectively. Multistage cluster, probability proportionate to size, stratified and simple random sampling methods were used to select the participating divisions, schools and students.

Data collection procedures and Statistical Analysis

Global School-Based Student Health Survey (GSHS) (2003) was used for the data collection. GSHS was adopted from Youth Risk Behavior Survey (YRBS) from US and modified for Kenyan adaptation in 2003. The researchers obtained a letter of introduction from Egerton University which was used to get research authorization and clearance from all the gatekeepers (Ministry of Health, Ministry of Science and Technology and Ministry of Education officers). The research assistants administered the questionnaires to the students who were given 30 minutes to answer the questions and then questionnaires were collected immediately at end of the response time. The data procedure was appropriate as high response rate was expected. Completing the survey was voluntary and students were assured of total confidentiality. Students had an option of answering a question or leaving it blank if they chose to.

Current Alcohol use was defined as ‘During the past 30 days, how many days did you have at least one drink containing alcohol?’ Then it was coded as dichotomous variable (users=1 and non-users=0). Mental health index was formed by summing up scores of questions 28 to 33 in GSHS (2003). Then the index was divided into three categories viz low (6-10), moderate (11-16) and high(17-20). All statistical analyses were conducted with Statistical Package Social Sciences (SPSS) 17.0 software and all tests were done at 0.05 level of confidence. Logistic regression was used to establish the co-occurrence of adolescent alcohol use and low mental health. Chi-square was used to test independence of age, gender and suicidal behaviors with alcohol use.

Ethical considerations
The researchers explained the purpose of the study to participants in order for them to make informed decision on whether to participate in the study or not. To ensure anonymity, the participants were not required to write their names on questionnaires. The identities of schools used were concealed and study findings were not reported on the basis of individual schools. The researchers applied for subject protection permit and research permit from Local Ethics Board and Ministry of Science and Technology respectively.

RESULTS

Prevalence of adolescent alcohol use

The results indicated that there were 16.1% (n=161) of students who indicated that they used alcohol 30 days prior to the study. Of these 11.2 (n=18) and 9.9% (n=16) indicated that they were drank at least 10 days a month and at least 4 drinks per day when they drank respectively. Thirty three percent of the respondents indicated they used wine as compared to 26% who used local brews.

Table 1:

Frequency of Alcohol Drinkers by Type

<table>
<thead>
<tr>
<th>Alcohol type</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beers</td>
<td>33</td>
<td>20.5</td>
</tr>
<tr>
<td>Wine</td>
<td>53</td>
<td>33.0</td>
</tr>
<tr>
<td>Spirits</td>
<td>33</td>
<td>20.5</td>
</tr>
<tr>
<td>Local Brews</td>
<td>42</td>
<td>26.0</td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Results in Table 2 indicate that there was statistically significant relationship between current alcohol use and age of the respondent ($\chi^2 = 19.465$, df=6 p<0.05 ) but significant relationship was not established between gender and alcohol use ($\chi^2 = 1.180$ df=2 p>0.05 ).The majority of alcohol drinkers were aged 16 and above (70.2%) and male drinkers were 64.0%.

Table 2:

Demographic Characteristics and Adolescent Alcohol Use

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Abstainers</th>
<th>Drinkers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Percent</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Association of adolescent alcohol use and mental health

Statistically significant relationship was established between current adolescent alcohol use and mental health ($\chi^2 = 6.037; df=2 p<0.05$). Sixteen percent (n=161) of students who reported use of alcohol 30 days prior to the survey as indicated earlier, 23.6% (n=38) of those had low state of mental health were drinkers as shown in Table 3.

Table 3: Adolescent Mental Health and Alcoholic Use

<table>
<thead>
<tr>
<th>Mental health</th>
<th>Abstainers</th>
<th>Drinkers</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Percent</td>
<td>Frequency</td>
</tr>
<tr>
<td>High</td>
<td>26</td>
<td>3.1</td>
<td>7</td>
</tr>
<tr>
<td>Moderate</td>
<td>671</td>
<td>8.0</td>
<td>116</td>
</tr>
<tr>
<td>Low</td>
<td>142</td>
<td>16.9</td>
<td>38</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>839</strong></td>
<td><strong>83.9</strong></td>
<td><strong>161</strong></td>
</tr>
</tbody>
</table>

$\chi^2 = 6.037; df=2 p<0.05$.

Cross tabulation results in Table 4 indicated that there were statistically significant associations between seriously considering attempting suicide ($\chi^2 = 21.356; df=2 p<0.05$) and making a plan to commit suicide ($\chi^2 = 24.580; df=2 p<0.05$) with alcohol use. Of the students who reported use of alcohol 30 days prior to the survey, 32.9% (n=53) and 31.6% (n=51)
seriously considered attempting suicide and making a plan on how to commit suicide 12 months preceding the study respectively.

**Table 4: Adolescents Suicidal Behaviors and Alcohol Use**

<table>
<thead>
<tr>
<th>Responses</th>
<th>Abstainers</th>
<th>Drinkers</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Percent</td>
<td>Frequency</td>
</tr>
<tr>
<td>Seriously considering attempting suicide during last 12 months</td>
<td>146</td>
<td>17.4</td>
<td>53</td>
</tr>
<tr>
<td>No</td>
<td>692</td>
<td>82.6</td>
<td>109</td>
</tr>
<tr>
<td>$\chi^2$</td>
<td>=21.356;</td>
<td>df=2 p&lt;0.05</td>
<td></td>
</tr>
<tr>
<td>Making a plan on how to commit suicide during last 12 months</td>
<td>131</td>
<td>15.6</td>
<td>51</td>
</tr>
<tr>
<td>No</td>
<td>708</td>
<td>84.4</td>
<td>110</td>
</tr>
<tr>
<td>$\chi^2$</td>
<td>=24.580;</td>
<td>df=2 p&lt;0.05</td>
<td></td>
</tr>
</tbody>
</table>

Logistic regression analysis was used to analyze the likelihood of respondent being in low mental health when one was an alcohol drinker than when abstainer. The model was tested and it was significant ($\chi^2$ =4.790; df=1 p<0.05). Logistic regression analysis indicated that alcohol drinker was 1.3 (95% C.I: 1.282-1.878) times likely to report low state of mental health than alcohol abstainer.

**DISCUSSION**

Sixteen percent of students used alcohol 30 days preceding the survey and results were comparable to past studies that indicated that some students do use alcohol (Johnston, O’Malley & Bachma, 2008; NACADA, 2007). Nakuru being an urban center, packed drinks (wines and beers) were most used type of alcohol which concurred with NACADA Rapid Situation Assessment of Drug and Substance Abuse in Kenya (NACADA, 2007). Being older was risk factor for adolescent alcohol use which was consistent with other past studies. The inferred association between adolescent alcohol use with increased likelihood of low mental health status among students concurred with the findings reported other past studies (CDC, 2006; Mack & Frances, 2003). Prior research has found elevated occurrences of diagnosed mental disorders among alcohol using youths (Sbrana et al., 2005 & Valentiner et al, 2004).

**CONCLUSION**

It is imperative to understand correlates that are more likely to appear during specific developmental stages in order to identify the young people at greater risk of transitioning
into stages of greater alcohol involvement (binging, alcohol abuse or dependence) and intervene to decrease alcohol-related cognitive, emotional, and behavioral impairments. Literature supports that alcohol-using young people were more likely to experience certain emotional or behavioral problems than their alcohol-abstainers counterparts and once alcohol drinking was started, the emergence of certain mental health syndromes was more sensitive to the increased consumption of alcoholic beverages. The current study has revealed that current alcohol use increases the relative risk of low mental health status among students and vice versa. The co-occurrence is not proof of cause-effect but in essence it implies that there is symbiotic relationship between adolescent current alcohol use and low mental health status. Alcohol use is not only risk factor for low mental health but also is negative coping strategy for those with low mental health. Therefore, there is need for a comprehensive program that target more than one behavior patterns that threaten the health and potential of adolescents. Alcohol related interventions need to incorporate strategies that promote mental health of adolescents.

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Abstract

The phenomenal growth of internet usage and size has brought about a unique set of challenges in maintaining the Quality of Service (QoS) as measured by the speed of access to information which is determined by the amount of bandwidth made available to the users. In the past, network administrators have attempted to improve QoS by supplying more bandwidth but internet links have remained perennially slow. Previous studies have focused on determining the optimum bandwidth supply using a variety of stochastic models but this has not helped to reduce the delays experienced by users. Other studies have focused on bandwidth demand as opposed to bandwidth supply to explain the behaviour of internet users. However, bandwidth demand has not been studied when taking into account the type of internet user demanding the bandwidth. The purpose of this study was to model internet traffic data while taking into account the different types of internet users generating the data. The Internet traffic data was collected from a total of 133 users comprising of students, lecturers and other university staff with ages varying between 19 to 48 years. The Internet Traffic Data obtained in the study was found to be skewed, heavy tailed and non-stationary. In addition, the data exhibited strong self similarity and long range dependence (LRD). The TAR, ARMA-GARCH, ARFIMA models captured the non-stationary, nonlinear, self similar and LRD characteristics of the data. The ARFIMA model exhibited the least variability among the fitted models. The MMPP model did not capture any of the key characteristics of the data. No models were fitted to the data sets from the different types of internet users since there were no significant differences observed in their marginal distributions ($p > 0.05$) after carrying out the Z-test for means comparison. The study thus established that the ARFIMA model exhibited the least variability among the fitted models.

Keywords – Markov Modulated Poisson Process (MMPP), self similarity, long range dependence (LRD), bandwidth, variability, non-linear, self similar.

INTRODUCTION

More people are finding themselves dependent on the Internet as its role increases. Just as it happened with the telephone demand in the early part of the last century, individuals, businesses and institutions, are finding that the Internet as a means of communication and as a source of information is fast becoming indispensable (Curtis and McGregor, 2001). In institutions of higher learning there is an increased demand for Internet resources by both students and staff which is used as a tool for research and teaching (Ng’etich, 2004). There is also the demand for open, distance and e-learning globally that has
led to a growing trend in universities to deliver courses and course material via the internet. Thus, the increased demand for bandwidth may be attributed to new academic programs, the increased use of non academic student usage and the inability to adequately capture or monitor this usage (Fleck and McQueen, 2004). The use of the Internet for communication continues to grow with increased use of e-mail, video streaming and more recently Voice over Internet Protocol (VoIP) for data and voice transmission.

However, with this growth in Internet usage, more demands are being placed on the infrastructure and resources available. A natural consequence of this is the need to understand usage patterns and demands to allow for more efficient, equitable usage and allocation of these resources. This requires an understanding of the characteristics of network traffic since the efficient design and control of networks needs to take into account the characteristics of the supported traffic (Nogueira et al, 2001). Statistical models have been developed that closely mimic the behaviour of traffic on the Internet. These models fall in the broad category of stochastic processes.

For the provision of quality Internet services, network dimensioning is becoming a more and more important issue in the Internet (Matoba et al, 2001). Network dimensioning is the process by which a network administrator determines the minimum capacity requirements that will allow for QoS requirements of the network to be achieved. Dimensioning involves planning for peak-hour traffic, i.e. that hour during the day during which traffic intensity is at its peak. The dimensioning process involves determining the network’s topology, routing plan, traffic matrix, and QoS requirements, and using this information to determine the maximum bandwidth required. A dimensioning rule is that the planner must ensure that the traffic load should never approach a load of 100 percent. In order to calculate the correct dimensioning to comply with the above rule, the planner must take on-going measurements of the network’s traffic, and continuously maintain and upgrade resources to meet the changing requirements. (Penttinen, 1999).

QoS standards cannot be achieved unless the network is properly dimensioned. As in other networks such as roads, telephone, electricity and water distribution networks, the fundamental first step in the design of the network is the estimation of the maximum flow required in the network. In this instance, the flow is measured in terms of bandwidth (bits per second). The need to meet QoS requirements for user’s of the Internet has led to numerous studies on bandwidth supply. However, few studies have attempted to model the bandwidth demand of internet users with their characteristics in mind, which is of vital importance for better management of Internet resources and bandwidth in particular. Network administrators and engineers are faced with the fundamental question of what the bandwidth usage patterns from the different types of users on their networks are given that there is a critical lack of methods and models to model bandwidth demand based on the user characteristics. Little effort has been made to use the knowledge on internet user behaviour to develop models with the user characteristics in mind. As the Internet continues to take on greater strategic importance in education and commerce, it is vitally important that methods and models be developed to improve network design and hence improve user experience. This calls for
further study into the development of models for bandwidth demand based on empirical variables and parameters.

The main objective of this study was to develop models for bandwidth demands for different types of Internet users.

The specific objectives of this study were as follows:

1. To model Internet traffic data generated by various types of Internet users based on behavioural and socio-demographic variables in Egerton University, Njoro.
2. To develop suitable mathematical models for use in bandwidth demand estimation based on identified behavioural and socio-demographic variables of different types of internet users in Egerton University, Njoro.

The principal value of this research will be to model the Internet traffic data generated by different types of Internet. This is in order to provide network administrators and engineers with information about the bandwidth demand of different types of Internet users that will enable them to procure sufficient bandwidth and allocate it equitably. Such a model will be a significant contribution to efforts to improve ICT infrastructure in institutions, and hence, by extension, will contribute to efforts at institutional transformation. Many institutions are relying on ICT to help implement institutional reform. By studying and characterizing Internet user behaviour within an institution such as Egerton University, it will be possible to estimate bandwidth requirements for the provision of quality Internet services.

PREVIOUS WORKS

The Internet

The internet is a global interconnection of networks over a variety of communication media for purposes of sharing information. The internet has opened a whole new world of possibilities to governments, businesses and education among other sectors for access and sharing of information. This is in addition to communication, distribution of information, sale of goods and services, research and course delivery. More specifically, the internet is applied in areas such as electronic commerce, accessing information databases, voice and video conferencing, electronic mail, online news, research and entertainment. As a result the internet has experienced a phenomenal growth in terms of size, volume of information and number of users since its inception in the 1970’s.

The increasing number of Internet users has led to increased interest in the need to know the socio-demographic characteristics and behavior of the users. Researchers, network administrators and engineers among other stakeholders have sought to understand the Internet user as a means for better service delivery. The issue of how different Internet users use the Internet is almost as old as the Internet itself and numerous studies have been conducted in this area that have resulted in very valuable insights and understanding of Internet user behaviour.

Hu et al, (2007) observed that there is a correlation between users’ browsing behaviour and their demographic attributes. They observed from their study that 74% of
women seek health or medical information online, while only 58% of men do so. Similarly, 34% of women seek religious information from the Web as compared to 25% of men. They concluded that the diversity of the user’s online browsing activities can be exploited to determine an unknown user’s demographic attributes such as gender and age on the basis of user’s online browsing activities and vice versa.

Paul and Stegbauer (2005) have studied the differences in internet usage between older and younger internet users. They concluded that the use of the Internet by the elderly people may not reach the levels noted for younger users. However, they further state that other factors like gender, education and socioeconomic status also play an important role in determining the differences in internet use by different internet users.

Peslack (2004) conducted a study to determine if significant statistical differences in Internet use existed based on regional and demographic factors within the United States. Factors such as race, region, sex, parental status and marital status were found not to significantly influence Internet use. However age, educational level, and income levels were significant with 71.9 % of respondents in the 18-29 age bracket using the internet as compared to only 19.7% of respondents in the age bracket 65 and above. With regards to education only 6.7% of those with none or 1-8 yrs of education used the internet whereas 83.7% of those with postgraduate level of education used the internet. For respondents earning less than US$10,000 only 33.2% of respondents used the internet as compared to 87.3% of respondents earning above US$ 100,000.

In a rather interesting study, Durndell and Haag (2002) established that there are significant differences between males and females as regards Internet use. Significant gender effects were found throughout, with males tending to report greater computer self efficacy, lower computer anxiety, more positive attitudes towards the Internet and longer use of the Internet than females.

The impact of the Internet on education cannot be underscored particularly in institutions of higher learning. The university communities are becoming increasingly reliant on the Internet for teaching and research purposes. However there are factors that have been found to hinder the full use of the Internet in the universities. Fleck and McQueen (1999), in a survey conducted in 919 university computer centres in the US, observed that appropriate policies, change management and funding were the major factors affecting the use of the internet as a medium for course delivery and research. In a follow-up survey (Fleck and McQueen, 2004), they observed that resource allocation continues to be a high management concern because of changing patterns of internet use in universities.

It is also worth noting that access demand for email, Internet, gaming, and music is increasing and institutions have responded by providing greater access. In addition to these demands, there is a growing trend in universities to deliver courses and course material via the internet. Thus the increased demand for bandwidth may be attributed to new academic programs, increased use of non academic usage by students and the inability to adequately capture or monitor this usage (Fleck and McQueen, 2004).
Modelling Internet Traffic Data

The internet has become the dominant networking technology today. With its growth, there has also been a corresponding increase in the demand for services provided on its platform. Users are also increasingly aware of their need for quality of service as they make use of the internet. There is thus a need to optimize resource allocation such that the provision of services complies with the QoS constraints while maintaining maximum network utilization. Accurate modelling of the traffic is the first step in optimizing resource allocation. These models are important for traffic forecasting, planning and design of networks.

Numerous attempts have been made in the direction of modelling internet traffic data. The most widely studied aspect of the data are packets. They are studied in terms of number, interarrival times and sizes. Flows and sessions have also been studied in similar respects. Several characteristics of the data have been exposed in the process. These include non stationarity, non linearity, self similarity, long range dependence (LRD), short range dependence (SRD), heavy tailed distributions and superposition.

Non stationary behaviour of internet traffic data can arise from the intermingling of data from different sources and destinations as well as shifting mean levels and the changing of parameters of a basic structural model. Internet traffic data has also been found to have a high occurrence of extreme values. This is a characteristic referred to as heavy tailed distribution. Heavy tails can cause long range dependence which in turn implies self similarity and vice versa. A self similar time series has the property that when aggregated (leading to a shorter time series in which each sum is the sum of multiple original points) the new series has the same autocorrelation function as the original. In addition the data looks the same when plotted at all aggregations. Self similarity implies long-range dependence. A process with long range dependence has an autocorrelation function \( r(k) \sim k^{-\beta} \) as \( k \to \infty \), where \( 0 < \beta < 1 \). Thus the autocorrelation function of such a process decays hyperbolically. Long range dependence implies that data has correlations that last a long time.

An accurate traffic model should have the ability to capture the prominent traffic characteristics such as short- and long- range dependence, self-similarity in large-time scale and multifractal in small-time scale. An effective traffic model must reproduce the first and second order statistics of the original traffic sample. The distribution function defines the first order statistics whereas the second order statistics can be accounted for by the autocorrelation function. The second order statistics play an important role in traffic modelling, because traffic auto-correlation is an important factor due to buffer and bandwidth limitations.

Linear time series models, e.g. Auto Regressive (AR) and Auto Regressive Integrated Moving Average (ARIMA) have previously been used to model internet traffic data (Adas, 1997 and Leland et al, 1994). The exponential decay of the autocorrelation function of these models gives them the ability to capture the short-range dependence (SRD) characteristics only. However, it has been shown that the traffic data exhibits a high degree of long-range dependence (LRD) characteristics in addition to SRD. Thus, such models cannot characterize...
the network traffic well. Another related model, known as the Fractional Auto Regressive Integrated Moving Average (FARIMA) model, can capture both SRD and LRD and has been used to model and predict traffic data (Shu et al, 1999 and Corradi et al, 2001). However, this model cannot capture the multifractal which has been found in the network traffic in small time scale. For this reason, another Multifractal Wavelet model (MWM) was introduced to solve this problem (Riedi et al, 1999). MWM model can capture multifractal but cannot predict traffic. On the other hand, it has been found that traffic exhibited non-stationary and non-linear properties and threshold autoregressive (TAR) model has been proposed to model such properties (Kavitha et al, 1999). The Auto Regressive Integrated Moving Average (ARIMA) with Generalized Auto Regressive Conditional Heteroscedasticity (GARCH) model has been found to capture SRD, LRD, selfsimilarity and multifractal characteristics of internet traffic data (Zhou et al, 2006). The Fractional Sum Difference (FSD) model has also been used to model long range dependent internet traffic data (Cao et al, 2001).

**Threshold Autoregressive (TAR) Model**

The threshold autoregressive (TAR) model proposed by Tong (1990), is a nonlinear model comprising of linear AR models which are valid in disjoint sub regions in amplitude. The TAR models and its variants have been successfully used to model time series data that exhibits cyclical properties and LRD features such as the Wolf sunspot numbers and the Canadian Lynx data (Tong, 1990). Both were more accurately modelled using non linear time series. Threshold autoregressive (TAR) models have been extensively employed to analyze economic and financial data. They are especially useful in the study of time series which are characterized by asymmetric adjustment. Polley (2004) estimated a threshold autoregressive model of Canadian/U.S. exchange rate adjustment and found that below the threshold, the process is approximately white noise. Above the threshold, errors are relatively more persistent, but they still dissipate quite rapidly. The US unemployment data has also been modelled using a TAR model by Hansen (1997).

**ARIMA-GARCH model**

ARIMA-GARCH is a combination of linear ARIMA with GARCH variance. It is a conditional mean and conditional variance model. The ARIMA model has been previously used for modeling data where the variance is constant. However internet traffic data has been found to be bursty i.e. a continuous transfer of data without interruption from one device to another, and therefore these models cannot capture such characteristics well. For this reason Zhou et al (2006) introduced the GARCH model to explain the bursty characteristics. The most important contribution of GARCH model is its dynamic variance, where the variance varies over time. Using this conditional variance property they explained the network’s bursty characteristic. The ARIMA-GARCH has been applied to model many financial time series (Bollerslev et al, 1992) (Gourieroux, 1997) (Nakatsuma and Tsurumi, 1996).

**ARFIMA model**

The fractional ARIMA model is a natural generalization of the traditional ARIMA model and provides a powerful tool to simultaneously model the short and long run behavior.
of economic time series. The presence of long or intermediate memory in the series is parsimoniously captured by a single parameter. In addition, through the combination of fractional and integer differencing the model also includes the pure unit as a special case Schmidt and Tschernig (1994). The fractional differencing approach has been applied to a number of economic problems. Cheung (1993) and Tschernig (1994) find long memory in the growth of exchange rates. Diebold and Rudebusch (1989) and Sowell (1992) investigated the U.S. GNP. Tcherig and Zimmerman (1992) analyzed the persistence of German unemployment rates.

Markov Modulated Poisson Process

The Markov Modulated Poisson Process is a special case of the Batch Markovian Arrival Process (BMAP). A Markov Modulated Poisson Process (MMPP) is a doubly stochastic Poisson process whose rate \( \lambda \) is determined by the state of the underlying continuous-time Markov chain. Since a Markov chain has a finite number of states, the Poisson arrival rate takes discrete values corresponding to each state. MMPP models have been used extensively in internet studies. Muscariello et al (2005) describes a MMPP model that accurately approximates the LRD characteristics of internet traffic over the relevant time scales. MMPP models have also been used to model click rate data. This was achieved by Scott and Smyth (2003) by decomposing the MMPP into a superstition of latent Poisson processes which are activated and deactivated by a latent Markov Process. A traffic model and parameter fitting procedure, based on Markov Modulated Poisson Processes (MMPP’s), has been proposed by Nogueira et al, (2001). The traffic model is a superposition of discrete time MMPP’s (dMMPPs), where each dMMPP represents a specific time scale.

METHODOLOGY

Study Area

The study was conducted at Egerton University, Njoro Campus with a pilot study at Daystar University Valley Road Campus.

Sampling

Sample size determination

The final sample size was determined following the pilot study by means of a technique known as Stein’s method (Nassium, 2000). The method is based on the use of a preliminary sample size of \( n_i \). The final sample size \( n \) was then obtained such that the \((1-\alpha)100\%\) confidence interval length is fixed at a value \( L_0 \). In this study Simple Random Sampling Without Replacement (SRSWOR) was used.
The final sample size was obtained from

\[ n = \frac{4N^2\bar{x}^2}{N\bar{x}^2 + 4s^2} \]

Where the standard deviation \( s_1 = 3.481 \) was obtained from the preliminary sample and \( t_{n/2} \) has \( n-1 \) degrees of freedom. The population of the university was approximated at \( N = 7000 \). The \( \alpha \) value selected was \( \alpha = 0.05 \) and the \( t_{n/2} \) value used was \( t_{n/2} = 2.045 \).

The final sample size was obtained from

\[
L_0 = 2.045 \times 3.481 / \sqrt{35} \times \sqrt{(1-35/7000)} \\
= 1.200258675 \\
n = \frac{4N^2\bar{x}^2}{N\bar{x}^2 + 4s^2} \\
= 137.93 \\
= \text{approx 138 respondents}
\]

**Data Collection and Instruments**

The data collected was both qualitative and quantitative in nature. Two methods were used in identifying user behaviour and characteristics as well as obtain data on their browsing.

1. A ‘User Characteristics Questionnaire’ was used to collect demographic and professional/academic information about the internet users. Randomization was achieved by sampling every 5th user who came into the cybercafé. The users sampled used the internet for varying periods of time ranging from 10 minutes to 1 1/2 hours.
2. A computer software program ‘SmartSniff’ Version 1.40 (2008) was then used to measure traffic flows generated by the various users during internet browsing. The data collected by the software consisted of a record of packets, timestamp, protocol, source, destination, data size and total data size.

**RESULTS AND DISCUSSION**

**Internet User Characteristics**

The study targeted a total of 138 respondents but only managed to obtain 133 of them. These respondents used the internet for periods ranging between 30 and 90 minutes. Of the total respondents, 93.3% were students with the rest comprising of lecturers and other administrative staff. 54.9% of the respondents were male and 45.1% were female. Respondent’s ages ranged from 19 to 48 years with 60.9 % of them aged below 24 years. Respondents demonstrated varying characteristics with respect to the frequency, type and reason for internet use. Daily usage was reported by 29.3% of the respondents with a majority 61.7% using the internet 2–3 times a week. The internet sessions were found to vary
moderately with most respondents using the internet for 30 minutes to 1 hour. Respondent’s perception of the internet speeds was not very favourable with 95.5% of them stating that the speeds were either slow or moderate. The internet link used in the study was 256 kbps and was shared among 10 computers.

It was observed that the most commonly visited websites were email, entertainment, search engines and reference websites, respectively. The entertainment websites were observed to contain lots of graphics whereas the email, search engines and reference sites contained relatively fewer graphics and more text. With respect to type of usage, 88% of respondents use the internet to gain new knowledge, 37.6% to seek employment, 30.1% to meet people, 29.3% to relax, 78.2% to exchange information, 24.8% to entertain themselves, 83.5% to research for assignments and 21.1% to download music and software. The search for new knowledge and research for assignments were the greatest uses for the internet as indicated by most respondents.

**Statistical Properties of the Internet traffic Data**

The data collected in the study consists of a record of packets, timestamp, protocol, source, destination, data size and total data size. TCP and UDP protocols were found to account for 99% of the data collected.

TCP traffic accounted for all the variability in the data while on the other hand UDP traffic was characterized by uniform data sizes. The UDP traffic was filtered out and the resulting data was aggregated over two time scales – seconds and minutes to give an average number of bytes per second and per minute for use in modelling and estimation. Table I shows the Basic statistical properties of the internet traffic data

*Table I : Basic Statistical Properties of the Internet Traffic Data.*

<table>
<thead>
<tr>
<th></th>
<th>Seconds time scale</th>
<th>Minutes time scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>29.84000</td>
<td>1,781.96000</td>
</tr>
<tr>
<td>Median</td>
<td>6.00000</td>
<td>1,272</td>
</tr>
<tr>
<td>Variance</td>
<td>5,425.25500</td>
<td>2,414.98300</td>
</tr>
<tr>
<td>Index of Dispersion</td>
<td>181.81150</td>
<td>1,355.23970</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>73.66000</td>
<td>1,554.02000</td>
</tr>
<tr>
<td>Skewness</td>
<td>11.97000</td>
<td>1.57000</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>227.65000</td>
<td>4.41000</td>
</tr>
<tr>
<td>Jarque-Bera statistic</td>
<td>1.00322e+7(0)</td>
<td>39.08350(0)</td>
</tr>
<tr>
<td>No of cases</td>
<td>4,717</td>
<td>79</td>
</tr>
</tbody>
</table>
The data was found to be skewed to the left and heavy tailed as indicated by the values of skewness and kurtosis respectively. In addition, the data was not normally distributed as indicated by the p-value of the Jarque-Bera statistic and the histogram in Figure 1. This implied that a log transformation of the data was necessary in order to fit a distribution with heavy tails like the student’s t-distribution. In addition, traffic variability was captured in terms of the expected value $E[N_t]$, where $N_t$ represents the number of bytes arriving in a time interval $t$, the variance $Var[N_t]$ and the index of dispersion $ID[N_t] = Var[N_t]/E[N_t]$. The index of dispersion represents the degree of variation of the internet traffic data relative to a Poisson process for which the index of dispersion converges to a constant value of unity.

The time plots in Figure 2 and Figure 3 provided basic characteristics of the series. Through the visual inspection, the time plots revealed that the mean and the variance of the data were not constant. In addition the average data size tends to decrease with time. To further confirm the non-stationarity of the data, a plot of the ACF and PACF was done. The correlogram revealed that the data was non-stationary and therefore required some transformation in order to attain stationarity at least in the first moment. The PACF also revealed that a very high order ARMA model could give an appropriate fit for the data. When aggregated, the new series had the same autocorrelation function as the original thus implying self similarity and long range dependence (LRD) in the data.

The transformation of choice was log-differencing, i.e $R_t = logX_t - logX_{t-1}$ where $R_t$ is the transformed series, $X_t$ is the average number of packets at time $t$. The transformed data plotted in Figure 4 and Figure 5 showed stationarity in the mean but the variance was still non stationary as shown by the sharp spikes on both sides of the mean. The sharp spikes revealed the heteroscedasticity and the long tail distribution property of the data. This suggested fitting of a non linear model such as the ARFIMA, Bilinear and the GARCH models to the data. Table II shows the basic statistical properties of the transformed internet traffic data.

| Table II: Basic statistical properties of the transformed internet traffic data. |
|-----------------------------------------------|------------------|------------------|
|                                | Seconds time scale | Minutes time scale |
| Mean                            | -0.00069          | -0.01590         |
| Median                          | 0.00000           | -0.01266         |
| Variance                        | 1.25800           | 0.53357          |
| Index of Dispersion             | 1,835.94150       | 33.55237         |
| Standard Deviation              | 1.12160           | 0.68874          |
| Skewness                        | -0.00295          | 0.73046          |
The transformed data was skewed to the left and heavy tailed as indicated by the values of skewness and kurtosis. The Jarque-Bera test also rejects the null hypothesis of normality. The data exhibited persistent non-stationarity on both time scales even when transformed was observed from the ACF and PACF of the transformed data. This persistent non-stationarity implied the use of models that are capable of capturing the non-linear, non-stationary and LRD characteristics exhibited by the data.

Figure 1: Average packets per Second (Seconds time scale)
Figure 2: Time plot for the Internet Traffic Data - Seconds time scale.

Figure 3: Time plot for the Internet Traffic Data - Minutes time scale.

Figure 4: Time plot for the Transformed Internet Traffic Data - Seconds time scale.
Models of Internet Traffic Data

The first objective of the study was to model the Internet Traffic data obtained from different types of internet users in order to establish if there was a significant difference in the models and subsequently the nature of the underlying data. In order to achieve this several nonlinear times series models were fitted to the aggregate data in order to establish which among them captured key characteristics observed in the data.

**TAR model**

The Threshold Autoregressive (TAR) model is a non-linear model comprised of linear AR models which are valid in disjoint sub regions in amplitude. At a given time, the sub region selected depends on the amplitudes observed over lagged time values. The model that was used in this study incorporated two amplitude ranges, low ($L$), and high ($H$). In the low-state the time series takes on values $L: [0, \hat{\phi}]$ where $\hat{\phi}$ is the threshold value and the high-state accommodates amplitudes $H_1[\hat{\phi}, \infty)$. In addition to this two delay values, $d_1, d_2$, were used in the conditional switching in order to capture the observed deviations about the threshold values. After model fitting a simulation was carried out using the model that showed best fit. A comparison between the original and simulated data in this study revealed that there were significant differences in the marginal distributions of the two data sets in addition to the inability of the model to capture the variability in the data.

**ARMA – GARCH model**

In the untransformed data, it was noted that there was no long-run average level about which the series evolves. This is evidence of a non-stationary time series. The first step in fitting the ARMA-GARCH model was to use ACF and PACF to test the time series’ stationarity, and subsequently a log-difference transformation was applied to the data. The log-differenced data appeared to be quite stable over time, and produced a stationary time series as observed from its ACF (Stationary ACF is balanced more or less evenly around zero correlation while non-stationary ones usually decline continuously with increasing lag). In order to capture the non-stationarity in the second moment the GARCH(r,m) model was utilized, Bollerslev’s (1986). Simulation results obtained from the ARMA-GARCH modeling showed that the model was not to capture variability in the data. In addition the marginal distributions of the original and simulated data were observed to be similar. As a result the ARMA-GARCH model used in this study was not able to explain the network’s bursty characteristic as was the case with Zhou et al (2006).

**MMPP model**

The MMPP model was fitted following a three step parameter estimation algorithm proposed by Bali and Frost (2007). The algorithm uses the internet traffic data to generate the infinitesimal generator matrix $D$ and matrix $\Lambda$ of the MMPP. Simulation results showed that the marginal distribution of the original and simulated data were different with the simulated data exhibiting a higher mean and standard deviation. The MMPP model was thus not able to adequately model the internet traffic data in this study. This is in contrast to the findings of
Nogueira et al. (2001) who had established that the model was able to capture variability over many time scales in the internet traffic data.

**ARFIMA Model**

The Fractional Auto Regressive Integrated Moving Average (FARIMA) model was also fitted to the Internet traffic data in an attempt to capture both the SRD and LRD features of the data. The conditional MLE method with the Gaussian assumption was used to estimate the models parameters’ values as well as the fractional difference value. The optimal model was selected using the Log likelihood and the Schwarz Bayesian Information Criterion (SBC) values, i.e. the model that minimized the SBC but maximized the log likelihood were considered to be the best. The standardized residuals and the squared standardized residuals through Box-Pierce Q statistics in addition to the residual time plots and the residual correlogram were also considered in the selection of the model. The ARFIMA parameter estimates are presented in Table III while the model diagnostics are presented in Table IV.

The model diagnostics indicate that the fitted model was adequate since its standardized and squared residuals were not significantly correlated based on the Box-Pierce Q statistics. In addition, the fitted model was found to be parsimonious with all the estimated parameters being significant. The Jarque-Bera statistic also strongly rejected the normality assumption in all the series.

The selected model parameters were then used to simulate data. The time plots for both the simulated and transformed simulated data are presented in Figure 6 and Figure 7. The time plots revealed that the simulated data was constant in the mean and exhibited less variation in the variance. The exponential decay in the PACF of the transformed data shows that the ARFIMA model captured the non-stationarity and LRD features of the data effectively.

*Table III: Maximum Likelihood Estimates for the ARFIMA model.*
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>P-val</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu$</td>
<td>64.75600</td>
<td>0.000</td>
</tr>
<tr>
<td>$D$</td>
<td>0.310850</td>
<td>0.000</td>
</tr>
<tr>
<td>$\theta_1$</td>
<td>-0.246510</td>
<td>0.000</td>
</tr>
<tr>
<td>$\theta_2$</td>
<td>-0.112660</td>
<td>0.000</td>
</tr>
</tbody>
</table>

**Table IV: ARFIMA Model Diagnostics.**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log Likelihood</td>
<td>-8,025.56000</td>
</tr>
<tr>
<td>Schwarz Criterion</td>
<td>-8,043.84000</td>
</tr>
<tr>
<td>Hannan-Quinn Criterion</td>
<td>-8,035.51000</td>
</tr>
<tr>
<td>Akaike Criterion</td>
<td>-8,030.56000</td>
</tr>
<tr>
<td>Sum of Squares</td>
<td>3.89845e+006</td>
</tr>
<tr>
<td>R-Squared</td>
<td>0.20870</td>
</tr>
<tr>
<td>R-Bar-Squared</td>
<td>0.20660</td>
</tr>
<tr>
<td>Residual SD</td>
<td>50.99220</td>
</tr>
<tr>
<td>Residual Skewness</td>
<td>3.40700</td>
</tr>
<tr>
<td>Residual Kurtosis</td>
<td>23.11030</td>
</tr>
<tr>
<td>Jarque-Bera Test</td>
<td>28,178.600000(0)</td>
</tr>
<tr>
<td>Box-Pierce $Q(12)$</td>
<td>17.63870 (0.127)</td>
</tr>
<tr>
<td>Box-Pierce $Q^2 (12)$</td>
<td>3.14570(0.994)</td>
</tr>
<tr>
<td>Observations</td>
<td>1,500</td>
</tr>
</tbody>
</table>
Figure 6: Time plot for the Simulated Internet Traffic Data – (ARFIMA) Seconds time scale.

Figure 7: Time plot for the Transformed Simulated Internet Traffic Data – (ARFIMA) Seconds time scale.

Figure 8: Histogram of the Simulated Internet Traffic Data (ARFIMA).

Table III presents the basic statistical properties of the Simulated Internet Traffic Data for the ARFIMA model. The marginal distribution of the original and simulated data were observed to be different with respect to the values of skewness, kurtosis and normality. The simulated data was not skewed and clustered around the mean as indicated by the values of skewness and kurtosis as well as the histogram in Figure 8. The simulated data was normally distributed as indicated by the p-value of the Jarque-Bera statistic. The index of dispersion of the final ARFIMA model was significantly lower compared to that of the original data. Thus
the ARFIMA model was able to adequately capture prominent characteristics of the data such as variability, SRD and LRD. This finding is consistent with those of Schmidt and Tschernig (1994) who determined that the ARFIMA model was able to simultaneously model the short and long run behavior of the time series through the combination of fractional and integer differencing.

CONCLUSIONS

Introduction

In this study Internet Traffic data was collected from different types of internet users and modelled by means of various nonlinear time series models. An attempt was also made at identifying suitable models for use in estimating bandwidth demands for the different types of internet users.

Data characteristics

The Internet traffic data was collected from various types of users comprising of students, lecturers and other university staff with ages varying between 19 to 48 years of age. The Internet Traffic Data obtained in the study was found to be skewed, heavy tailed, nonlinear and non-stationary. In addition the data exhibited strong self similarity and long range dependence (LRD).

Bandwidth demand modelling

Given the observed characteristics of the data, various nonlinear time series models were considered for fitting to the data. The Threshold AutoRegressive (TAR) model was first fitted to the data. The model fitting process involved the identification of a suitable threshold value and delay values. Subsequently the data was classified into the various regimes and models were fitted. The TAR model fitting process resulted in adequate model that captured the non-stationary, nonlinear, self similar and LRD characteristics of the data. However, the TAR model did not attain parsimony and its parameter estimates were insignificant. The model still showed evidence of skewness and heavy tails in addition to having significant variability.

The ARMA-GARCH model was then fitted to the data in an attempt to capture this variability as well as the non stationary in the second moment. The ARMA-GACRH model also captured the non-stationary, nonlinear, selfsimilar and LRD characteristics of the data. The model was parsimonious and had significant parameter estimates in addition to having less variation. The GARCH conditions for covariance stationarity were however violated.

The ARFIMA model was also considered and the model obtained was parsimonious with significant parameter estimates. The model captured the non-stationarity and LRD features of the data effectively. The resulting simulation was a normally distributed data set that exhibited significantly less variability as compared to the original data thus the model was able to capture the variability in the data effectively. The ARFIMA model is therefore recommended for modelling and forecasting internet traffic data generated by the internet users at Egerton University Njoro.
The MMPP model was also fitted and it was not able to capture the non-stationarity and LRD features of the data as well as the variability in the data effectively.

Conclusions

From the results obtained, the ARFIMA model was found to be the most suitable model for use in modelling the internet traffic data. There was however, no significant difference in the marginal distributions of the data obtained from the different types of internet users. The study also revealed that there was no significant correlation between the selected user socio-demographic variables and bandwidth demand. The lack of correlation implies that, despite the perceived differences between the users with respect to age, education and gender, there are similarities in internet usage by these users in Egerton University, Njoro.

Recommendations from the study

The following are the recommendations from, the study

1. The ARFIMA model is suitable for modelling the internet traffic data obtained in the study.
2. That bandwidth allocation be done on the basis of the number of users instead of their characteristics.

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ASSESSMENT OF OCCURRENCE AND CONCENTRATIONS OF XENOBIOTICS IN SELECTED FISH SPECIES FROM LAKE NAIVASHA, KENYA

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Abstract

Aquatic organisms are good bio-indicators of the environmental health in freshwater lakes; Xenobiotics are foreign materials to the organisms’ body and do not occur naturally in nature. Xenobiotics accumulate in adipose tissues due to high affinity to fatty tissues. This paper reports the levels of Organochlorine pesticide (OCPs) residues, their metabolites and Polychlorinated Biphenyl (PCBs) congeners in selected fish species from Lake Naivasha, Kenya. PCBs and OCPs are persistent organic pollutants most of which are banned or under restricted usage. The levels of p, p’-DDT, p, p’-DDE, p, p’-DDD, heptachlor, heptachlor epoxide, aldrin, dieldrin, CB28, CB52 and CB105 were determined in Tilapia, Orechromis leucostictus, Common carp, Cyprinus carpio, and Mirror carp, Cuprinus spectacularus, during the months of September - December 2008. The concentrations ranged within Below Detection Limit (BDL) - 0.29 for Heptachlor epoxide, 0.42 - 4.19 µg/Kg, for
Heptachlor, 0.43 - 4.73 Aldrin, BDL - 0.34 Dieldrin, p, p′ - DDT, BDL - 6.69 p, p′ - DDE, BDL - 27.15 p, p′ - DDD, BDL - 28.87 methoxychlor, 0.05 - 5.56 CB28, 0.012 - 13.91 CB52 and BDL - 0.45 CB105. The OCPs and PCBs varied widely between and within species. C. spectacularus showed high levels followed by C. carpio and O. leucostictus respectively. Trophic position, lipid contents, weight and age/size of fish were important parameters in Xenobiotics concentrations in specimens. The occurrences of the Xenobiotics in fish indicate recent use in the catchment. The mean values and ranges of residues found in fish were below the FAO/WHO maximum acceptable limits in fish and sea food however increased monitoring is recommended to detect any changes.

Key words: Pesticides, Organochlorine, Pollution, PCBs, Methoxychlor, DDT, Heptachlor.

Introduction and Literature Review.

Polychlorinated organic pollutants (POPs) use has resulted in acute and chronic ecological damage, either by direct injury to both target and non-target organisms such as insects, primary producers, crustacea, anthropod, birds and fish, or by indirect effects such as elimination of natural enemies (UNEP, 1999). POPs are manmade and persistent in the environment, the hydrophobic nature lead to bio-accumulation in fatty tissues thus entering the food chain (UNEP, 1999). POPs find wide applications in agriculture in vector control and in industry in Kenya (Mitema and Gitau, 1992; Mugacia et al., 1992; Gitahi 2002). Once applied in the fields they are transported to aquatic bodies by rain runoff, rivers and streams and associate with biotic and abiotic macro-particles (Wandiga, 2001; Wandiga et al., 2002; Getanga et al., 2004). They are removed from the water column to the benthic layers by settling of the particles into the water column (Jalili et al., 2007). The lipophilic nature, hydrophobicity, low chemical and biological degradation rates lead to their accumulation in biological tissues and subsequent magnification in organisms progressing up the food chain (Mugacia et al., 1992; Wandiga 2001; Gitahi et al., 2002; Mavura and Wangila, 2004).

Consumption of fish from contaminated water bodies is considered to be an important route of exposure to persistent Organochlorine compounds (Mavura and Wangila, 2004; Mwevura et al., 2002). Detectable levels of pesticide residues have been reported in inland waters in Kenya (Mugacia et al., 1992; Wandiga, 2001; Gitahi et al., 2002; Getanga et al., 2004).

Polychlorinated biphenyls (CAS number 1336-36-3) are a class of organic compounds with 1 to 10 chlorine atoms attached to biphenyl, which is a molecule composed of two benzene rings. PCBs were used as coolants and insulating fluids ('transformer oil') for transformers and capacitors especially in components of early fluorescent light fittings, the locomotive's electrical transformers, plasticizers in paints and cements, stabilizing additives in flexible PVC coatings of electrical wiring and electronic components, pesticide extenders, cutting oils, reactive flame retardants, lubricating oils, hydraulic fluids, sealants (for caulking in schools and commercial buildings (Rudel et al., 2008), adhesives, wood floor finishes (such as Fabulon and other products of Halowax in the U.S.) (Rudel et al., 2008; Kathleen et al., 2009), paints, de-dusting agents, water-proofing compounds, casting agents, vacuum pump fluids, fixatives in microscopy, surgical implants, and in carbonless copy paper. Due to PCB's toxicity and classification as a persistent organic pollutant, PCB production was banned by the United States Congress in 1979 and by the Stockholm Convention on Persistent Organic Pollutants in 2001 (Kathleen et al., 2009).
Due to the undesirable effects on environmental quality and aquatic life, the production and usage of POPs were banned or severely restricted during the 1970s and 1980s in most developed countries. However, their demand has been increasing in some developing 124 countries in Africa, Latin America and Asia (Tanabe et al., 1993). There has been widespread use of chlorinated pesticides in Kenya in the last four decades because agriculture has been the mainstay of Kenya’s economy. Organochlorine pesticides have been extensively used and particularly, DDT and endosulfan for the control of maize and cotton pests. Lindane, dieldrin, aldrin, endrin and heptachlor have also had wide usage in Kenya, which has made their presence ubiquitous in the environment (Wandiga, 2001).

Lake Naivasha, Kenya’s second largest freshwater lake was recognized as a site of international significance and was awarded RAMSAR status in 1995 (RCW, 2010), however in recent years the lake has undergone significant ecological changes leading its classification as a RAMSAR site requiring urgent attention to save it from extinction.

The purpose of this study was to assess occurrence and concentrations of $p, p'$- DDT, $p, p'$- DDE, $p, p'$- DDD, heptachlor, heptachlor epoxide, aldrin, dieldrin, CB28, CB52 and CB105 in Tilapia Oreochromis leucostictus, Common carp, Cyprinus carpio, and Mirror carp, Cuprinus spectacularus, from the Lake Naivasha basin, Kenya.

Materials and methods

Field sampling

Sampling was carried out November 2008 and May 2009. Fish net caught O. leucostictus, C. carpio and C. spectacularus specimens were bought from licensed fishermen and identification done by the Kenya Marine and Fisheries Research Institute (KEMFRI) staff. Fish specimens were wrapped with aluminum foils and transported to the laboratories in cooler boxes under ice. The samples were extracted immediately and analyzed for $p, p'$- DDT, $p, p'$- DDE, $p, p'$- DDD, heptachlor, heptachlor epoxide, aldrin, dieldrin, CB28, CB52 and CB105 in Tilapia Oreochromis leucostictus, Common carp, Cyprinus carpio, and Mirror carp, Cuprinus spectacularus, from the Lake Naivasha basin, Kenya.

Extraction

Twenty grams samples were taken in triplicates and mixed with 20 g analytical grade anhydrous sodium sulfate in a mortar and crushed to give a homogeneous dry mixture. The mixtures were transferred into flasks and shaken for about 15 minutes with HPLC grade dichloromethane. The extracts were filtered through a glass wool plug into an evaporating flask and extraction repeated three times, with 50 cm$^3$ of dichloromethane. The extracts were pooled and evaporated completely at 40 ºC with a rotor vapor leaving only the lipid portion.

The pesticides were salted out through partitioning by dissolving in HPLC grade petroleum ether and 650 ml distilled water, 20 ml phosphate buffer pH 6.0, and shaken with hexane. 500 ml distilled water and 50 ml saturated sodium sulfate was then added and shaken vigorously. The aqueous layer was discarded and the hexane layers combined. The hexane extract was concentrated in rotary vapor.
Clean up

The extracts were cleaned by passing through a column packed with analytical grade florisil from Florisin Company packed with a one inch layer of anhydrous sodium sulfate both at the top and below the florisil.

Analysis

Sample analysis was done using Varian CP 3800 Gas Chromatograph equipped with Electron Capture Detector. Separation was done using BPX 5 capillary column of dimensions 30 m x 0.25 mm x 0.25 µm film thickness. Confirmatory analysis was done using BPX35 capillary column of dimensions 50 m x 0.25 mm x 0.25 µm film thickness.

A temperature program was used starting from 90 °C (with hold time of 3 minutes), increased to 215 °C at 8 °C/min (with hold time of 25 min), then increased to 270 °C at 5 °C/min (with hold time of 5.37 min), and finally ramped to 275 °C at 5 °C/min (with hold time of 18.63 min). The carrier gas was high purity helium (99.995%) with white spot nitrogen as the makeup gas. Quantification followed external calibration method using high purity pesticide reference standards mixture obtained from Ultra Scientific USA.

Quality Control and Quality Assurance

All sampling, extraction and analysis were done in triplicate to allow verification detected pesticide residues. The samples were spiked with PCB 155 during extraction and PCB 198 during analysis to minimize errors due to detector fluctuations. Recovery tests were also carried out using the reference pesticide standards to determine performance of the methodology. Quantification of pesticide residues was carried out using high purity pesticide reference standards.

Results

The average percentage recoveries were determined by spiking a known sample of lipid with standard and the sample treated using the analytical procedure, results are presented in Table 1. Precision and accuracy were also determined as measures of quality of analytical data and are presented.

Table 1. Quality control and assurance data for pesticide and PCB residues in fish.

<table>
<thead>
<tr>
<th>OCPs</th>
<th>Average recovery (%)</th>
<th>RSD</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>p, p’-DDT</td>
<td>79.56 ± 2.89</td>
<td>9.1± 1.8</td>
<td>90.2± 2.3</td>
</tr>
<tr>
<td>Aldrin</td>
<td>80.23 ± 2.12</td>
<td>12.2± 0.9</td>
<td>88.8± 3.4</td>
</tr>
<tr>
<td>Heptachlor</td>
<td>76.12 ± 1.56</td>
<td>8.5± 2.5</td>
<td>87.2± 2.9</td>
</tr>
<tr>
<td>CB105</td>
<td>83.24± 2.56</td>
<td>6.7± 1.3</td>
<td>92.3± 3.1</td>
</tr>
</tbody>
</table>

Mean ± Standard Deviation, n = 3.
Lipid content (% wt/wt), length (cm), moisture (%), and weight (g) of Fish specimens were determined and are presented in Table 2.

**Table 2.** Lipid content (% wt/wt), length (cm), moisture (%), and weight (g) of Fish specimens

<table>
<thead>
<tr>
<th></th>
<th><em>O. leucostictus</em></th>
<th><em>C. carpio</em></th>
<th><em>C. spectacularlus</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lipid content (%)</td>
<td>1.87 ± 0.97</td>
<td>0.78 ± 0.01</td>
<td>0.92 ± 0.19</td>
</tr>
<tr>
<td>Moisture content (%)</td>
<td>78.89 ± 3.07</td>
<td>79.22 ± 3.81</td>
<td>79.78 ± 1.25</td>
</tr>
<tr>
<td>Weight (g)</td>
<td>202.69 ± 33.05</td>
<td>829.96 ± 196.67</td>
<td>765.13 ± 29.75</td>
</tr>
<tr>
<td>Length (cm)</td>
<td>22.57 ± 1.02</td>
<td>42.1 ± 3.94</td>
<td>41.66 ± 0.76</td>
</tr>
</tbody>
</table>

Mean ± Standard Deviation, n = 3.

The mean weight and length show similar trends and were highest for *C. carpio* followed by *C. spectacularlus* and *O. leucostictus* respectively. *O. leucostictus* had the highest percentage lipid content of 1.87 ± 0.97, 0.78 ± 0.01 *C. spectacularlus* and 0.92 ± 0.19 *C. carpio*. The moisture contents were within the range of 78.89 - 79.78 %, there was no significant difference at p=0.05. Organochlorine pesticides were determined in *O. leucostictus*, *C. carpio*, and *C. spectacularlus* data is presented in Table 3.

**Table 3.** Organochlorine pesticide residues (µg/Kg, wet weight) in Fish specimens

<table>
<thead>
<tr>
<th></th>
<th><em>O. leucostictus</em></th>
<th><em>C. carpio</em></th>
<th><em>C. spectacularlus</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>p, p’ - DDT</td>
<td>BDL - 1.91</td>
<td>BDL - 7.26</td>
<td>BDL - 0.72</td>
</tr>
<tr>
<td>p, p’ - DDE</td>
<td>0.21 - 0.47</td>
<td>0.14 - 0.51</td>
<td>0.21 - 6.69</td>
</tr>
<tr>
<td>p, p’ - DDD</td>
<td>BDL - 21.13</td>
<td>BDL - 27.15</td>
<td>0.23 - 4.33</td>
</tr>
<tr>
<td>Heptachlor</td>
<td>0.410 - 1.01</td>
<td>0.42 - 4.19</td>
<td>0.81 - 1.58</td>
</tr>
<tr>
<td>Heptachlor epoxide</td>
<td>BDL - 0.03</td>
<td>BDL - 0.14</td>
<td>0.14 - 0.22</td>
</tr>
<tr>
<td>Aldrin</td>
<td>0.43 - 1.63</td>
<td>0.17 - 2.89</td>
<td>1.35 - 4.73</td>
</tr>
<tr>
<td>Dieldrin</td>
<td>BDL</td>
<td>BDL - 1.19</td>
<td>BDL - 1.58</td>
</tr>
</tbody>
</table>

Mean ± Standard Deviation, n = 3, BDL - Below detection limit

*p, p’- DDT and its metabolites p, p’- DDE and p, p’- DDD residues were analyzed and ranged within BDL - 7.26 µg/Kg, wet weight (Table). p, p’- DDE was detected in all specimens and ranged within 0.14 - 6.69 µg/Kg, wet weight. The highest concentration of p, p’- DDE was found in *C. spectacularlus*, whereas *C. carpio* recorded the highest*
concentrations for \( p, p' \)- DDD and \( p, p' \)- DDT. The concentration of \( p, p' \)- DDD were high in most of the cases, followed by \( p, p' \)- DDT and \( p, p' \)- DDE respectively. The high levels of \( p, p' \)- DDD compared to \( p, p' \)- DDT implied degradation of DDT to the \( p, p' \)- DDD metabolite and \( p, p' \)- DDE.

Among the screened pesticides, heptachlor was detected in all specimens; however heptachlor epoxide was not detected in all specimens analyzed (Table 3). Results indicate low concentrations of the epoxide compared to heptachlor indicating recent use of heptachlor in the catchment. The highest concentrations of heptachlor were recorded in \( C. carpio \) followed by \( C. spectacurlus \) and \( O. leucostictus \) respectively. Compared to its main metabolite heptachlor epoxide, heptachlor concentrations were 10 to 50 times higher for most specimens. The highest level of heptachlor epoxide is found in \( C. carpio \) followed by \( C. spectacurlus \) and \( O. leucostictus \) respectively. The fact that heptachlor was detected in fish samples indicate recent use of the pesticide in the catchment. In addition, the high levels of heptachlor compared to heptachlor epoxide imply the possibility of recent use of heptachlor.

Aldrin was detected in all specimens whereas dieldrin was detected in \( C. carpio \) and \( C. spectacurlus \) only (Table). Aldrin ranged within 0.17 - 4.73 \( \mu \)g/Kg, wet weight, the highest concentrations were found in \( C. spectacurlus \), \( C. carpio \) and \( O. leucostictus \) respectively. Aldrin is converted in the environment to dieldrin through epoxidation; the low dieldrin concentrations could indicate recent use of aldrin in the catchment. Dieldrin was not detected in \( O. leucostictus \) but higher levels were registered in \( C. spectacurlus \) compared to \( C. carpio \).

The levels of CB28, CB52 and CB105 were determined in fish specimens and the results are presented in Table.

**Table 4.** Polychlorinated biphenyls concentrations (\( \mu \)g/Kg, wet weight) in Fish specimens

<table>
<thead>
<tr>
<th></th>
<th>( O. leucostictus )</th>
<th>( C. carpio )</th>
<th>( C. spectacurlus )</th>
</tr>
</thead>
<tbody>
<tr>
<td>CB28</td>
<td>0.07 - 0.19</td>
<td>0.17 - 5.57</td>
<td>0.19 - 1.61</td>
</tr>
<tr>
<td>CB52</td>
<td>0.04 - 3.08</td>
<td>0.11 - 1.56</td>
<td>0.19 - 13.94</td>
</tr>
<tr>
<td>CB105</td>
<td>BDL - 0.43</td>
<td>BDL - 0.33</td>
<td>BDL - 0.45</td>
</tr>
</tbody>
</table>

Mean \( \pm \) Standard Deviation, \( n = 3 \), Below detection limit - BDL

CB28 was detected in all samples analyzed (Table 4), this ranged within 0.07 - 5.57 \( \mu \)g/Kg, wet weight, the highest concentrations were found in \( C. carpio \) followed by \( C. spectacurlus \) and \( O. leucostictus \) respectively. CB28 concentrations are appreciably low in \( O. leucostictus \) compared to other species. CB52 was detected in all specimens and ranged within 0.04 - 13.94 \( \mu \)g/Kg, wet weight, the highest concentrations were recorded in \( C. spectacurlus \) and the lowest in \( O. leucostictus \) however CB52 was higher in \( O. leucostictus \) than in \( C. carpio \) unlike CB52. CB105 was not detected in all specimens. The study shows that the highest CB105 were recorded in \( C. spectacurlus \) followed by \( O. leucostictus \) and \( C. carpio \) respectively. The study show wide variations both between and within samples.
Conclusions

The detection of xenobiotics in fish indicate recent use of the chemicals or mixtures in the catchment. The determined xenobiotics are banned or under restricted use in Kenya, this calls for regular monitoring to identify sources and to detect changes. Though the chemicals were in low concentrations they are likely to adversely affect the health and well being of the aquatic life and should thus be banned.

Acknowledgements

The authors wish to acknowledge Jomo Kenyatta University of Agriculture and Technology, Kenya, the Finnish Government for providing scholarship for study at the Lappeenranta University of Technology through the CIMO- N-S-S.

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EFFECT OF HYDROGEN ON THE STRUCTURAL, OPTICAL AND ELECTRICAL PROPERTIES OF DC MAGNETRON-SPUTTERED TiO$_2$:Nb TCO FILMS

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Abstract

TiO$_2$:Nb thin films have been fabricated by DC magnetron sputtering at various hydrogen gas flow rates between 0 and 3 sccm equivalent to a hydrogen partial pressure of 0 and 0.334 mTorr. The effect of the gas on films was studied at two different temperatures and the optical, electrical and structural properties were investigated. The results show that at high temperature ~ 400°C, an increase in hydrogen pressure induces anatase to rutile phase transition while at a lower temperature 250°C, anatase phase is maintained even with the increase in hydrogen partial pressure. The work also shows that an increase in hydrogen partial pressure increases the resistivity of the TiO$_2$:Nb films.

Keywords: TNO, optical properties, resistivity, titanium oxide, sputtering, thin films

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1. Introduction

Transparent and conducting TiO$_2$:Nb (TNO) is now among high quality TCO materials such as ITO, ZTO and FTO [1], with the attainment of resistivity values in the order of $10^{-4}$ Ω-cm [1,3,4]. The abundance of titanium coupled with the environmental friendliness of its oxides means that TNO stands a good chance of being incorporated into the existing technologies as a replacement for the conventional TCO’s or in emerging applications. For instance, it has been shown that TNO TCO properties can be used to fabricate a spectrally selective reflector surface for solar energy applications [5,6].

Several techniques have been used to fabricate TNO [7-9, x, xi, xii, xiii, xiv, xv] and among them is DC magnetron sputtering which although conceptually simple, is a complex and non-linear process which involves many interdependent parameters [xvi]. The presence of the reactive gas at both the cathode surface and the substrate results in strong interactions of the reactive gas not only with the condensing material but also with the cathode surface, the so-called target poisoning. This often leads to a drastic drop in the deposition rate and may lead to films with undesired stoichiometry. One way of stabilizing the process is by introducing some hydrogen gas into the plasma [xvii, xviii]. Sato et al reported an increase in resistivity from 1.6 x $10^{-3}$ Ω-cm to the order ~$10^{-2}$ Ω-cm for TNO films fabricated at a pH$_2$ of 1% (=0.075mTorr) and 5% (=0.375 mTorr) respectively [xix]. While these films are among those reported which were fabricated on unheated substrates, some authors have reported conducting films resulting from TiO$_2$:Nb deposited on heated ones [7-15]. In both cases, the films were post-heat treated in a reducing atmosphere. In this work, films were made at
different temperatures with and without hydrogen gas in the plasma and their properties analyzed. The effect of hydrogen and temperature on film structure, optical and electrical properties is reported.

2. Film deposition

Thin films of TiO$_2$:Nb were made by dual-target reactive dc magnetron sputtering following procedures described elsewhere [5]. Sputtering took place in Ar + O$_2$ + H$_2$, having at least 99.995 % purity, mixed so that the Ar/O$_2$/H$_2$ ratio was 60/3.5/z with 0 < z < 3 sccm. The sputter pressure was set at 8.5 mTorr, i.e., the H$_2$ partial pressure was 0 < $p_{H2}$ < 0.334 mTorr. The films were formed on glass plates at temperatures of 250°C and 400 °C. The films were then annealed in vacuum at 450°C for 30 minutes and left to cool therein. The presence of Nb in the films was analysed by Rutherford Back Scattering and complimented by Energy Recoil Detection Analysis techniques as reported in our earlier work where both methods showed Nb concentration in the films as 3.7 at.% [6].

3 Results and discussion

3.1 Structural properties

Film structures were studied by X-ray diffraction (XRD) using a Siemens D5000 instrument operating with CuK$_\alpha$ radiation. Figure 1 shows results for different $p_{H2}$s for two sets of films prepared at different temperatures. The XRD peaks could be unambiguously assigned to reflections due to the anatase and rutile phases of TiO$_2$ (JCPDS data cards 00-021-1272 and 00-21-1276, respectively). The diffraction peaks at $2\theta = 25.2^\circ$ and $27.2^\circ$ indicate some preferential orientation along the (004) direction and (110) for anatase and rutile phase respectively. Films deposited at 250°C change from almost amorphous to crystalline after post-deposition heat treatment and maintain the anatase phase even at high hydrogen flow (0.268 mTorr). However, as shown in Figure 2, those deposited at 400°C exhibit crystalline structure before annealing in vacuum and at $p_{H2} = 0.268$ mTorr, a strong peak associated with rutile phase is evident. A comparison of the diffractograms for as-deposited and annealed films reveal that at increased $p_{H2}$, there are traces of rutile, and higher $p_{H2}$s lead to a growing portion of rutile until the anatase and rutile phases are of comparable magnitude at $p_{H2} = 0.35$ mTorr (Figure 3). These observations lead to a conclusion that increased H$_2$ flow levels in the plasma induces growth of rutile phase.
Figure 1 XRD spectra for films at different hydrogen partial pressure (pH$_2$) deposited at 250°C in as-deposited state (a) and post-heat treated in vacuum at 450°C for 30 minutes. A and R represents anatase and rutile phases of TiO$_2$ respectively.
Figure 2 X-ray diffractograms for TiO$_2$:Nb films made by sputtering at the shown H$_2$ partial pressures at 400°C.

Fig. 3. Comparison of X-ray diffractograms for TiO$_2$:Nb films made by sputtering at the shown H$_2$ partial pressures: a. as-deposited and b. annealed at 450°C for 30 minutes in vacuum.

3.2 Optical Properties

3.2.1 Reflectance and transmittance data

Spectral normal transmittance $T(\lambda)$ and near-normal reflectance $R(\lambda)$ were recorded in the 300 $< \lambda <$ 2550 nm wavelength range by use of a Perkin-Elmer Lambda 900 double-beam spectrophotometer and having a barium sulphate film as reflectance standard. Figure 4 shows data for zero, intermediate, and high value of $p$H$_2$ for as-deposited at 250°C and after they
were annealed in vacuum for 30 minutes at 450°C. The as-deposited R and T data indicates that the optical properties were insensitive to the increase in H₂ flow before annealing. This contrasts with data for films deposited at a higher temperature (400°C) where the largest pH₂ tends to give a low transmittance and a high reflectance at the longest wavelengths (Figure 5). When the two sets of films (prepared at 400°C and 250°C) were annealed, there was a remarkable change in transmittance and reflectance especially for those deposited at a lower temperature (250°C). The change is in conformity with XRD data for both cases as observed previously where the observed net change in the degree of crystallinity before and after annealing was highest in films deposited at 250°C.

Fig. 4. Spectral transmittance (T) and reflectance (R) for TiO₂:Nb films made by sputtering at the shown H₂ partial pressures at 250°C for as-deposited case (a) and annealed at 450°C in vacuum (b).
Fig. 5. Spectral transmittance ($T$) and reflectance ($R$) for TiO$_2$:Nb films made by sputtering at the shown H$_2$ partial pressures at 400°C for as-deposited case (a) and annealed at 450°C in vacuum (b).

3.2.2 Band gap

The optical band gap $E_g$ was evaluated from the standard expression [xxi]

$$\alpha \propto (h\nu - E_g)^n$$

where $\alpha$ is absorption coefficient evaluated using the expression [xxii]:

$$\alpha = \frac{1}{d} \ln \left( \frac{1-R}{T} \right)$$
$d$ is the film thickness, $h\nu$ is photon energy, and $m = 2$ and accounts for the fact that the indirect allowed transitions across the band gap are expected to dominate. Fig. 6 shows data on $(a h \nu)^{1/2}$ vs. $h \nu$ for TiO$_2$:Nb as-deposited films and annealed films. A band gap of $\sim$3.3 eV is obtained from the intersection of the fitted straight line and the abscissa for films deposited at 250°C. There was no noticeable change in band gap with increase in pH for films deposited at this temperature. For films deposited at $\sim$ 400°C, there was a shift to lower energy with increase in pH$_2$ and it was more pronounced for annealed films as can be seen in Figure 7. As compared with anatase TiO$_2$ ($E_g$=3.2 eV), rutile TiO$_2$ has a smaller band gap ($E_g$=3.0 eV). However, these values concern single crystals or well-crystallised samples. The values of band gap cited for weakly crystallized thin films [xxiii, xxiv] are usually higher. Impurity doping also plays a role in band gap modification in a semiconductor [xxv]. Therefore the shift in band gap from $\approx$ 3.4 eV to $\approx$ 2.9 eV shown in Figure 7 for post-annealed films deposited at higher temperature can be attributed to a gradual formation of rutile phase as pH$_2$ increases. Given that films deposited at 250°C maintained the band gap of $\approx$ 3.4 eV, it means that anatase phase was maintained. The band gap data corroborates the XRD data on the formation of rutile phase with increase in pH$_2$.

Figure 6 Sample band gap analysis for TiO$_2$:Nb films for made at different H$_2$ partial pressures for as-deposited case (left panel) and annealed in vacuum at 450°C for 30 minutes (right panel)
3.3 Electrical resistivity

Electrical resistivity $\rho$ was measured between sputter deposited Ag contacts on the TiO$_2$:Nb films. The as-deposited films were too resistive to give reliable data. However, when the samples were annealed in vacuum at 450°C for 30 minutes, electrical resistivity dropped significantly to measurable levels. Table 1 shows the resistivity data for TiO$_2$:Nb films prepared at different pH$_2$ for two substrate temperatures. An increase in H$_2$ in the plasma, led to an increased resistivity of the films. Moreover, films deposited at 400°C exhibited higher resistivity than those deposited at 250°C. The increase in resistivity with increase in pH$_2$ can be attributed to a phase change from anatase to rutile which is well supported by optical and XRD data which showed the formation of rutile phase with an increase in H$_2$. The formation of rutile phase could also be attributed to high deposition temperature.

Table 1 Comparison of resistivity for films deposited at 250°C and 400°C

<table>
<thead>
<tr>
<th>pH$_2$ mTorr</th>
<th>Resistivity Ω-cm</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>250°C</td>
</tr>
<tr>
<td>0</td>
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</tr>
<tr>
<td>0.134</td>
<td>0.0074</td>
</tr>
<tr>
<td>0.268</td>
<td>0.026</td>
</tr>
</tbody>
</table>
Conclusion

This work has demonstrated the effect hydrogen in the plasma for sputtered TiO$_2$:Nb thin films deposited by DC Magnetron sputtering. At a substrate temperature of 250°C, an increase in pH$_2$ led to an increase in film resistivity from $5.9 \times 10^{-3}$ Ω-cm for pH$_2 = 0$ mTorr to $2.6 \times 10^{-2}$ Ω-cm for pH$_2 = 0.268$ mTorr. This trend was also maintained for films deposited at a higher temperature (~400°C) even though the corresponding resistivity values for the films were higher than for those deposited at 250°C. The increase in resistivity with increase in pH$_2$ and temperature was attributed to the formation of a rutile phase of TiO$_2$ which is well supported by structural and optical data.

Acknowledgement. One of the authors (C. M. M.) would like to thank the International Science Programme of Uppsala University for a scholarship.

References


HUMAN POPULATION DYNAMICS IN GREAT LAKES COUNTRIES UP TO 2050

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Abstract.

The first principle of population dynamics is widely regarded as the exponential law of Malthus, as modelled by the Malthus growth model. The early period was dominated by demographic studies such as the work of Benjamin Gompertz and Pierre Francois Verhulst in the early 19th century, who refined and adjusted the Malthusian demographic model. The Verhulst model is very popular and is called the Logistic equation. All these models use Ordinary Differential Equations (ODEs). The human population of the great lakes countries (BURUNDI, DRC, KENYA, RWANDA, TANZANIA and UGANDA) is growing rapidly. Considering the estimated population from 1950 to 2000, this paper investigates two models: the exponential model and the logistic model to predicting the future population up to 2050. For each country, we estimate the carrying capacity and compute the logistic model. The results of the two models are determined. The comparison of the results of two models shows that there is a significant difference between the two estimated populations. Note that for the two models, the population of the great lakes countries could reach the number of 500,000,000 inhabitants in 2050, which number is very high according the estimate entire population.

AMS (MSC 2000) Mathematics Subject Classification: 34A12, 92D25, 93A30

Key word: population growth, exponential growth model, logistic model, limiting population.

1. Introduction.

A mathematical model is a set of formulas and/or equations based on quantitative description of real phenomena and created in the hope that the behaviour it predicts will resemble the real behaviour on which it is based (Glenn LEDDER, 2005)
A model is any simplified representation of a real system. One uses models in all aspects of our lives, in order to extract the important trends from complex processes, to permit comparison among systems, to facilitate analysis of causes of processes acting on the system, and to make predictions about the future.

A complete description of a natural system, if it were possible, would often decrease our understanding relative to that provided by a good model, because there is “noise” in the system that is extraneous to the processes we wish to understand. For example, the typical representation of the growth of a population by an annual percent growth rate is a simplified mathematical model of the much more complex changes in population size.

Here is a natural question related to population problems:

What will the population of a certain country be in ten, twenty, fifty years?

Interest in how populations tend to grow was stimulated in late 18th century when Thomas Malthus (1766-1834) published “An essay on the principle of population” as it affects the future improvement of society. In his book, Malthus put forth an exponential growth model for human population and concluded that eventually the population would exceed the capacity to grow an adequate food supply. Although the assumptions of the Malthusian model leave out factors important to population growth, it is instructive to examine this model as a basis and to construct an other more realistic model (limiting growth model).

2. Material and methods

Two methods are developed here: the Exponential growth model and the limiting growth models. The data used have been entirely collected from the International Data Base (IDB).

2.1 Exponential growth model

Suppose we know the population at some given time, for example $P_0$ at time $t = t_0$, and we are interested in predicting the population $P$ at some future time $t = t_1$. In others words, we want to find a population function $P(t)$ for $t_0 \leq t \leq t_1$ satisfying $P(t_0) = P_0$

Consider the initial value problem

$$\frac{dP}{dt} = kP, \quad t_0 \leq t \leq t_1$$

(1)

$$P(t_0) = P_0$$

(2)

Where (for growth) $k$ is a positive constant. $P_0$ is the initial population at time $t_0$.

The solution that verifies the equation (1) and satisfies the initial condition (2) is given by

$$P(t) = P_0 \exp \{k(t - t_0)\}$$

(3)

Equation (3) known as the Malthusian model of population growth predicts that population grows exponentially with time.
Malthus affirms in his book that:”’ The only true criterion of a real and permanent increase in the population of any country is the increase of the means of subsistence’” (Malthus, 1798). But even, this criterion is subject to some slight variations which are, however, completely open to our view and observations.

The major inconvenient of this model is that the population of one country (i.e United States of America) would exceed current estimates of the maximum sustainable population of the entire planet. We are forced to conclude that this model is unreasonable over the long term. Some populations do grow exponentially provided that the population is not too large. In most populations, however, individual members eventually compete with one another for food, living space, and other natural resources. We now refine our Malthusian model of population’s growth to reflect this competition.

2.2. Logistic model

Let us consider that the proportionality factor k, measuring the rate of population growth in equation (1) is now no longer constant but a function of the population. As the population increases and gets closer to the maximum population M, the rate decreases. One simple sub model for k is the linear one

\[ k = r(M - P), \quad r > 0 \]

Where r is a constant. Substitution into equation (1) leads to

\[
\frac{dP}{dt} = r(M - P)P
\]

Again we assume the initial condition

\[ P(t_0) = P_0 \]

(The model (4) was first introduced by the Dutch mathematical biologist Pierre Francois Verhust 1804-1849, and is referred to as Logistic growth)

The solution of the equation (4) that satisfies the initial condition (5) is of the form

\[
P(t) = \frac{P_0M}{P_0 + (M - P_0)\exp\{-r(M(t-t_0))\}}
\]

Notice from Equation (6) that \( P(t) \) approaches M as \( t \) tends to infinity. Moreover, from equation (4), we have

\[
\frac{d^2P}{dt^2} = rM \frac{dP}{dt} - 2rP \frac{dP}{dt} = r(M - 2P) \frac{dP}{dt}
\]

So that \( \frac{d^2P}{dt^2} = 0 \) when \( P = \frac{M}{2} \). This means that when the population \( P \) reaches half the limiting population \( M \), the growth \( \frac{dP}{dt} \) is most rapid and then starts to diminish toward zero.

One advantage or recognizing that the maximum rate of growth at \( P = \frac{M}{2} \) is that the information can be used to estimate \( M \). In a situation in which the modeller is satisfied that
the growth has been reached and then $\frac{M}{2}$ can be estimated. It is often convenient to express the logistic equation (6) in another form. To this end, let $t^*$ denote the time when the population $P$ reaches half the limiting value. That is $P(t^*) = \frac{M}{2}$, it follows from equation (6) that

$$t^* = t_0 - \frac{1}{rM} \ln \frac{P_0}{M - P_0}$$

Solving this last equation for $t_0$, substituting the result into equation (6) and simplifying algebraically gives

$$P(t) = \frac{M}{1 + \exp\left\{-rM(t - t^*)\right\}}$$

The value of $t^*$ can be estimated from empirical data.

2.3. **Population of Great lakes Countries (1950-2050)**

The starting year of 1950 is convenient as it shows the population growing and recovering from the great demographic bleeding. And we would like to show the population growth in that centenary.

The figures shown have been entirely taken (and processed) from the International Data Base (IDB). Every individual value has been automatically rounded to nearest thousand, to assure data coherence, particularly when adding up (sub) totals. Although data from specific statistical offices may be more accurate. The information provided here has the advantage of being homogeneous.

Population estimates, as long as they are based on recent censuses can be more easily projected into the near future. This means that it is more accurate to make demographic estimates for the next five (even ten) years than to calculate the probable evolution of a GDP through the same time period. However, no projected population figures can be considered exact. Figures beyond 2020-2025 should be taken with caution.

2.4. **Geometrical growth model**

In consideration to the average annual growth for each previous five years period (except the first period 1950-1955), the formulas used to carry out these last calculations are standard ones, used both by the united Nations Statistical Division and by National Census Offices Worldwide. They correspond to the exponential geometrical growth and have the following general form

$$\left(\frac{P_f}{P_i} - 1\right) \times 100$$

(9)
Where \( P_i \) and \( P_f \) stand for the initial population respectively within a stated time period. The same criteria apply to \( y_i \) and \( y_f \) the two variables indicating the two years involved.

In terms of natural logarithms, both formulas can be expressed as follows

\[
\exp \left\{ \frac{1}{y_f - y_i} \ln \left( \frac{P_f}{P_i} \right) \right\} - 1 \times 100 \quad (10)
\]

For the practical purposes of the calculations shown here, where five-year period are involved we can simplify the formulas, leaving them like

\[
\exp \left\{ \frac{1}{5} \ln \left( \frac{P_f}{P_i} \right) \right\} - 1 \times 100
\]

\( (11) \)

Table 1. Presentation of Data (in thousands). Period 1950-2000

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Burundi</td>
<td>2,363</td>
<td>2,576</td>
<td>2,815</td>
<td>3,171</td>
<td>3,522</td>
<td>3,676</td>
<td>4,298</td>
<td>4,922</td>
<td>5,536</td>
<td>6,165</td>
<td>6,823</td>
</tr>
<tr>
<td>DRC</td>
<td>13,569</td>
<td>14,953</td>
<td>16,610</td>
<td>18,856</td>
<td>21,781</td>
<td>25,033</td>
<td>29,013</td>
<td>33,344</td>
<td>39,047</td>
<td>46,299</td>
<td>51,849</td>
</tr>
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<td>Kenya</td>
<td>6,121</td>
<td>7,034</td>
<td>8,157</td>
<td>9,549</td>
<td>11,247</td>
<td>13,433</td>
<td>16,331</td>
<td>19,761</td>
<td>23,354</td>
<td>27,124</td>
<td>30,508</td>
</tr>
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<td>Rwanda</td>
<td>2,439</td>
<td>2,698</td>
<td>3,032</td>
<td>3,265</td>
<td>3,769</td>
<td>4,357</td>
<td>5,140</td>
<td>5,987</td>
<td>6,999</td>
<td>5,473</td>
<td>8,398</td>
</tr>
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<td>Tanzania</td>
<td>7,935</td>
<td>8,971</td>
<td>10,260</td>
<td>11,870</td>
<td>13,807</td>
<td>16,148</td>
<td>18,665</td>
<td>21,618</td>
<td>25,214</td>
<td>29,753</td>
<td>33,712</td>
</tr>
<tr>
<td>Uganda</td>
<td>5,522</td>
<td>6,317</td>
<td>7,262</td>
<td>8,389</td>
<td>9,743</td>
<td>10,952</td>
<td>12,415</td>
<td>14,392</td>
<td>17,456</td>
<td>20,690</td>
<td>23,956</td>
</tr>
<tr>
<td>Total</td>
<td>37,949</td>
<td>42,549</td>
<td>48,136</td>
<td>55,100</td>
<td>63,869</td>
<td>73,599</td>
<td>85,862</td>
<td>100,024</td>
<td>117,606</td>
<td>135,504</td>
<td>155,246</td>
</tr>
</tbody>
</table>

To estimate the future population, we need to determine the growth rate for each year. Using the previous growth, the following are the formula used to estimate the corresponding rate

1. For Burundi
   \[ k_i = 0.02241 + 0.000136189(t_i - 1973) \]  \( (12) \)

2. For DRC
   \[ k_i = 0.02875 + 0.000136502(t_i - 1973) \]  \( (13) \)

3. For Kenya
   \[ k_i = 0.03491 + 0.00002009(t_i - 1973) \]  \( (14) \)

4. For Rwanda
   \[ k_i = 0.03158 + 0.000115001(t_i - 1973) \]  \( (15) \)

5. For Tanzania
   \[ k_i = 0.03113 + 0.0000260464(t_i - 1973) \]  \( (16) \)

6. For Uganda
   \[ k_i = 0.03158 + 0.000115001(t_i - 1973) \]  \( (17) \)
Using the formula (12) - (17), we estimate the population for each country up to 2050 by the exponential model of the form (3).

Table 2. Estimated population (in thousands). Period 2005-2050

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Burundi</td>
<td>8,162</td>
<td>9,863</td>
<td>11,574</td>
<td>13,429</td>
<td>15,465</td>
<td>17,650</td>
<td>19,950</td>
<td>22,321</td>
<td>24,729</td>
<td>27,149</td>
</tr>
<tr>
<td>DRC</td>
<td>60,474</td>
<td>70,916</td>
<td>82,657</td>
<td>95,605</td>
<td>109,675</td>
<td>124,622</td>
<td>140,244</td>
<td>156,368</td>
<td>172,793</td>
<td>189,311</td>
</tr>
<tr>
<td>Kenya</td>
<td>34,912</td>
<td>40,047</td>
<td>44,753</td>
<td>48,319</td>
<td>51,261</td>
<td>54,150</td>
<td>57,248</td>
<td>60,317</td>
<td>62,990</td>
<td>65,176</td>
</tr>
<tr>
<td>Rwanda</td>
<td>9,611</td>
<td>11,056</td>
<td>12,662</td>
<td>14,327</td>
<td>16,081</td>
<td>17,983</td>
<td>20,080</td>
<td>22,378</td>
<td>24,859</td>
<td>27,506</td>
</tr>
<tr>
<td>Tanzania</td>
<td>37,771</td>
<td>41,893</td>
<td>46,123</td>
<td>49,989</td>
<td>53,428</td>
<td>56,530</td>
<td>59,397</td>
<td>62,068</td>
<td>64,548</td>
<td>66,843</td>
</tr>
<tr>
<td>Uganda</td>
<td>28,199</td>
<td>33,399</td>
<td>39,941</td>
<td>47,691</td>
<td>56,745</td>
<td>67,286</td>
<td>79,524</td>
<td>93,632</td>
<td>109,752</td>
<td>128,008</td>
</tr>
<tr>
<td>Total</td>
<td>179,129</td>
<td>207,174</td>
<td>237,710</td>
<td>269,360</td>
<td>302,655</td>
<td>338,221</td>
<td>376,443</td>
<td>417,084</td>
<td>459,671</td>
<td>503,993</td>
</tr>
</tbody>
</table>

The following graphs present the image of the population growth for each country for the centenary 1950-2050 according to the figures presented by IDB.

Fig.1 Dynamic population of Burundi (1950-2050)

Fig.2 Dynamic population of DRC (1950-2050)
Fig. 3 Dynamic population of Kenya (1950-2050)

Fig. 4 Dynamic population of Rwanda (1950-2050)

Fig. 5 Dynamic population of Tanzania (1950-2050)

Fig. 6 Dynamic population of Uganda (1950-2050)
2.5. Limiting growth model

While analyzing the diagrams of the evolution of the population of these countries, one notes that the growth can be considered as exponential for the BURUNDI, DRC, RWANDA and especially UGANDA countries; and approximatively logistical for KENYA and TANZANIA. For these two last countries one can construct a model of the form (8). However, for Rwanda and Burundi countries where there is living space restriction and availability of food and water, the exponential model is not reasonable. If one supposes 30,000 thousands the possible maximum of the population, one can also establish the limiting growth model for these countries.

Suppose that the limiting population for Burundi is \( M=30,000 \) thousands.

The limiting growth model of the form (8) is given by

\[
P(t) = \frac{30,000}{1 + \exp\{-0.054078759(t - 2023.19)\}}
\]  

(18)

If the same limiting population is taken for Rwanda, the logistic growth model is given by

\[
P(t) = \frac{30,000}{1 + \exp\{-0.042714654(t - 2022.6)\}}
\]  

(19)

Let \( M=90,000 \) thousands be the limiting population which can be reached by Kenya. Then the limiting growth model is given by

\[
P(t) = \frac{90,000}{1 + \exp\{-0.047149295(t - 2014.67)\}}
\]  

(20)

Let \( M=90,000 \) thousands be also the limiting population of Tanzania. Then the logistic growth model of the form (8) is given

\[
P(t) = \frac{90,000}{1 + \exp\{-0.037157467(t - 2013.7)\}}
\]  

(21)

For the DRC and UGANDA countries, where there is no space restriction, the conditions of health, the pandemics (e.g. VIH / AIDS, etc...) cannot permit an exponential growth. For these countries, it is also possible to suppose a population limit, for example 200,000 thousands for DRC and 120,000 thousands for UGANDA and then to establish a logistical model of growth.

Thus, for a population limits \( M=200,000 \) thousands for DRC, the logistical growth model (8) is the form

\[
P(t) = \frac{200,000}{1 + \exp\{-0.047414033(t - 2022.6)\}}
\]  

(22)

If we let \( M=120,000 \) thousands be the limiting population of Uganda, the logistic growth model of the form (8) is of the form

\[
P(t) = \frac{120,000}{1 + \exp\{-0.045510254(t - 2030.9)\}}
\]  

(23)

The table below compares the values predicted by IDB and the values predicted by the logistic equations (18)-(23). The observed values of the population would show that the models defined are conforming.
3. RESULTS

The computation of the obtained models (18)-(23) gives the following results

For each country, we present the predicted population up to 2050 according to both models: exponential geometrical model and limiting model

<table>
<thead>
<tr>
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<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Burundi</td>
<td>Exponential</td>
<td>6,823</td>
<td>8,162</td>
<td>9,863</td>
<td>11,574</td>
<td>13,429</td>
<td>15,465</td>
</tr>
<tr>
<td></td>
<td>Logistical</td>
<td>6,659</td>
<td>8,165</td>
<td>9,866</td>
<td>11,731</td>
<td>13,709</td>
<td>15,734</td>
</tr>
<tr>
<td>DRC</td>
<td>Exponential</td>
<td>51,849</td>
<td>60,474</td>
<td>70,916</td>
<td>82,657</td>
<td>95,605</td>
<td>109,675</td>
</tr>
<tr>
<td></td>
<td>Logistical</td>
<td>51,021</td>
<td>60,539</td>
<td>70,987</td>
<td>82,175</td>
<td>93,844</td>
<td>105,684</td>
</tr>
<tr>
<td>Kenya</td>
<td>Exponential</td>
<td>30,508</td>
<td>34,912</td>
<td>40,047</td>
<td>44,753</td>
<td>48,319</td>
<td>51,261</td>
</tr>
<tr>
<td></td>
<td>Logistical</td>
<td>30,029</td>
<td>34,916</td>
<td>40,066</td>
<td>45,350</td>
<td>50,625</td>
<td>55,747</td>
</tr>
<tr>
<td>Rwanda</td>
<td>Exponential</td>
<td>8,398</td>
<td>9,611</td>
<td>11,056</td>
<td>12,662</td>
<td>14,327</td>
<td>16,081</td>
</tr>
<tr>
<td></td>
<td>Logistical</td>
<td>8,274</td>
<td>9,613</td>
<td>11,058</td>
<td>12,586</td>
<td>14,168</td>
<td>15,768</td>
</tr>
<tr>
<td>Tanzania</td>
<td>Exponential</td>
<td>33,712</td>
<td>37,771</td>
<td>41,893</td>
<td>46,123</td>
<td>49,989</td>
<td>53,428</td>
</tr>
<tr>
<td></td>
<td>Logistical</td>
<td>33,787</td>
<td>37,789</td>
<td>41,912</td>
<td>46,087</td>
<td>50,243</td>
<td>54,311</td>
</tr>
<tr>
<td>Uganda</td>
<td>Exponential</td>
<td>23,956</td>
<td>28,199</td>
<td>33,399</td>
<td>39,941</td>
<td>47,691</td>
<td>56,745</td>
</tr>
<tr>
<td></td>
<td>Logistical</td>
<td>23,619</td>
<td>28,234</td>
<td>33,438</td>
<td>39,192</td>
<td>45,416</td>
<td>51,993</td>
</tr>
</tbody>
</table>

Table 4. Prediction of the population of the great lakes countries from 2030 to 2050

<table>
<thead>
<tr>
<th>country</th>
<th>model</th>
<th>2030</th>
<th>2035</th>
<th>2040</th>
<th>2045</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burundi</td>
<td>Exponential</td>
<td>17,650</td>
<td>19,950</td>
<td>22,321</td>
<td>24,729</td>
<td>27,149</td>
</tr>
<tr>
<td></td>
<td>Logistical</td>
<td>17,731</td>
<td>19,634</td>
<td>21,384</td>
<td>22,946</td>
<td>24,299</td>
</tr>
<tr>
<td>DRC</td>
<td>Exponential</td>
<td>124,622</td>
<td>140,244</td>
<td>156,368</td>
<td>172,793</td>
<td>189,311</td>
</tr>
<tr>
<td></td>
<td>Logistical</td>
<td>117,365</td>
<td>128,578</td>
<td>139,060</td>
<td>148,617</td>
<td>157,138</td>
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<tr>
<td>Kenya</td>
<td>Exponential</td>
<td>54,150</td>
<td>57,248</td>
<td>60,317</td>
<td>62,990</td>
<td>65,176</td>
</tr>
<tr>
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<td>60,590</td>
<td>65,055</td>
<td>69,076</td>
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<td>75,691</td>
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<td>Rwanda</td>
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<td>20,080</td>
<td>22,378</td>
<td>24,859</td>
<td>27,506</td>
</tr>
<tr>
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<td>17,351</td>
<td>18,882</td>
<td>20,331</td>
<td>21,674</td>
<td>22,896</td>
</tr>
<tr>
<td>Tanzania</td>
<td>Exponential</td>
<td>56,530</td>
<td>59,397</td>
<td>62,068</td>
<td>64,548</td>
<td>66,843</td>
</tr>
<tr>
<td></td>
<td>Logistical</td>
<td>58,226</td>
<td>61,933</td>
<td>65,390</td>
<td>68,569</td>
<td>71,454</td>
</tr>
<tr>
<td>Uganda</td>
<td>Exponential</td>
<td>67,286</td>
<td>79,524</td>
<td>93,632</td>
<td>109,752</td>
<td>128,008</td>
</tr>
<tr>
<td></td>
<td>Logistical</td>
<td>58,771</td>
<td>65,582</td>
<td>72,250</td>
<td>78,618</td>
<td>84,551</td>
</tr>
</tbody>
</table>

3. CONCLUSIONS

The planning is one of the indispensable activities of the life of each organized society. It is then necessary to know, for how many individuals must foresee everything. However, as it is difficult even
impossible to know the exact future population of a country or a city precisely, it is convenient to estimate (to predict) it by the existing models when one knows some conditions of subsistence’s of these populations. For the great lakes countries, the population who was valued to 37,949,000 inhabitants in 1950, it is estimated if one considers the model of geometric exponential growth (IDA), to $503,993,000$ inhabitants in 2050 around 13.3 times. And, if one considers the logistic growth models defined in (12)-(17), it is predicted to $436,029,000$ inhabitants; about 11.5 times the difference between the expected results for the two models is estimated to $67,964,000$ inhabitants. This difference is significantly enough to conclude that the projection of the future population would be better if we use the logistic model. But, even for the limiting growth model, it is evident that, there is a demographic explosion in the great lakes countries.

I would like to end this paper by the following questions.

- That the population grows as quickly, is it a negative factor for the development of these countries?
- What about the influence of the population growth on the environment in the great lakes countries?

References

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*List of countries by past and future population*. Wikipedia, the free encyclopaedia

Abstract.
Sugarcane farming has been identified as the single most cultivated cash crop in Lake Victoria basin. Use of high agronomic inputs is employed in these regions for better yields. Most rivers feeding Lake Victoria from these catchments have been reported to accumulate total heavy metals downstream above background concentrations. The source of these heavy metals to the rivers is not known. This study, therefore, aimed at determining levels of pH, Cd, Cu, Zn, Pb and Cr in River Kuywa surface water and sediments before and after traversing sugarcane farms within Lake Victoria basin as well as in farm soils, canals runoff water and sediments within the sugarcane farms to assess if agronomic input in sugarcane farming influenced their levels. The results indicated significant differences at $p \leq 0.05$ in the heavy metal levels of River Kuywa before the farms and after the farms. Canals water and sediments levels were significantly higher than river water levels suggesting them to be the main contaminants to the river. In addition canals values differed significantly from the control canal implicating agronomic inputs over the increase. However, soil levels did not differ significantly from their control with all the values going beyond international standards suggesting the area to have higher background concentrations of these metals. None the less, soil pH and total organic carbon values differed significantly between the sugarcane farms and the control implicating agronomic inputs in sugarcane farming over their increase that aided in mobility of the naturally occurring metals to the aquatic systems.

Key words: Lake Victoria catchment; sugarcane farming; River Kuywa; heavy metals; agronomic inputs; Kenya.

Introduction
River Kuywa originates from Mount Elgon before traversing several sugarcane farms in Bungoma County in Western Kenya and finally joins River Nzoia to drain into Lake Victoria. Sugarcane was found to be the single most important cash crop extensively grown in this region by small scale farmers, large scale farmers and company/factory nucleus estates (Netondo et al., 2010). Most small scale farmers rent out their land to companies/factories hence adopting high agronomic inputs such as the ones used in the nucleus estates (Netondo et al., 2010; GoK, 2002). Intensive agronomic inputs such as nitrogenous fertilizers, pesticides and sewage sludge are employed in these zones for high yields (Allen, 2009). The impact of these agronomic inputs in sugarcane farming on river water quality is of major concern since animals and humans use this water domestically apart from the general aquatic life sustainability of the rivers and their sinks. Assessment of heavy metals at the mouths of major rivers feeding Lake Victoria on the Kenyan side (Rivers: Nzoia, Nyamasaria, Sondu-Mirio, Sio, Nyando, Kuja, Awach and Yala) reveal levels of total Cd, Pb, Cu, Cr and Zn in both aerobic sediments and water beyond background concentrations (Lalah et al., 2008, Ongeri, 2010). These authors suggest that the elevated levels are due to agricultural activities taking place in the Lake Victoria catchments. This research aimed at justifying this claim by determining the
levels of heavy metals (Cd, Cu, Zn, Pb and Cr) in River Kuywa water and sediments before and after traversing sugarcane farms and in soils, runoff water and sediments in canals draining water from the sugarcane farms to the river. This was done both in the long wet and dry seasons with the results being compared to controls selected such that agronomic inputs in sugarcane farming was the only major difference.

In other areas like Australia, especially in the Great Barrier Reef, aquatic systems in sugarcane farms have been found to contain heavy metals beyond background concentrations (Haynes, 2001); indicating that the activity has a positive effect on heavy metal concentration. However, of major concern in most of the research in sugarcane field is the lowering of soil pH by inorganic fertilizers (Wood, 2003; Oliver, 2004). A change in soil pH is usually accompanied with other chemical changes in sugarcane fields like converting both naturally occurring and arthropogenically added heavy metals to bioavailable and mobile forms hence raising the possibility of aquatic contamination due to surface runoffs, leaching and soil erosions (Oliver, 2004; Alloway, 1995).

**Materials and Methods**

The study was carried out in sugarcane farms traversed by River Kuywa between 34° 50’ 49” E to 35° 35’ 41” E longitudes and 0° 4’ 55” N to 0° 20’ 11” S latitudes. The farms are located in Bungoma County within Lake Victoria catchment region that is one of the main sugarcane producing areas in Western Kenya. The studied sugarcane farms have many water canals which run across the farms and discharge waste water into River Kuywa that flows through the farms before joining River Nzoia that finally drains into Lake Victoria.

**Experimental design and sampling**

A site on River Kuywa before entering the sugarcane farms was used as a control for the river. Two other sites on the river, within the middle of the farms and at the end of the farms, were used to get the total impact of sugarcane farming on River Kuywa aquatic ecosystem. Different specific canals were chosen with respect to farming activities taking place in the locations where the canals drained water into and sampling sites located at strategic points along the canals as illustrated in Figure 1. Site 1 was located on a canal that drained water from a tree plantation that had no agronomic inputs and was at a higher elevation with no possibility of receiving water flow and/or leachate from other areas hence used as a control to check agronomic inputs impact. Site 2 was located on a canal draining water from the factory premises. Site 3 was located on a canal draining water from freshly cultivated plots. Site 4 was located on a canal draining water from sugarcane farms awaiting harvesting and sites 5, 6 and 7 were located on canals that drained water from sugarcane fields that were approximately 1, 2, and 5 months old during the dry season and 3, 5 and 7 months old during the wet season respectively. Soil samples from the farms where the canals drained water from were also sampled at random. Soil samples from a football pitch in a nearby school that was at an elevated level with no possibility of receiving heavy metal leachate and or erosions from sugarcane farms was used as a control for the soils of sugarcane farms. Most of the cane fields in site 3 had sugarcane planted during the wet season sampling whereby Di Ammonium Phosphate (DAP) fertilizer was used at the rate of 3.4 bags of the 50 kg bags per hectare while most of the plots in site 5, 6 and 7 had Urea fertilizer and pesticides application during the wet and dry seasons respectively.
Sampling was done during the dry season in February 2009 and wet season in May 2009. Water pH and turbidity were measured directly in the field using a pH meter (3071 Jenway) and a turbidity meter (HI 93703) respectively. Four replicates of 500 ml surface water samples were taken from each sampling site in glass bottles using a grab sampler, transported in an ice box to the laboratory and refrigerated at 4°C according to John et al. (1996) prior to analysis. Ten replicates each measuring 100 g of surface soil (2 cm deep) and four replicates of surface sediments (2 cm deep) were sampled per site using a hollow plastic pipe, kept in black plastic bags and transported in an ice box to the laboratory for processing. The sediments and soils were air dried at room temperature, ground by a pestle and motor then sieved through a 45 µm mesh sieve and kept in clean plastic containers ready for analysis.

**Key:** River Kuywa: ⚭; Canals: ⬃; 1 – 7: Sampling sites on canals; A – C: Sampling points on River Kuywa.

Sampling sites grid positions: 1 – 0° 33’ 53.25”N, 34° 39’ 37.27”E. elev. 1475 m. 2 – 0° 34’ 15.67”N, 34° 39’ 36.57”E. elev. 1470 m. 3 – 0° 32’ 17.07”N, 34° 40’ 40.43”E. elev. 1432 m. 4 – 0° 31’ 54.11”N, 34° 40’ 15.71”E. elev. 1420 m. 5 – 0° 35’ 03.20”N, 34° 41.12”E. elev. 1438 m. 6 – 0° 32’ 56.16”N, 34° 41’ 18.72”E. elev. 1428 m. 7 – 0° 32’ 31.39”N, 34° 41’ 12.45”E. elev. 1428 m. A - 0° 36’ 11.37”N, 34° 41’ 20.20”E. elev. 1438 m. B - 0° 34’ 24.22”N, 34° 40’ 49.07”E. elev. 1431 m. C - 0° 31’ 32.80”N, 34° 40’ 43.86”E. elev. 1417 m.

**Fig. 1:** The map of the sampled sugarcane farms from Lake Victoria basin in Western Kenya.

**Sample analysis**

For soil and sediments pH, a method adopted from Rhodes (1982) was used; whereby 50 ml of deionized water was added to 20 g of crushed soil/sediment, stirred well for ten minutes and allowed to stand for 30
minutes before stirring again for two minutes followed with pH measurement using a pH meter (3071 Jenway).

Total organic carbon for both soils and sediments was determined by measuring 10 g of a well mixed air dried sample and heating it in an oven for 3 hours at 105°C in a crucible to remove water vapor then placed in a Vulcan A-550 muffle furnace and temperature raised gradually from 105°C to 550°C for eight hours. The difference in weight between the resultant ash and the moisture free sample was noted as the total organic carbon (Okalebo, 2002). The Hydrometer method was used to measure % silt of both the soil and sediment samples (ASTM 152H with scale in g/l) (Zhu et al., 2004).

Heavy metals in water samples were determined by filtering 200 ml of the sample through a 1 µm cellulose acetate filter with mill pores into an acid-washed 500 ml Erlenmeyer flask. The sample was then acidified to about 1% by adding 2 ml of concentrated nitric acid (analytical grade), placed on a hot plate at 60°C and allowed to evaporate to approximately 30 ml (Mzimela et al., 2003). The evaporated sample was then transferred to a 50 ml volumetric flask and made up to volume with double distilled water after addition of 1.5 mg/ml of strontium chloride (Ikuo et al., 1965). The extract was analyzed for Cd, Cu, Zn, Pb and Cr using a calibrated (with specific salts) Shimadzu AA-6200 Atomic Absorption Spectrophotometer with specifications outlined in Table 1.

Heavy metals in surface sediments and soils were determined by taking ten grams of air dried surface sediments/soils and moisture content determined by drying in an oven at 105°C, cooled in a desiccator and weight measured. The difference in weight was noted then the sample was put in a 50 ml Pyrex digestion tube and 10 ml mixture of concentrated nitric acid and concentrated hydrochloric acid (4:1, aqua regia digestion) added. This was followed by a digestion of 3 hours in a Gerhardt digester at 100°C, the contents were filtered through 0.45 µm polyethersulfon filter membrane into a 50 ml volumetric flask and made up to volume with double-distilled water (Tack and Verloo, 1999) after addition of 1.5 mg/ml of strontium chloride (analytical grade, SrCl₂.6H₂O, Ikuo et al., 1965). The extracts were analyzed for Cd, Cu, Zn, Pb and Zn using the conditions of the AAS discussed above.

Method detection limits for all the analytical methods were determined using respective standards (Table 1) in accordance to method 40 CFR 136 and recovery studies done by spiking acid washed sediments/soils, double distilled water for water samples, with twenty times the method detection limits concentration of standards in accordance to method 40 CFR 136 (USEPA, 2007).

Analysis of variance (ANOVA) at P ≤ 0.05, a factorial two experiment and least significant differences at P ≤ 0.05 were used to check the variations. Statistical analysis was performed using MSTATC two factor completely randomized design, with season as the main factor and site as the sub treatment.

Results and discussion

Detection limits for the various methods used in this research have been recorded in Table 2 while the AAS machine operation specifications are recorded in Table 1. Zinc lamp did not pass line search at the given lamp current of 8 mA but after trial and error 6 mA worked. The results have been recorded in Tables 3, 4, 5, 6 and 7 for river and canal water, river and canal sediments and soil samples respectively. Average wet weight to dry weight ratios for sediment samples was 1.035 ± 0.024 for river and 1.054 ± 0.011 for canals while for cane farm soils and control farm soils it was 1.027 ± 0.014 and 1.001 ± 0.002 respectively.
Table 1: Atomic Absorption flame emission Spectrophotometer (Shimadzu AA-6200) experimental specifications

<table>
<thead>
<tr>
<th>Element</th>
<th>Cd</th>
<th>Cu</th>
<th>Cr</th>
<th>Zn</th>
<th>Pb (II)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamp current (mA)</td>
<td>8</td>
<td>6</td>
<td>10</td>
<td>6*</td>
<td>10</td>
</tr>
<tr>
<td>Wavelength (nm)</td>
<td>228.8</td>
<td>324.7</td>
<td>357.9</td>
<td>213.9</td>
<td>283.3</td>
</tr>
<tr>
<td>Slit width (nm)</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>Mode</td>
<td>BGC-D₂</td>
<td>BGC-D₂</td>
<td>BGC-D₂</td>
<td>BGC-D₂</td>
<td>BGC-D₂</td>
</tr>
<tr>
<td>Flame</td>
<td>Air-C₂H₅</td>
<td>Air-C₂H₅</td>
<td>AIR-C₂H₅</td>
<td>Air-C₂H₅</td>
<td>Air-C₂H₅</td>
</tr>
<tr>
<td>Fuel flow ( l/min)</td>
<td>1.8</td>
<td>1.8</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Prespraytime</td>
<td>3 sec</td>
<td>3 sec</td>
<td>3 sec</td>
<td>3 sec</td>
<td>3 sec</td>
</tr>
<tr>
<td>Integration time t</td>
<td>5 sec</td>
<td>5 sec</td>
<td>5 sec</td>
<td>5 sec</td>
<td>5 sec</td>
</tr>
<tr>
<td>Calibrations (ppm)</td>
<td>0.1-0.6</td>
<td>0.1-0.6</td>
<td>0.1-0.6</td>
<td>0.1-0.6</td>
<td>0.1-0.6</td>
</tr>
<tr>
<td>MDL (ppm)</td>
<td>0.012</td>
<td>0.04</td>
<td>0.12</td>
<td>0.11</td>
<td>0.28</td>
</tr>
</tbody>
</table>

Key: MDL – machine detection limit; BGC-D₂ – Deuterium background correction (compensates for matrix interferences); * - the one recommended for the machine could not work hence tried a new one which worked.

Table 2: Detection limits and recovery studies for various methods used in analysing heavy metals in samples from sugarcane farms traversed by R. Kuywa using AAS 6200 Shimadzu.

<table>
<thead>
<tr>
<th></th>
<th>Cd</th>
<th>Cu</th>
<th>Zn</th>
<th>Pb</th>
<th>Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water samples</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machine detection limits µg/l</td>
<td>0.012</td>
<td>0.04</td>
<td>0.11</td>
<td>0.28</td>
<td>0.12</td>
</tr>
<tr>
<td>Method detection limits µg/l</td>
<td>0.08</td>
<td>0.14</td>
<td>0.09</td>
<td>0.11</td>
<td>0.07</td>
</tr>
<tr>
<td>Recovery studies as a %</td>
<td>89</td>
<td>92</td>
<td>88</td>
<td>90</td>
<td>79</td>
</tr>
<tr>
<td>Sediment samples</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machine detection limits mg/kg</td>
<td>0.012</td>
<td>0.04</td>
<td>0.11</td>
<td>0.28</td>
<td>0.12</td>
</tr>
<tr>
<td>Method detection limits mg/kg</td>
<td>0.12</td>
<td>0.07</td>
<td>0.11</td>
<td>0.17</td>
<td>0.15</td>
</tr>
<tr>
<td>Recovery studies as a %</td>
<td>88</td>
<td>89</td>
<td>93</td>
<td>87</td>
<td>88</td>
</tr>
<tr>
<td>Soil samples</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machine detection limits mg/kg</td>
<td>0.012</td>
<td>0.04</td>
<td>0.11</td>
<td>0.28</td>
<td>0.12</td>
</tr>
<tr>
<td>Method detection limits mg/kg</td>
<td>0.13</td>
<td>0.11</td>
<td>0.21</td>
<td>0.11</td>
<td>0.22</td>
</tr>
<tr>
<td>Recovery studies as a %</td>
<td>77</td>
<td>76</td>
<td>87</td>
<td>89</td>
<td>80</td>
</tr>
</tbody>
</table>

Table 3: Mean seasonal variations of heavy metals in River Kuywa water traversing sugarcane farms within Lake Victoria catchments.

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>Cd µg/l</th>
<th>Cu µg/l</th>
<th>Zn µg/l</th>
<th>Pb µmg/l</th>
<th>Cr µg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry season</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R. Kuywa before sugarcane farms</td>
<td>7.30</td>
<td>0.66</td>
<td>1.87</td>
<td>17.20</td>
<td>1.62</td>
<td>0.35</td>
</tr>
<tr>
<td>R. Kuywa in the middle of sugarcane farms</td>
<td>7.20</td>
<td>0.81</td>
<td>2.40</td>
<td>26.31</td>
<td>1.84</td>
<td>0.21</td>
</tr>
<tr>
<td>R. Kuywa after the sugarcane farms</td>
<td>7.00</td>
<td>0.97</td>
<td>2.53</td>
<td>28.13</td>
<td>1.89</td>
<td>0.50</td>
</tr>
<tr>
<td>Dry season mean</td>
<td>7.17</td>
<td>0.81</td>
<td>2.27</td>
<td>23.88</td>
<td>1.78</td>
<td>0.35</td>
</tr>
<tr>
<td>Wet season</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R. Kuywa before sugarcane farms</td>
<td>6.27</td>
<td>0.92</td>
<td>4.41</td>
<td>41.85</td>
<td>4.70</td>
<td>0.68</td>
</tr>
<tr>
<td>R. Kuywa in the middle of sugarcane farms</td>
<td>6.16</td>
<td>1.08</td>
<td>6.41</td>
<td>65.49</td>
<td>3.56</td>
<td>0.82</td>
</tr>
<tr>
<td>R. Kuywa after the sugarcane farms</td>
<td>6.00</td>
<td>1.54</td>
<td>8.90</td>
<td>66.18</td>
<td>5.44</td>
<td>0.95</td>
</tr>
<tr>
<td>Wet season mean</td>
<td>6.14</td>
<td>1.19</td>
<td>6.57</td>
<td>57.81</td>
<td>4.57</td>
<td>0.82</td>
</tr>
</tbody>
</table>

Statistics

<table>
<thead>
<tr>
<th></th>
<th>p ≤ 0.05</th>
<th>0.07</th>
<th>0.54</th>
<th>4.35</th>
<th>0.24</th>
<th>0.06</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSD site dry season</td>
<td>0.23</td>
<td>0.14</td>
<td>1.23</td>
<td>10.23</td>
<td>0.45</td>
<td>0.10</td>
</tr>
<tr>
<td>LSD site wet season</td>
<td>1.03</td>
<td>0.10</td>
<td>0.60</td>
<td>3.55</td>
<td>0.36</td>
<td>0.05</td>
</tr>
<tr>
<td>LSD season mean</td>
<td>3.54</td>
<td>5.17</td>
<td>16.56</td>
<td>5.74</td>
<td>27.51</td>
<td>6.22</td>
</tr>
</tbody>
</table>

Kenyan domestic water stds

|                           | 6.5-8.5 | 5.00 | 100.00 | 5000.00 | 50.00 | NG   |

165
<table>
<thead>
<tr>
<th>Stds</th>
<th>pH</th>
<th>Cd µg/l</th>
<th>Cu µg/l</th>
<th>Zn µg/l</th>
<th>Pb µg/l</th>
<th>Cr µg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenyan Aquatic life stds(^a)</td>
<td>6.76</td>
<td>0.69</td>
<td>1.81</td>
<td>31.18</td>
<td>1.16</td>
<td>0.09</td>
</tr>
<tr>
<td>US EPA domestic water stds(^b)</td>
<td>6.61</td>
<td>0.91</td>
<td>2.60</td>
<td>63.19</td>
<td>3.82</td>
<td>0.42</td>
</tr>
<tr>
<td>US EPA aquatic water stds chronic(^b)</td>
<td>7.04</td>
<td>0.81</td>
<td>2.72</td>
<td>46.92</td>
<td>1.40</td>
<td>2.40</td>
</tr>
<tr>
<td>Canadian aquatic life Stds(^c)</td>
<td>6.23</td>
<td>1.12</td>
<td>2.39</td>
<td>33.88</td>
<td>1.47</td>
<td>0.90</td>
</tr>
<tr>
<td>R. Nyara mean at the mouth of L. Victoria(^d)</td>
<td>6.86</td>
<td>1.14</td>
<td>2.26</td>
<td>41.93</td>
<td>1.72</td>
<td>0.80</td>
</tr>
<tr>
<td>R. Yala mean at the mouth of L. Victoria(^d)</td>
<td>7.01</td>
<td>1.01</td>
<td>3.39</td>
<td>88.44</td>
<td>1.80</td>
<td>2.36</td>
</tr>
<tr>
<td>R. Yamun, India(^e)</td>
<td>8.13</td>
<td>1.31</td>
<td>3.08</td>
<td>33.92</td>
<td>1.72</td>
<td>0.97</td>
</tr>
</tbody>
</table>

Dry season mean: **6.95** 1.00 2.61 48.49 1.87 1.33

Wet season mean: **5.19** 1.67 13.56 185.22 5.22 1.69


**Table 4:** Mean seasonal variations of heavy metals in canals runoff water within sugarcane farms traversed by River Kuywa within Lake Victoria catchment.

<table>
<thead>
<tr>
<th>Stds</th>
<th>pH</th>
<th>Cd µg/l</th>
<th>Cu µg/l</th>
<th>Zn µg/l</th>
<th>Pb µg/l</th>
<th>Cr µg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenyan Aquatic life stds(^a)</td>
<td>6.5-8.5</td>
<td>5.00</td>
<td>100.00</td>
<td>5000.00</td>
<td>50.00</td>
<td>NG</td>
</tr>
<tr>
<td>Kenyan Aquatic life stds(^a)</td>
<td>5-9.0</td>
<td>≤1.1</td>
<td>NG</td>
<td>NG</td>
<td>NG</td>
<td>3.21</td>
</tr>
<tr>
<td>US EPA domestic water stds(^b)</td>
<td>5-9.0</td>
<td>5.00</td>
<td>1000.00</td>
<td>7400.00</td>
<td>50.00</td>
<td>NG</td>
</tr>
<tr>
<td>US EPA aquatic water stds chronic(^b)</td>
<td>6.5-9.0</td>
<td>0.25</td>
<td>NG</td>
<td>120.00</td>
<td>2.50</td>
<td>16.00</td>
</tr>
<tr>
<td>US EPA aquatic water stds acute(^b)</td>
<td>6.5-9.0</td>
<td>2.00</td>
<td>NG</td>
<td>120.00</td>
<td>65.00</td>
<td>16.00</td>
</tr>
<tr>
<td>Canadian aquatic life Stds(^c)</td>
<td>NG</td>
<td>0.017</td>
<td>2-4.00</td>
<td>30.00</td>
<td>1-7.00</td>
<td>1-9.00</td>
</tr>
</tbody>
</table>

LSD site dry season p ≤ 0.05: 0.26 0.09 0.72 23.75 0.42 0.25
LSD site wet season p ≤ 0.05: 0.69 0.12 0.54 19.90 0.54 0.32
LSD seasons mean P ≤ 0.05: 0.56 0.05 0.39 12.70 0.22 0.13
CV%: 3.11 1.34 6.56 4.25 8.55 12.93

<table>
<thead>
<tr>
<th>Stds</th>
<th>pH</th>
<th>Cd µg/l</th>
<th>Cu µg/l</th>
<th>Zn µg/l</th>
<th>Pb µg/l</th>
<th>Cr µg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenyan Aquatic life stds(^a)</td>
<td>6.5-8.5</td>
<td>5.00</td>
<td>100.00</td>
<td>5000.00</td>
<td>50.00</td>
<td>NG</td>
</tr>
<tr>
<td>Kenyan Aquatic life stds(^a)</td>
<td>5-9.0</td>
<td>≤1.1</td>
<td>NG</td>
<td>NG</td>
<td>NG</td>
<td>3.21</td>
</tr>
<tr>
<td>US EPA domestic water stds(^b)</td>
<td>5-9.0</td>
<td>5.00</td>
<td>1000.00</td>
<td>7400.00</td>
<td>50.00</td>
<td>NG</td>
</tr>
<tr>
<td>US EPA aquatic water stds chronic(^b)</td>
<td>6.5-9.0</td>
<td>0.25</td>
<td>NG</td>
<td>120.00</td>
<td>2.50</td>
<td>16.00</td>
</tr>
<tr>
<td>US EPA aquatic water stds acute(^b)</td>
<td>6.5-9.0</td>
<td>2.00</td>
<td>NG</td>
<td>120.00</td>
<td>65.00</td>
<td>16.00</td>
</tr>
<tr>
<td>Canadian aquatic life Stds(^c)</td>
<td>NG</td>
<td>0.017</td>
<td>2-4.00</td>
<td>30.00</td>
<td>1-7.00</td>
<td>1-9.00</td>
</tr>
</tbody>
</table>

In the dry season, river water pH differed significantly from the time the river entered the sugarcane farms to the time it left the farms (Table 3). The same situation was repeated in the wet season even though the wet season values were significantly lower than the dry season values (Table 3). As River Kuywa left the sugarcane farms, especially during the wet season, its pH values were below the expected levels in Kenyan domestic water standards (Table 3).

The reduction in River water pH values were explained with the lower values recorded in canals feeding this river from sugarcane farms (Table 4). These canals drained water from different cane fields with different activities. Canal 1 that was used as a control registered a significantly higher pH value than the rest (Table 4). Canal 2 that drained water from a factory premises did not differ significantly from the control canal suggesting that factory activities might not be affecting the pH values. This might look debatable until we mention the fact that the sewage from the factory was not considered nor the treatment plants for it was believed that the acidification problem from chemicals used in processing sugar were corrected in the lagoons. However, most of the areas canal 2 drained water from were from open fields and staff residential areas. This was aimed at assessing if maybe contaminants from the atmosphere around the factory and its workers could have an effect on pH and other values.

However, this research finds addition of agronomic inputs in sugarcane farming to have a detrimental impact on water pH. A case in mind is canal 3 that had just been freshly cultivated as virgin land and the water pH values from these farms were not different from the control canal during the dry season. A problem came in when the plots had been planted with young cane during the wet season using DAP and the difference in pH values were now significantly different from the control (Table 4). Canal 4 posed a special case whereby the sugarcane fields that was ready for harvesting in both seasons registered significantly different values in the two seasons (Table 4). This situation can be explained by the fact that during the dry season, there is no transport media to transfer the contaminants from the plots to the canals as is the case in the wet season with plenty of surface runoffs and soil erosions. Sites 4, 5, 6 and 7 that had its plots applied with Urea fertilizer during the wet season registered lower pH values that differed from one canal to the other significantly (Table 4).

It is therefore evident from water pH data that agronomic inputs in sugarcane farming affect the pH of aquatic systems. The verdict is further justified with similar results being recorded in sediments of both river and canals although the sediments values are a notch higher due to bioaccumulation effect. Not only were the fertilizers the only agronomic inputs but also others like sewage sludge and pesticides applied during the wet and dry season respectively which may equally play a significant role in pH reduction as we shall see later. The average pH in River Nzoia downstream of 6.75 is reflective of the effects of sugarcane farming activities along its basins.

| Table 5: Mean seasonal variations of heavy metals in River Kuywa surface sediments traversing sugarcane farms within Lake Victoria catchments (dry weight) |
|-----------------|--------|------|--------|--------|--------|--------|--------|
|                 | pH    | TOC  | Cd     | Cu     | Zn     | Pb     | Cr     |
| Dry season       |       |      | mg/kg  | mg/kg  | mg/kg  | mg/kg  | mg/kg  |
| R. Kuywa before sugarcane farms | 6.70  | 5.65 | 3.53   | 35.27  | 104.23 | 28.22  | 29.19  |
| R. Kuywa in the middle of sugarcane farms | 6.50  | 6.54 | 3.84   | 38.27  | 132.42 | 37.33  | 46.45  |
| R. Kuywa after the sugarcane farms | 6.30  | 6.87 | 4.20   | 45.91  | 129.93 | 44.72  | 48.78  |
| Dry season mean  | 6.50  | 6.35 | 3.86   | 39.82  | 122.19 | 36.77  | 41.47  |
### Table 6: Mean seasonal variations of heavy metals in canals surface sediments within sugarcane farms traversed by River Kuywa within Lake Victoria catchment (dry weight)

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>%TOC</th>
<th>Cd</th>
<th>Cu</th>
<th>Zn</th>
<th>Pb</th>
<th>Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dry season</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Canal from tree fields (control)</td>
<td>7.35</td>
<td>3.25</td>
<td>1.47</td>
<td>15.75</td>
<td>31.18</td>
<td>19.81</td>
<td>14.20</td>
</tr>
<tr>
<td>2. Canal from the factory premises</td>
<td>6.32</td>
<td>5.23</td>
<td>1.12</td>
<td>34.26</td>
<td>63.18</td>
<td>23.42</td>
<td>64.27</td>
</tr>
<tr>
<td>3. Canal from new cultivated plots</td>
<td>6.50</td>
<td>4.87</td>
<td>1.87</td>
<td>31.69</td>
<td>46.92</td>
<td>25.44</td>
<td>51.63</td>
</tr>
<tr>
<td>4. Canal from mature cane fields</td>
<td>6.15</td>
<td>6.43</td>
<td>1.84</td>
<td>25.04</td>
<td>33.93</td>
<td>29.04</td>
<td>51.80</td>
</tr>
<tr>
<td>5. Canal from 1 months cane fields</td>
<td>7.76</td>
<td>7.98</td>
<td>2.15</td>
<td>31.67</td>
<td>41.93</td>
<td>30.95</td>
<td>59.53</td>
</tr>
<tr>
<td>6. Canal from 2 months cane fields</td>
<td>6.88</td>
<td>5.87</td>
<td>2.55</td>
<td>18.12</td>
<td>88.44</td>
<td>33.67</td>
<td>48.61</td>
</tr>
<tr>
<td>7. Canal from 3 months cane fields</td>
<td>6.57</td>
<td>6.76</td>
<td>2.11</td>
<td>24.70</td>
<td>33.92</td>
<td>26.20</td>
<td>14.66</td>
</tr>
<tr>
<td><strong>Dry season mean</strong></td>
<td><strong>6.64</strong></td>
<td><strong>5.77</strong></td>
<td><strong>1.86</strong></td>
<td><strong>25.89</strong></td>
<td><strong>48.49</strong></td>
<td><strong>26.93</strong></td>
<td><strong>43.53</strong></td>
</tr>
</tbody>
</table>

| **Wet season**                 |     |      |     |     |     |     |     |
| 1. Canal from tree fields (control) | 7.05 | 3.45 | 1.10 | 18.58 | 40.56 | 22.42 | 18.65 |
| 2. Canal from the factory premises | 5.32 | 7.54 | 3.12 | 74.87 | 242.00 | 51.45 | 58.02 |
| 3. Canal from new cultivated plots | 5.42 | 6.87 | 3.60 | 81.78 | 327.37 | 54.16 | 94.52 |
| 4. Canal from mature cane fields | 3.69 | 7.98 | 2.22 | 56.41 | 197.77 | 50.79 | 74.53 |
| 5. Canal from 3 months cane fields | 5.55 | 10.45 | 4.39 | 45.46 | 132.00 | 56.46 | 52.82 |
| 6. Canal from 4 months cane fields | 5.00 | 6.95 | 3.24 | 20.26 | 178.19 | 51.14 | 106.30 |
| 7. Canal from 7 months cane fields | 4.05 | 7.67 | 2.16 | 55.58 | 181.67 | 51.13 | 86.10 |
| **Wet season mean**            | **5.15** | **7.27** | **2.83** | **50.42** | **185.22** | **48.22** | **70.13** |

### Statistics

|                                |     |      |     |     |     |     |     |
| **LSD site dry season p ≤ 0.05** | 0.36 | 1.45 | 0.08 | 5.96 | 23.75 | 4.06 | 5.97 |
| **LSD site wet season p ≤ 0.05** | 0.43 | 1.98 | 0.10 | 6.87 | 26.98 | 7.06 | 6.98 |
| **LSD seasons mean P ≤ 0.05**   | 0.21 | 1.56 | 0.04 | 3.18 | 12.70 | 3.77 | 3.77 |
Soil pH further explained the changes in aquatic pH levels for it recorded the lowest pH of average 5.41 (Table 7). However, the values did not differ significantly between the two seasons and this was expected for rising or lowering soil pH does not happen overnight (Table 7). In the specific cane farms, the pH differed significantly from the football pitch used as a control implicating agronomic inputs in sugarcane farming over the increase (Table 7). However, this is expected as some of the agronomic inputs such as nitrogenous fertilizers have the potential of lowering soil pH through nitrification processes (equations 1 and 2)

\[(\text{NH}_4)_2\text{CO} + 4\text{O}_2 = 6\text{H}^+ + 2\text{NO}_3^- + \text{CO}_2 + \text{H}_2\text{O} \]  
\[(\text{NH}_4)_2\text{HPO}_4 + 4\text{O}_2 = 3\text{H}^+ + 2\text{NO}_3^- + \text{H}_2\text{PO}_4^- + 2\text{H}_2\text{O} \]

Total hydrogen ions produced from this reaction are capable of lowering soil pH over time. The pH situation in this study is no different from other sugarcane growing areas with most Australian farms registering an average soil pH of 6.5, Taiwan 6.5 and South Africa 6.0 as reported by Zueng-Sang (2000) (Table 7).

This soil pH values are of major concern in sugarcane fields as they have the potential of affecting the solubility of naturally occurring and anthropogenically added heavy metals hence making them bioavailable to plants and transportation to aquatic systems (Alloway, 1995). The situation was vindicated with high heavy metal levels being recorded in both river water and canal waters (Tables 3, 4, 5 and 6). It is important to mention that these high values of heavy metals reported in this study in water, sediments and soils seem to be of natural origin in this area as was shown from the lack of significant difference of the values in soil from cane farms and the control farm (Table 7).

Table 7: Mean seasonal variations of heavy metals in surface soils from sugarcane farms traversed by River Kuywa within Lake Victoria basin (dry weight).

<table>
<thead>
<tr>
<th>Element (mg/kg)</th>
<th>pH</th>
<th>% Silt</th>
<th>%TOC</th>
<th>Cd</th>
<th>Cu</th>
<th>Zn</th>
<th>Pb</th>
<th>Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry season</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Football pitch (control)</td>
<td>7.46</td>
<td>16.45</td>
<td>4.76</td>
<td>2.82</td>
<td>63.68</td>
<td>123.49</td>
<td>58.54</td>
<td>116.20</td>
</tr>
<tr>
<td>2. Tree plantation farm</td>
<td>6.62</td>
<td>15.26</td>
<td>6.24</td>
<td>3.10</td>
<td>46.01</td>
<td>120.32</td>
<td>56.08</td>
<td>90.20</td>
</tr>
<tr>
<td>3. Factory premises</td>
<td>5.08</td>
<td>17.98</td>
<td>7.28</td>
<td>3.35</td>
<td>83.36</td>
<td>134.39</td>
<td>53.21</td>
<td>130.05</td>
</tr>
<tr>
<td>4. Newly cultivated farms</td>
<td>5.34</td>
<td>23.43</td>
<td>6.60</td>
<td>2.16</td>
<td>75.95</td>
<td>132.02</td>
<td>55.00</td>
<td>147.85</td>
</tr>
<tr>
<td>5. Farms with mature cane</td>
<td>5.25</td>
<td>16.78</td>
<td>9.35</td>
<td>4.24</td>
<td>71.08</td>
<td>116.11</td>
<td>63.41</td>
<td>184.66</td>
</tr>
<tr>
<td>6. Farms with 1 months cane</td>
<td>5.27</td>
<td>23.67</td>
<td>10.89</td>
<td>5.33</td>
<td>93.52</td>
<td>104.34</td>
<td>63.38</td>
<td>143.53</td>
</tr>
<tr>
<td>7. Farms with 3 months cane</td>
<td>5.15</td>
<td>28.89</td>
<td>10.67</td>
<td>6.84</td>
<td>84.51</td>
<td>110.71</td>
<td>71.09</td>
<td>178.95</td>
</tr>
<tr>
<td>8. Farms with 5 months cane</td>
<td>5.54</td>
<td>32.43</td>
<td>9.4</td>
<td>3.73</td>
<td>67.31</td>
<td>96.02</td>
<td>51.66</td>
<td>160.98</td>
</tr>
</tbody>
</table>
Reduction in pH is not the only culprit in increasing bioavailability of heavy metals but also increase in organic carbon of soil/sediment has been identified to enhance heavy metal bioavailability for both plant uptake and mobility from soils to aquatic systems (Antoniadis and Alloway, 2001). The current research reveals that sugarcane farming increased the levels of organic carbon content in soil and sediments as is evidenced from statistically different values in cane soils/sediments and their controls (Table 5, 6 and 7). It is therefore not surprising to find elevated levels of heavy metals in both canals and river systems.

Considering each metal variation specifically, it was noted that Cd levels did not differ significantly between the dry and wet seasons of river water levels (Table 3). However, in both seasons, Cd levels differed significantly in River Kuywa water before the sugarcane farms and after the sugarcane farms with higher values in the latter suggesting sugarcane farming to have a positive impact on the levels of this metal. Canal water registered similar trends with the values being higher than River water (Table 4). Cd levels in canal water differed significantly from the control canal implicating agronomic inputs in sugarcane farming over the increase. However, different farming activities affected the levels differently as is evidenced by the significant differences in Cd levels between different canals draining water from sugarcane fields with different farming activities (Table 4). Water in canal 2 draining water from the factory premises registered the lowest values from other canals indicating that the increase in the metal levels was due to agronomic inputs in sugarcane farming and not processing.
Considering the aquatic system, cadmium levels were beyond Canadian standards in water (Table 3 and 4) and beyond chronic level with respect to USEPA standards (Table 4) in both the river and canals. With respect to sediments, the behavior in cadmium levels variations was similar to water levels but with sediments registering higher values (Tables 5 and 6). Although the results of the current study indicate that cadmium levels were above internationally set limits for sediments, there is need to determine toxicity levels due to cadmium to benthic organisms using toxicity models like equilibrium partitioning model and narcosis theory (USEPA 2005) for unbiased conclusive recommendation to be made. This is due to the fact that this research did not determine binding phases for heavy metals like sulfide, iron and manganese neither did it extract the metals simultaneously for comparison with acid volatile sulfide (USEPA, 2005).

However, cadmium levels in the soils within the studied region were well over the calculated intervention levels putting in consideration the percent silt and organic carbon for these soils (Table 7; Zueng-sang, 2000). The values were above other sugarcane regions suggesting this area to be having high amounts of these metals that calls for immediate intervention (Table 7). It is therefore extremely important for this region to control the lowering of soil pH in order to avoid aquatic systems being contaminated by bioavailable heavy metals to unacceptable levels.

Other Heavy metals studied Cu, Zn, Cr and Pb had no different behavior from cadmium values prompting the conclusion that agronomic inputs in sugarcane farming affected heavy metal levels in aquatic systems within these zones and to a larger extent their sinks like Lake Victoria in the present case. The main impact of the agronomic inputs was found to be the lowering of soil pH that further aided in conversion of the naturally occurring heavy metals to bioavailable mobile forms that through surface runoffs, soil erosion and leaching found their way into aquatic systems.

**Recommendations**

It is recommended that actions be put in place to raise the soil pH in the studied area and those other sugarcane growing fields in Lake Victoria catchment to follow suit.

Use of sewage sludge and other organic oriented fertilizers should be reconsidered to avoid increasing organic levels of the soils since this also increases bioavailability of the naturally occurring heavy metals in this region.

Toxicity tests to be done in the studied area to determine if benthic organisms are being negatively affected with the high reported levels of heavy metals.

**Acknowledgment**

The authors are grateful to all the technical staff of the Department of Chemistry, Maseno University for their support throughout the study. This work was supported by Maseno University and partly by the IAEA CRP Project 13695/RO.

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**IMPROVING HANSEN-HURWITZ ESTIMATOR UNDER ADAPTIVE CLUSTER SAMPLING**

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**Abstract**

Adaptive Cluster Sampling (ACS) design was introduced as a powerful tool for assessing populations (clustered, rare, hidden or hard to reach such as rare plants or animal species, drug users, people engaged in illegal activities, people infected by HIV and AIDS among others) that are difficult to estimate using conventional sampling methods. The ACS is such that whenever an observed value of a unit selected satisfies a given criterion more units in the neighborhood are added to the sample and are observed. Adaptive Cluster Sampling with a data driven stopping rule (ACS) was proposed to control the effective sample size and to prevent from efficiency loss when no prior knowledge of population structure is available. The design unbiased estimator, Hansen-Hurwitz (HH) applied with ACS is however not a function of a sufficient statistic. This study explores the behavior of ACS design with Rao-Blackwell method of conditioning on sufficient statistics that is not necessarily minimal. We use the simulated population by Su and Quinn (2003) for this study. Results from simulated populations show that application of the Rao-Blackwell version of the HH estimator results in higher efficiency gain with ACS design than when applied to the ordinary ACS design. This version is recommended when prior knowledge of the population structure is not known.

**Keywords:** Adaptive cluster sampling; Rao-Blackwell theorem; Stopping rule; Hansen-Hurwitz estimation

**Introduction**

To study populations that rare and highly clustered using conventional sampling designs (such as simple random sampling, systematic sampling or stratified sampling) lead to estimates with high variances. This is because such sampling designs detect relatively few members of population of interest leading to estimates of population characteristics with high uncertainty. Thompson (1990) introduced adaptive cluster sampling design for sampling populations that are rare, clustered, hidden or hard to reach. Chao *et al.* (2008) described the basic idea behind ACS as taking a small initial sample by some
conventional designs, and then to increase the sampling efficiency in the neighborhood of the sampling units satisfying a condition, say \( C \), previously defined. A neighborhood of a unit \( i \) is defined such that if unit \( i \) is in the neighborhood of unit \( j \) then unit \( j \) is in the neighborhood of unit \( i \). A set of unit is known as a network if selection in the initial sample of any unit in the set will result in inclusion in the final sample of all units in that network. A population unit is said to be an edge unit if it does not satisfy the condition but is in the neighborhood of one that does satisfy the condition. Chao et al. (2008) defined any unit not satisfying the condition \( C \) as a network of size 1. Finally, a network with edge units forms a cluster.

A major limitation of the ACS design is the lack of control of the final sample size. Several studies have been conducted to control the final sample size but they all require prior knowledge of the population structure (Gattone and Battista, 2010). This prior knowledge is not always available. The adaptive cluster sampling with data driven stopping rule (ACS) design proposed by Gattone and Battista (2010), limits the final sample size. This design changes at each level of the aggregative procedure and for each unit in the initial sample. However, the usual design unbiased estimators applied with ACS did not make use of all information in the final sample.

This paper seeks to explore the behavior of the Rao-Blackwell HH estimator with ACS design. Here we use the Rao-Blackwell version of the HH estimator of conditioning on sufficient statistics that is not necessarily minimal as proposed by Dryver and Thompson (2005). We make use of the same simulated data by Su and Quinn (2003) for this study.

Section 2 briefly describes ACS’ design with associated estimators. Section 3 looks into the Rao-Blackwell method of conditioning on sufficient statistics that is not necessarily minimal. Section 4 evaluates the performance of the estimators for a varied population structure. Discussion is given in section 5.

2 Adaptive cluster sampling with data driven stopping rule

Let \( n_i = \{1, 2, \ldots, i, \ldots, n\} \) be an initial sample of size \( n \). For each unit \( i \in n_i \), Gattone and Battista (2010) described ACS design as a set of steps. The initial step \( h = 0 \) is composed of the initial unit \( i \) and if unit \( i \) satisfies the condition \( C \), adaptive sampling is carried out in the neighborhood of that unit. The second step \( h = 1 \) is composed of the initial unit \( i \) and the neighboring units added at step \( h = 0 \). Thus at step \( h = 1 \) we have just the ordinary ACS. In the second step, neighboring units satisfying the condition \( C \) are added to the sample forming units for step \( h = 2 \). The procedure continues until there are no units satisfying condition \( C \). For every unit \( i \in n_i \), units in the network associated with unit \( i \) will be sampled if and only if
(Gattone and Battista, 2010) where \( s_i^{(h)} \) is the within network variance estimate for the \( h^{th} \) step for the \( i^{th} \) initial unit and \( m_i^{(h)} \) is the cardinality of the set of units adaptively sampled after the \( h^{th} \) step. For a detail review of ACS design, refer to Gattone and Battista (2010).

The modified HH estimator is based on selection probabilities (Thompson, 1990) and its unbiased estimator of the population mean given by (Dryver and Thompson, 2005)

\[
\hat{\mu}_{HH} = \frac{1}{n_1} \sum_{k=1}^{K} \bar{y}_k^i z_k
\]

(2.2)

where

\[
z_k = \begin{cases} 
1, & \text{if unit } i \text{ is in the initial sample} \\
0, & \text{otherwise} 
\end{cases}
\]

and \( \bar{y}_k^i \) is the average number of units in network \( i \), or

\[
\hat{\mu}_{HH} = \frac{1}{n_1} \sum_{k=1}^{n} \bar{y}_k^i
\]

(2.3)

An unbiased estimator of the variance is given as (Dryver and Thompson, 2005)

\[
\hat{\sigma}^2(\hat{\mu}_{HH}) = \frac{N - n_1}{N n_1(n_1 - 1)} \sum_{k=1}^{n} (\bar{y}_k^i - \hat{\mu}_{HH})^2
\]

(2.4)

3 Rao-Blackwell method

The design unbiased estimator computed above made use of edge units that were in the initial sample only. Rao-Blackwell method takes into consideration all units sampled (Thompson, 1990).

3.1 Rao-Blackwell method conditioning on sufficient statistic

Dryver and Thompson (2005) proposed Rao-Blackwellized estimators that are easy-to-compute by conditioning on sufficient statistic that is not necessarily minimal. Let the final sample \( n^* \) be partitioned into a ‘core’ part \( n_c^* \) and the remaining part \( n_e^* \). \( n_c^* \) contains all distinct units in the final sample where the condition, \( C \), to adaptively add units is satisfied. \( n_e^* \) consists of all units in the sample for which unit \( i \) is
an edge unit. For unit \( i \), let \( f_i \) be the number of times that the network to which unit \( i \) belongs is intersected by the initial sample. Dryver and Thompson (2005) proved that the statistic

\[
d^* = \{(i, y_i, f_i), (j, y_j); i \in n^*_e, j \in n^*_e\}
\]  

is a sufficient statistic. Let the average \( y \)-value for the sample edge units in the final sample be denoted by

\[
\overline{y}_e = \frac{\sum e_i y_i}{e_n^*}
\]

where

\[
e_i = \begin{cases} 1, & \text{if unit } i \text{ is an edge unit and is in the neighborhood of some } j \in n^*_e \\ 0, & \text{otherwise} \end{cases}
\]

and \( e_n^* \) is the number of \( e_i \) in the final sample. Rao-Blackwellized HH estimator is given by

\[
\hat{\mu}_{RBHH} = E[\hat{\mu}_{HH} | d^*] = \frac{1}{n_1} \sum_{k=1}^{n_1} \overline{y}_e^k
\]

where

\[
\overline{y}_e^k = \begin{cases} \overline{y}_e^k, & \text{if the sum of the edge units in the sample is zero} \\ \overline{y}_e^k, & \text{if the sum of the edge units in the sample is one} \end{cases}
\]

for every network \( k \) in the sample. A more efficient estimator is given by (Dryver and Thompson, 2005)

\[
\hat{\hat{\mu}}(\hat{\mu}_{RBHH}) = E[\hat{\hat{\mu}}(\hat{\mu}_{RBHH}) | d^*]
\]

\[
= \frac{1}{L} \sum_{s \in S} I\{g(n_i) = d^*\} \frac{N - n_1}{N n_1(n_1 - 1)} \sum_{k=1}^{n_1} (\overline{y}_e^k - \hat{\mu}_{HH})^2 - \frac{1}{L n_1^2} \sum_{s \in S} I\{g(n_i) = d^*\} \left( \sum_{i \in S, s, s \neq s} y_i - e_n^* \overline{y}_e^k \right)^2
\]

where \( S \) is the sample space containing all possible initial samples, \( g(n_i) \) is the function that maps an initial sample into a value of \( d^* \) resulting from its selection and \( L \) is the number of initial samples that are compatible with \( d^* \).

4 Performance evaluation

We use simulated populations by Su and Quinn (2003) where each population has \( N = 20 \times 20 = 400 \) units. Each population was re-sampled 10000 times using simple random sampling
(SRS), ordinary ACS and ACS'. ACS designs were conducted over a varied initial sample sizes $n_i = 5, 10, 15, 20$ and $25$. Rao-Blackwell estimates were obtained by conditioning on sufficient statistic that is not necessarily minimal. Relative efficiency was calculated for each population for both ordinary ACS and ACS'. This was done by taking the ratio of the MSE of SRS and that of ACS designs. For Rao-Blackwell estimates, relative efficiency was obtained by taking ratio of variance of SRS and variance of the ACS designs. Further, the final sampling fraction $f_n$ was obtained by taking the ratio of the effective sample size (for both ordinary ACS and ACS') and the population size $N$. The condition to adaptively add units in the sample was set to $C = \{ y : y > 1 \}$ throughout the adaptive procedure. The variance was estimated by

$$\hat{v} = \frac{1}{10000 - 1} \sum_{i=1}^{10000} (\hat{\mu}_i - \bar{\mu}_m)^2$$

where $\hat{\mu}_i$ is the value of the HH estimator (modified and Rao-Blackwell for ordinary ACS and ACS') for sample $i$ and $\bar{\mu}_m = \frac{1}{10000} \sum_{m=1}^{10000} \hat{\mu}_i$.

Results of relative efficiency are shown on Table 1 and Figure 1. From the table and figure, both ACS and ACS' are efficient compared to SRS for highly aggregated population. The ACS' is more efficient than ordinary ACS for intermediary aggregated population. This efficiency is higher for small initial sample sizes. SRS is preferable for less aggregated population.

The current results are in agreement with Gattone and Battista (2010) results that ACS design is as efficient as the ordinary ACS design for highly aggregated population and more efficient than ordinary ACS design for intermediary and less aggregated populations. The results are also in agreement with Thompson (1990) that ACS is efficient for highly aggregated population.

**Table 5: Relative Efficiencies (RE) for varied population structures and for varied initial sample sizes for ACS and ACS' designs**

<table>
<thead>
<tr>
<th>Population type</th>
<th>Initial sample sizes</th>
<th>RE for ACS</th>
<th>RE for ACS'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low aggregated population</td>
<td>5</td>
<td>0.258556112</td>
<td>0.589758294</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>0.271015535</td>
<td>0.559474057</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>0.289809874</td>
<td>0.540947469</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>0.337653178</td>
<td>0.524049248</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>0.346344051</td>
<td>0.530883266</td>
</tr>
<tr>
<td>Intermediary aggregated</td>
<td>5</td>
<td>0.283315159</td>
<td>0.535952367</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>0.34349165</td>
<td>0.495927401</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>------</td>
<td>-------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>population</td>
<td>15</td>
<td>0.392329695</td>
<td>0.461085017</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>0.456741942</td>
<td>0.439762962</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>0.510408038</td>
<td>0.418683251</td>
</tr>
<tr>
<td>Highly aggregated population</td>
<td>5</td>
<td>1.060937297</td>
<td>1.091132884</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>1.071636721</td>
<td>1.082149404</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>1.139526582</td>
<td>1.093800988</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>1.137633868</td>
<td>1.102007165</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>1.115047331</td>
<td>1.096849589</td>
</tr>
</tbody>
</table>
Figure 1: Relative efficiencies (RE) for HH estimator of ordinary ACS (solid line) and ACS’ (broken line) for varied population structure with various initial sample sizes.
One of the main challenges of ACS design is the lack of control of the final sample size. Results for the final sampling fraction for a varied population structure with varying initial sample sizes are given in Table 2 and Figure 2. From Figure 2, the margins between final sampling fractions for ordinary ACS and ACS are small for highly aggregated population; this margin widens as population becomes less aggregated. The ACS design has helped in the control of the final sample size for varied population structure. This is in agreement with the results from Gattone and Battista (2010). This achievement is more on intermediary and highly aggregated populations.

Table 6: Final and ACS' sampling fractions for varied population structures for ACS

<table>
<thead>
<tr>
<th>population type</th>
<th>Final sampling fraction for ACS</th>
<th>Final sampling fraction for ACS'</th>
</tr>
</thead>
<tbody>
<tr>
<td>low aggregated population</td>
<td>0.08</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>0.14</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>0.1875</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>0.2225</td>
<td>0.1175</td>
</tr>
<tr>
<td></td>
<td>0.2525</td>
<td>0.1425</td>
</tr>
<tr>
<td>intermediary aggregated population</td>
<td>0.11</td>
<td>0.035</td>
</tr>
<tr>
<td></td>
<td>0.175</td>
<td>0.0675</td>
</tr>
<tr>
<td></td>
<td>0.2175</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>0.2475</td>
<td>0.1275</td>
</tr>
<tr>
<td></td>
<td>0.2725</td>
<td>0.155</td>
</tr>
<tr>
<td>Highly aggregated population</td>
<td>0.035</td>
<td>0.025</td>
</tr>
<tr>
<td></td>
<td>0.0675</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>0.095</td>
<td>0.0725</td>
</tr>
<tr>
<td></td>
<td>0.1225</td>
<td>0.095</td>
</tr>
<tr>
<td></td>
<td>0.1475</td>
<td>0.1175</td>
</tr>
</tbody>
</table>
Figure 2: Sampling fraction ($f_n$) for ordinary ACS (solid line) and ACS' (broken line) for various population structures with various initial sample sizes.
Results for the performance of Rao-Blackwell method on the ordinary ACS and ACS’ are reported are shown in table 3 and figure 3 below. Rao-Blackwell methods of conditioning on sufficient statistics increases efficiency of the HH estimator for all population structures and for both the ordinary ACS and ACS . The results are in agreement with Thompson (1990) and Dryver and Thompson (2005) that Rao-Blackwell method improves the efficiency of design unbiased estimators. Efficiency gain through Rao-Blackwell method follows similar pattern for the HH estimates. This is seen in all population structures and the ordinary ACS and ACS’ designs.

There is higher efficiency gain on ACS compared to the ordinary ACS design for all the population structures. This is more so on highly and intermediary aggregated populations. This is as a result of the use of all edge units in the sample in calculating estimates.

Results for relative efficiency are shown only when the initial sample size $n_1 = 15$ since the stopping rule behaves in a similar manner with varying initial sample sizes (Gattone and Battista, 2010).

Table 7: Relative Efficiencies (RE) for varied population structures for modified HH estimator and the Rao-Blackwell HH estimator

<table>
<thead>
<tr>
<th>Population Structure</th>
<th>REHH</th>
<th>REHHRB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly aggregated population with ACS’</td>
<td>1.05379906</td>
<td>1.176876883</td>
</tr>
<tr>
<td>Intermediary aggregated population with ACS’</td>
<td>0.584993472</td>
<td>0.722408777</td>
</tr>
<tr>
<td>Less aggregated population with ACS’</td>
<td>0.561075215</td>
<td>0.556800676</td>
</tr>
<tr>
<td>Highly aggregated population with ordinary ACS</td>
<td>1.139430428</td>
<td>1.16042999</td>
</tr>
<tr>
<td>Intermediary aggregated population with ordinary ACS</td>
<td>0.392289858</td>
<td>0.352037082</td>
</tr>
<tr>
<td>Less aggregated population with ordinary ACS</td>
<td>0.289798359</td>
<td>0.291479941</td>
</tr>
</tbody>
</table>
Figure 3: Relative efficiencies (RE) for modified HH (broken line) and Rao-Blackwell HH (solid line) for highly, intermediary (inter) and less aggregated populations. ‘sr’ is added to designs with stopping rule.

5 Discussion

ACS design is known to be an efficient design for rare, clustered, hidden or hard to reach population (Thomson, 1990). The design however, has a major limitation of controlling the final sample size. Gattone and Battista (2010) proposed a data driven stopping rule (that changes at each step of the aggregative procedure and for each unit in the initial sample) which contributed to the control of the final sample size. Gattone and Battista’s procedure made use of the usual design unbiased estimators (modified HH and HT estimators).

Rao-Blackwell method is used to improve the usual design unbiased estimators by conditioning on sufficient statistic that is minimal. Dryver and Thompson (2005) proposed easy to compute Rao-Blackwell estimators that are not necessarily a function of the minimal sufficient statistics.

It is well known that the ACS design can have similar final sample originating from the different initial samples. However, the estimates obtained are not always the same. Rao-Blackwell method takes the average value of the estimator \( \hat{\mu}_{\text{HH}} \) for all initial samples that result in the same final sample.

Results from the simulated data show that Rao-Blackwell estimates have improved efficiency of estimators for the various population structures and for both the ordinary ACS and ACS design. Rao-Blackwell estimates with ACS are efficient for highly aggregated population and less efficient for intermediary and less aggregated population. To this, we say that our interest was to examine the behavior of the Rao-Blackwell method with ACS design. The higher efficiency gain on Rao-Blackwell estimates with ACS design was due to the use of all edge units in the final sample in obtaining the estimates and the control of the final sample size.

We can thus conclude that, Rao-Blackwell estimators applied on ACS design are as efficient as the ordinary ACS for highly aggregated population and are more efficient for intermediary and less aggregated population. Also the efficiency gain is higher when Rao-Blackwell method is applied to ACS compared to when applied to the ordinary ACS design.

Our focus in this paper was only on the HH estimator since there is no suitable variance estimator for ACS design. The provision of a suitable variance estimator with ACS design could be the goal of further research. Then the analysis of the application of Rao-Blackwell method with the suitable variance HT estimator with ACS design can be looked at. The current results are in agreement with the inequality

\[
\text{var}(\hat{\mu}_{\text{RBHHs}}) \leq \text{var}(\hat{\mu}_{\text{HH}}) \quad (\text{Thomson, 1990}).
\]

We know that conditioning on minimal sufficient statistics results in much efficient estimates compared to the current work. The evaluation of the ACS design with Rao-Blackwell method of by conditioning on minimal sufficient statistics deserves further research.
Acknowledgements  We wish to thank Arthur Dryver and Chang-Tai Chao for their useful contributions and thank Su Z and Quinn TJII (2003) for allowing us to use his simulated data.

References


UTILIZATION OF RESEARCH FINDINGS FOR SUSTAINABLE MANAGEMENT OF LAKE NAIVASHA BASIN

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Abstract

Lake Naivasha is one of the fresh water lakes in the Kenyan Rift Valley. The population and human activities within the basin has experienced rapid growth, placing enormous strain on the ecosystems within/around the Lake Naivasha Basin. The basin has been faced by a myriad of environmental challenges leading to serious consequences for the already fragile ecosystem. Several research activities have already been conducted, with others underway, to capture and document the ecosystem health status within the Lake Basin. In spite of these efforts, ecosystem health degradation is continuing at an alarming rate. Clearly a gap exists between the research conducted on one hand, and
utilization of the findings for sustainable development, on the other hand. This paper reports on a study which sought to understand the underlying reasons for continuing environmental resources’ degradation for a region that has had more than a fair share of research undertakings. The study employed a social survey methodology targeting qualitative and quantitative data. A sample of 304 households was derived and used for collecting data from primary stakeholders. A questionnaire was administered to this group to elicit their views and experiences. In addition, focus group discussions and key informants in-depth interviews Data collected from primary stakeholder was analyzed by SPSS. Results show that in spite of a wide range of research work conducted in the study area, a significant amount of the output has not reached the stakeholders. Moreover, stakeholders decried the language used in disseminating scientific research, arguing it was not comprehensible for use by the ordinary stakeholder. This suggests that much as they would be interested in using the findings to address environmental resources’ conservation issues, most stakeholders are disadvantaged from this double problem. Arising from the findings, this study suggests a number of mitigations – the need to digest research findings and make them easily available and accessible to stakeholders; the formation of a stakeholder advisory board to serve as a link between the research community and local stakeholders, and in particular to synthesize, simplify (and where necessary translate), store and disseminate research findings, as and when required for informing decisions and practices aimed at sustainable management of resources in the Lake Naivasha basin.

**Key Words:** Utilization of research findings, Sustainable management, Stakeholders

**Introduction**

Lake Naivasha is a fresh water lake located within the Kenyan section of the Great Rift Valley. The lake derives its name from a ward *Naiposha*, a Maasai word meaning “rough water” in reference to sudden storms which commonly occur in the area. The lake has a surface area of 139 km$^2$, and is surrounded by a swamp which covers an area of 64 km$^2$. It is situated at an altitude of 1884 meter (6180ft) above sea level. The lake has an average depth of 6 meters (20ft) with the Crescent Island as the deepest end, at a maximum depth of 30 meters (100ft) Francesca .G et al (2011)

The lake provides habitat to a variety of wildlife, with over 400 different species of birds that include; water fowls, fowls, penguins, flamingos, falcons, eagles, hawks, cranes, doves, parrots, cuckoos, owls, kingfishers, woodpeckers, mouse birds and many others(Francis 2010). A sizeable population of hippos also exists within the lake. Two smaller lakes are found within the vicinity of Lake Naivasha, namely Oloidien and Sonachi. The latter lake shore is known for its population of European immigrants and settlers.

Since Kenya’s independence in 1963, Lake Naivasha basin has undergone rapid land use transformations characterized by commercial ranching, and small-scale agricultural activities. In the last two decades, the area has become an expansive commercial flower-growing zone, largely by foreign companies. It is one of the contributors of Kenya’s export of approximately 134,000 tonnes of cut flower, fresh fruits and vegetables (HCDA 2007). This has increased demand for the scarce ecosystem resources and services, especially water and land. The results have been significant water abstraction from both the Lake and underground sources by the floriculture industry, a major ecosystem health problem. In the absence of any meaningful controls e.g. metering, water is “free for all”.

Accelerated water abstraction through direct and indirect methods poses immediate and long-terms risks to the ecosystem and the existence of the Lake. The demand on water for flower growing is compounded by the needs of the fast growing population. The likelihood of increased ecosystem health degradation is
certain unless mitigation measures are put in place. What is not immediately clear is whether or not the water users such as flower growing companies are aware of the ecosystem consequences of their actions. Or could it be that they lack essential research based information on the basis of which they could make more informed decisions on management of the basin’s resources?

Other harmful practices in the basin include rampant discharge of raw sewage into the Lake, resulting in eutrophication and high demand on available oxygen in the Lake. The consequences of such practice are disastrous for the ecosystem health. A related problem is rampant use of pesticides by flower farms and chemical fertilizers among small scale farmers in the upper catchment area of the Aberdares. It is alleged that some flower farmers are using unacceptable chemicals such as organo-chlorine pesticides and some of these pesticides have been detected in Lake Naivasha. Through biomagnifications, such chemicals could affect bird species at the top of the food chain. These activities have the potential to adversely affect the health status of a growing number of people and other life systems within the Lake Naivasha Basin (Lake Naivasha Management Plan, 2004). Evidence of the emerging ecosystem health degradation is the decline in the number of bird and fish species found on the lake Abiya (1996).

The quantity of data and research on Lake Naivasha and its drainage is overwhelming (Robert et al., 2006). According to Trick the number of basic research done to generate knowledge is 123 and applied research 55 (Personal communication 19/04/2010). Despite all these, ecosystem health degradation is still a threat to Lake Naivasha basin. Strategies for bridging the gap between ecosystem health research findings and utilization by stakeholders to address the ecosystem challenges are still lacking (LNROA, 2000).

There are many players with different, and many times, competing needs and influence within Lake Naivasha Basin. These have disruptive effects on the water balance, quality of water and air, sustainability of ecosystem including fish, vegetation, birds etc (Aberdares) (LNROA, 2000). However, it is not quite clear how each of these stakeholders can contribute towards sustainable management of the Lake’s basin. It was in view of this that, this study carried out stakeholder analysis to understand the main players in Lake Naivasha basin, and their influence and role in ensuring sustainable use of Lake Naivasha. Similar important studied was how to disseminate ecosystem health research findings information in a simplified way, and participation in the formation of a stakeholder advisory board.

**Research methodology**

The study was conducted in Hell’s Gate Location, which is located in Rift Valley Province of Kenya (figure 1). The basin extends 60° North from the equator and lies between 36°07’ and 36°47’ east of Greenwich meridian. The population in the area surrounding the lake has rapidly grown from 7000 in 1969 to about 300,000 by 2007 (Food and Water Watch 2008). It is estimated that the population will be close to one million by 2025, in consonance with sub-Saharan estimated urban population growth rate of 6.9% per annum as compared to 3.1% of the total population of the region (Ayenew et al., 2007).
The data from the study area was collected through a variety of instruments such as questionnaire administered to individual respondent, Focus Group Discussions, in depth interviews as well as observation schedules. Stakeholder analysis tool was also used to understand the various stakeholders competing interests and influence.

RESULTS AND DISCUSSION

Stakeholder analysis of different communities and organizations living and working within Lake Naivasha Basin with a view to assessing their knowledge of ecosystem health.

The first objective of this study focused on assessing the knowledge of various stakeholders on the status of ecosystem health. Discussion was participatory where five groups were established.

From the deliberations, it became clear that, the Lake had many users who pose many threats to its existences, people knowledgeable about the Lake existed, good will existed for the support of the sustainability of the Lake, so long as they were involved since they faced same or different challenges on utilization of research findings information for sustainable management of the resource. For those who will not support the conservation effort will be made to win them. This relates closely with Closs et al., (1994) suggesting that utilizing research findings was a highly complex task, requiring a positive attitude towards research for its success during the time of implementation.

Grid was used to categorize the stakeholder within Lake Naivasha Basin to show how their power and interest is at play. From the grid the stakeholders were categorized based on power and interest (Figure 2).
From the same discussions, it was agreed that the stakeholders should form Stakeholders Advisory Board (SAB) to manage sharing of the ecosystem health research information and the resource centre with a view to sustainable use the lake. It was suggested that SAB should comprise 15 members board drawn from WRUA, Pastoralist, Lake Naivasha Grower Group, Small scale farmers, C.S.O forum, Eco-tourism, BMU, CFA, LNRA, Naivasha municipal council, Business community, other local authority, youth groups, women representatives and government ministries. This compares well with study done (Kostas and Kostas 2011) where all the stakeholders were involved in the management of the Greek Municipality success which was achieved through consultation, deliberations, co-operation with important organizations and the use of international best practices. Issues brought on board were social, economic and cultural. The benefit has been good economic growth, productivity, competitiveness, social inclusion and sustainable development.

**To determine factors influencing utilization of ecosystem health research findings by various stakeholders towards sustainable management in Lake Naivasha Basin**

In response to question on whether the respondents were aware of researches going on within Lake Naivasha Basin, the study found that majority of the respondents indicated that they were not aware. Leading in lack of awareness were the pastoralist (86.7%), followed closely were self employed (79.1%), farmers (75.7%) and employed (63.4%). Only the fishermen (54.5%) indicated that they were aware of the researches which were being carried out around the lake. This was attributed to the fact that many fishermen interacted with the researchers as they carry out their activities in the lake. Lack of awareness among the pastoralist can be attributed to migratory life style where they move from one place to another in search of pasture for livestock and that has reduced their awareness of research activities since they probably don’t meet or interact with researchers. Lack of education or low level of education as noted...
elsewhere on this study has also contributed to lack of awareness since they can’t tell whether research is going on or not. The self employed lack of awareness can be attributed to probably most of them are tied at their place of business where they do not get time to interact or meet the researchers. The same situation is probably applicable to the employed respondents where most of them are tied at their place of work where they do not get opportunity to meet or interact with researchers. As for farmers lack of awareness can be attributed to most of the farming are done on the outskirts of the town where their interaction with researchers is very minimum since most of research activities are concentrated long or inside the Lake.

In responses to the question as to how much knowledge the respondents had on effect of chemical on the environment and human health. The study found that indigenous farmers had “above average” knowledge as indicated by (35%) of the respondents. It was also found that only (5%) had “average knowledge” on the effect of chemicals on environment and human health. This can be attributed to their farming activities which does not involve the use of chemicals or interacting with chemicals. For the fishing community, the study found that (59%) of the respondents indicated that they had “above average” knowledge of effect of chemicals on the environment and human health. This is probably due to the fact that the fishing community interact more with the Lake and during the process they have seen the fish die at some point in time and may be they attribute it to the effect of chemicals. They may also be interacting with many researchers who they may be sharing with information. Regarding the knowledge of the pastoralists, the study found that (35%) of the respondent indicated that they had “most knowledge” followed by “some knowledge” (27%), “above average” knowledge at (24%). This can be probably attributed to them keeping large number of livestock and they interact with environment very closely, where they have seen cattle die due to poisoning, grazing land reduced or polluted and hence that explain why they are very knowledgeable. Among the employed respondents, the study found that (35%) of the respondents indicated that they had “above average” knowledge and (32%) had “some knowledge” on the effect of chemicals on the environment and health. This can be attributed to the environment which they work in, where they come into contact with chemicals directly or indirectly. They had probably seen what these chemicals can do to our surroundings and health. From the response of the self employed, (36%) had “above average” knowledge, followed by “least knowledge” at (22%), “average knowledge” and “some knowledge” was less than (15%). This was probably due to their socioeconomic activities which does not
To test the knowledge of respondents, they were asked to define environment. The study found that (79.2%) defined the environment as their surroundings. The study also found that (7.1%) don’t know, (3.7%) defined it as trees and animals, (3.0%) defined it as water, trees and animals, (0.7%) defined it as pasture and livestock. From the findings of the study, it can be said that majority of the respondents had an idea of what the environment was. With the majority of the respondents knowing the definition of the environment this can be used to help educate and conserve the environment.

Having tested the knowledge level of respondents on definition of environment and awareness of research going on in Naivasha, they were asked the usefulness of ecosystem health research findings. Leading in “usefulness” of research findings were Fishermen (39.1%), followed by Farmers (35.1%), Pastoralist (22.5%), Self employed (10.3%), and finally Employed (8.8%). “Above average” usefulness of research findings leading was Self employed (48.7%), followed by Employed (41.8%), Fishermen (34.8%), Pastoralist (32.5%) and Farmers (21.6%). “Very useful” leading was Pastoralist (25%), followed by Employed (24.2%), Fishermen (13%), Farmers (10.8%) and finally Self employed (10.3%). These results elaborate probably the fact that ecosystem health research findings are useful to respondent in one way or the other and this had strong link with their socioeconomic activities (Figure 3).

For the Self employed (48.7%) the result show that research findings are “above average” useful to them, this can be attributed to the fact that they interact with Employed, Pastoralist, Fishermen and Farmers, they have seen or witnessed how chemicals affect them in one way or the other. This probably explains why the research finding is above averagely useful to them to try to explain some of the challenges. For the employed (41.8%) research findings are above averagely useful to them due to the fact that most of them are employed in flower farms and they have probably also seen or witnessed how people are affected by chemical and may want to know why that is the case. With regard to the pastoralist (32.5%)
the research finding is above averagely useful to them probably due to the fact that they are very close to nature and they have seen some of their livestock die as a result of chemical poisoning. That explain why they are probably seeking answers through research findings. Just like the Pastoralists the Fishermen (34.8%) the research findings are above averagely useful to them and this probably attributed to the fact that they have seen fish die in the Lake and seen/interacted more with researchers carrying out research in the lake. That explains the curiosity to seek for answers through research to explain the deaths of the fish. For the Farmers (21.6%) research findings are above averagely useful to them, this was probably attributed to the fact that most farming is done in the outskirt of Naivasha and hence less interaction with effects of chemicals. That explains low usefulness of research findings to them.

![Figure 3: Usefulness of research information by respondents](image)

On probing further the respondents who had idea of the research going on within Lake Naivasha, they were asked to mention the kinds of researches going on within Naivasha which they know. The study found that indigenous farmers mentioned that the leading researches they know were on environmental issues (38%), followed by chemicals in lake (25%), pollution (12%) and human health (12%) respectively. The farmers were probably more concern with their immediate environmental where they do most of the farming activities and a few were concern with pollution of the Lake and human health. Fishermen mentioned the researches which they knew; starting with water (66%), followed by pollution of lake (16%), chemicals in lake (8%) and environmental issues (8%) respectively. This probably explains that fishermen are more concern about state of water and pollution of the lake by nearby flower farms since they have witness fish dying in the lake as noted earlier.
The study further found that pastoralists were aware of researches as follow; environmental issues (40%), water (20%), human health (20%), chemical in lake (20%). The pastoralist being migratory people with their livestock they are very close to nature where they use pasture from the surrounding environment for their livestock, use water from the lake to water their livestock and they are equally concerned about human health since they drink that water directly without treatment too. They see themselves as being vulnerable to all these challenges and hence the concern in all areas. Employed people mentioned the researches which they were aware of done; leading was environmental issues (39%), followed by human health (19.5%), pollution of lake (16%), water (10%), chemical in lake (6%), cultural issues (4%). Employed respondents were aware of many type of researches going on within the study area and this can be probably be attributed to them working in different work environment such as flower industry, tourism, government, and schools. Self employed respondents mentioned the researches which they were aware done were as follows; starting with water (34%), human health (34%), environmental issues (22%) and pollution of lake (11%). Most of the respondents connected research activities in Naivasha with their socioeconomic activities. In other words they probably viewed research as coming to solve some of the problems affecting them for instance the fishing community were keener on clean water and to reduce the deaths of fish which will improve their livelihood. The pastoralists were more concerned with the health of pasture and water for livestock and hence reduce death of animals and that means more income to them.

In response to the question on whether the respondents had access to ecosystem health research information, the study found that most of the respondents had no access to ecosystem health research information. This was evidenced by the fact that pastoralists (80%) had no access to the information. The study also found that fishermen (70%), indigenous farmers (64%), self employed (60%) and employed (58%) had no access to ecosystem health research information. This can be attributed to their level of education which is probably low as noted elsewhere on this study. Among the employed the findings can be attributed to the probability that most of them are either primary school leavers or secondary school leavers who understand what is going on around the environment and hence they had some access to ecosystem health research information. This demonstrates probably that either the people did not know where to get the information or they did not know how to go about the process of getting the research information which can help them solve some of the environmental problems.

Since most of the respondents who were interviewed had no access to ecosystem health research information, they were asked to mention some of the sources of ecosystem health research information they use for conservation of environment. The study found that the major source of the information for the respondents was radio (Figure 4). This was indicated by farmers (51%), fishermen (61%), pastoralist (50%), employed (64%) and self employed (75%). This was probably attributed to the fact that radio is cheap and can be afforded by most household. The study also found that television was a source of ecosystem health research finding as indicated by farmers (26%), fishermen (18%), pastoralist (23%), employed (27%), and self employed (33%). This percentage was probably lower than that for radio because most household find television set expensive hence low use.
The study further found that some of the respondents accessed research information from printed media as indicated by farmers (0%), fishermen (5%), pastoralist (2%), employed (15%) and self employed (8%). This was very low probably due to the fact that cost of printed media is expensive to most respondents and low level of education prevents them from using it. Use of internet to access ecosystem health research information was even lower as indicated by farmers (0%), fishermen (9%), pastoralist (0%), employed (15%) and self employed (0%). This can be attributed to low level of education of the respondents, cost of using internet may be high to most respondents and lack of computer skills. Use of research institutions to access ecosystem health research information was low as indicated by farmers (11%), fishermen (0%), pastoralist (6%), employed (11%) and self employed (11%). Probably this was due to lack of awareness that research institutions have ecosystem health research information needed by respondents. Use of Baraza to access ecosystem health research information was also very low as indicated by farmers (4%), fishermen (4%), pastoralist (19%), employed (2%), and self employed (3%). The low usage of baraza can be attributed to lack of awareness by the respondents of the importance of Baraza, or probably most respondents have not be sensitized why Baraza are important.

![Figure 4: Sources of research information by respondents](image)

In establishing the importance of research information accessed by the respondents, they were asked to indicate the most important information they were interested in. The study found that fishermen (65%) indicated that the most important information for them was that which highlights on concentration and type of pollutant in Lake Naivasha, followed by human health (26%), watershed hydrology (4%), ecosystem health (4%) and management of solid waste (4%). Since the livelihood of fishermen revolves around the lake that probably explain why they are concern about pollutants in the lake and how it can affect the human health. The study also found that the importance information for farmers was ecosystem health (28%), followed by concentration and type of pollutants in the lake (22%), human health (20%),
watershed hydrology (18%) and management of solid waste (11%). Among the pastoralists, the important information was found to be concentration and type of pollutant in Lake Naivasha (32%), followed by watershed hydrology (29%), ecosystem health (23%), human health (14%) and management of solid waste (10%). The study finally found that among the employed and the self employed population interviewed watershed hydrology was important as indicated by (29%) and (30%) respectively. From the findings of the study, it can be said that all the respondents valued the information got from the ecosystem health researches done around lake Naivasha but the degree of importance varied with the lines of their socioeconomic activities in the ecosystem (Figure 5).

![Figure 5: Most important research information required by respondents](image)

Figure 5: Most important research information required by respondents
The findings of the study clearly show that people who live around Lake Naivasha need ecosystem health research information on various issue based on their socio-economic activities. Problem influencing access to ecosystem health research information include lack of resource centre leading were farmers (26.7%), followed by self employed (20.4%), employed (13.9%) fishermen (13.04%) and finally pastoralist (12.5%). Cost of accessibility; leading employed (20.8%), followed by farmers (8.89%), pastoralist (8.33%), self employed (7.41%) and last was fishermen (4.35%). With regard to level of education leading was pastoralist (8.33%), followed by employed (6.93%), self employed (5.6%), farmers (4.4%) and finally fishermen (4.35%). Use of technical language leading fishermen (13.04%), employed (10.9%), self employed (7.4%), and farmers (0%). Lack of interest; leading was pastoralist (8.33%), followed by employed (6.93%), self employed (5.56%), farmers (4.44%) and fishermen (4.35%). Lack of resource personnel was also a problem; leading was employed (15.84%), followed by fishermen (8.7%), pastoralist (8.33%), self employed (7.41%) and finally farmers (6.67%). Lastly lack of proper translation was also a challenge as indicated by fishermen (8.7%), employed (7.92%), pastoralist (6.25%), farmers (4.44%), self employed (1.82%).
Based on the level of education of the respondents where the majority of the respondents were either primary or secondary school leavers as noted elsewhere in this study, this probably contributed to problem of accessibility of ecosystem health research information (Figure 6). Since most of the respondents had no access to ecosystem health research information as noted elsewhere in this study, this explains probably why they were not able to tell whether the language used was technical hence the low percentage response. On the other hand most respondents were probably interested on accessing ecosystem health research findings as demonstrated by low response of those who are not interested on research findings. Lack of resource centre came out very strongly since most respondents wanted a place they can visit and access the ecosystem health research information they need which was lacking. Given the fact that there is no resource centre, the respondents probably could not tell whether the ecosystem health research information generated needed personnel to management them or they need to be translated into a simple version for them to understand hence the low percentage response. This is applicable to the cost of accessing ecosystem health research findings, how can they know that cost is involved? When in the first place they had no access to research information hence the low percentage in response.

![Diagram](image)

**Figure 6: Problems in accessing research information by respondents**

Related to accessibility of ecosystem health research information was awareness. The major factor limiting access to ecosystem health research information (Figure 7) was lack of awareness on the existence of ecosystem health research information as indicated by farmers (65%), self employed (50%), fishermen (42%) employed (42%) and pastoralists (40%). Another factor which limited the accessibility of ecosystem health research findings was lack of education as indicated by farmers (30%), fishermen (56%), pastoralist (40%), employed (40%) and self employed (25%).
These factors which limit utilization of research findings conquers with the findings of a study done by Michael et al., (2007), where he found that the factors influencing the utilization of research findings by all stakeholders include access to information, relevance of the research, use of the research perceived as a time consuming process, trust in the research, authority of those who present their views, competency in research methods, and priority of research in policy process and accountability. This also compares with study done by Thomas (2010) where reasons for failure of research finding to translate into utilization include historical, social, economic, cultural, organizational factors slow or impede the transfer, high cost, intensive time demanded, high level of staff expertise required, difficulty to learn or understand, not developed to suit the users need, not designed to be self sustaining and highly specific to a particular setting.

![Figure 7: Problems that limit accessing research information by respondents](image)

To establish the link between awareness, accessibility and usefulness of ecosystem health research information to respondents with education, a cross tabulation was done. This was to see if there is a relationship between awareness and education level, usefulness and education level and accessibility and education level.

**Table 1: Cross tabulation of Level of education and awareness of research activities**

<table>
<thead>
<tr>
<th></th>
<th>Is respondent aware of research activities</th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Aware</td>
<td>Not aware</td>
<td></td>
</tr>
<tr>
<td>No formal</td>
<td>Count</td>
<td>4</td>
<td>43</td>
<td>47</td>
</tr>
</tbody>
</table>
At 95% confidence interval the relationship between education and awareness of research activities was statistically significant (p) < 0.05 ($\chi^2$=37.644, P=0.00, df=4). Therefore there was a strong relationship between level of education and awareness of research activities. From (Table 1) level of awareness increases with increase with the level of education. This is attributed to the fact that people’s aware of the importance of ecosystem health research activities was due to exposure which is brought about by their level of education.
Table 2: Cross tabulation of level of education and access to research information

<table>
<thead>
<tr>
<th>Highest level of education</th>
<th>Do you have access to research information</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>No formal education</td>
<td>10</td>
<td>39</td>
</tr>
<tr>
<td>% within Highest level of education</td>
<td>20.4%</td>
<td>79.6%</td>
</tr>
<tr>
<td>Primary</td>
<td>32</td>
<td>67</td>
</tr>
<tr>
<td>% within Highest level of education</td>
<td>32.3%</td>
<td>67.7%</td>
</tr>
<tr>
<td>Secondary</td>
<td>51</td>
<td>61</td>
</tr>
<tr>
<td>% within Highest level of education</td>
<td>45.5%</td>
<td>54.5%</td>
</tr>
<tr>
<td>College</td>
<td>17</td>
<td>11</td>
</tr>
<tr>
<td>% within Highest level of education</td>
<td>60.7%</td>
<td>39.3%</td>
</tr>
<tr>
<td>University</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>% within Highest level of education</td>
<td>100.0%</td>
<td>.0%</td>
</tr>
<tr>
<td>Total</td>
<td>111</td>
<td>178</td>
</tr>
<tr>
<td>% within Highest level of education</td>
<td>38.4%</td>
<td>61.6%</td>
</tr>
</tbody>
</table>

At 95% confidence interval the relationship between level of education and access to ecosystem health research information is statistically significant ($\chi^2=18.159$, df=4, $p=0.001$). From the result (Table 3) it confirms there was a strong relationship between level of education and access to ecosystem health research information. This was attributed to the fact that the higher the level of education one has the more access to research information they had, since they know the importance and how to access it.

**Conclusion**

From the findings of the study, it can be concluded that Lake Naivasha Basin is composed of many types of stakeholders who have different amount of resources and power. They all use the lake resource in
different ways to satisfy their needs. The lake is threatened by sewage discharge into it, over abstraction of water, extraction of natural environmental resources such as wildlife, trees for charcoal burning. People who are knowledgeable about the Lake are WRMA, Fisheries, BMU, LNGG, Municipal Council of Naivasha, Naivasha Water and Sewage Company. The depth and breadth of knowledge varies from group to group and depend on how the resource is used. Many research initiatives have been done and no full involvement of all the stakeholders there in research and sharing of ecosystem health research findings. In this regard there is need to share the research findings to empower all the stakeholders for sustainable management of Lake Naivasha Basin. This information need to be simplified and disseminated in Kiswahili which everybody can understand through the Radio, Poster, Baraza, Pamphlets, Drama and Music.

Factors contributing to the utilization of ecosystem health research findings included: lack of awareness of the existence of ecosystem health research finding information and inadequate access to research findings. The only sources of ecosystem health research finding were through Radio, Television and Friends and Relatives. Other factors included: lack of resource personnel, use of technical language and inadequate education among the stakeholders.

**Recommendation**

There is need to form Stakeholder Advisory Committee which can bring in all stakeholders representative from those with less influence to those with more influence. This will help the stakeholder develop mechanisms to manage the generated ecosystem health research findings. To manage the information better a resource centre should be established where all the ecosystem health research findings will be stored for access to the researchers and public. The information can be in the form of hard copies or soft copies. In this regard, there is need to employ/engage/volunteer qualified personnel who can manage the resource centres. Going hand in hand with the resource centre, there is need to link the resource centre to the internet to allow it accessed by the rest of the world. Finally researchers should be encouraged to share the information on the findings of their studies and to allow access by other researchers and member of public for better decision making with regard to the ecosystem.

Results of the findings of the studies done in the ecosystem health should be simplified and summarized in a simple form to allow the local people to understand (Swahili). Panel of experts to simplify the findings of the studies should be formed to allow for easy translation and dissemination of the findings among the stakeholders. This can then be produced in the form of flyers, posters and brochures.

Develop simple programs/documentaries based on ecosystem health research findings information generated. This can be done in partnership with local media houses such as Nation TV, Citizen TV, Radio stations which are accessed by many local people. The information will reach Naivasha and the whole country which are facing the same challenges like Lake Naivasha. To further facilitate the process of dissemination of research information people will need to be mobilized through the help of local chiefs, political leaders to attend Baraza, seminars, conferences and workshops for purpose of educating them on ecosystem health research findings. Lastly local NGOs and CBO need also be involved in the advocacy for legislative and policy change at local and national level. They can only be engaged once suggested policy briefs have been prepared by stakeholder’s advisory committee. Through this advocacy the agenda
of ecosystem health research findings of concern will be able to reach national level to push for more allocation of resources to sustain the environment.

REFERENCES


STABILITY CRITERION OF PERIODIC OSCILLATIONS IN IMMUNE RESPONSE TO HIV INFECTION WITH TIME LAG

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Abstract
The use of ARVs to fight HIV does not eradicate the disease completely but maintains low viral load helping reduce infectivity of exposed individuals. The time lag between the action of HIV virus and the reaction of the immune system leads to periodic solutions of oscillating cell populations. In this paper we analyze a mathematical model that describes the dynamics of the immune system and a drug sensitive wild-type HIV variant. We study the behaviour of steady state of the model to assess the effects of time delay on its stability. The periodic solutions are stable at minimum drug efficacy $\varepsilon_{\text{min}}$ if the value of time lag is greater than the critical value $\tau_{\text{min}}$. The values of time delay and minimum drug efficacy parameters once determined, help in designing an effective recipe on management and control of the HIV pandemic. This reduces the problem of toxicity and viral rebound.

Keywords: Equilibrium, Basic reproductive number, Stability, Oscillations.

1. Introduction
Since HIV pandemic first became visible, enormous research on how to control the epidemic in terms of prevention of transmission and treatment has been conducted. Mathematical modeling has proven to be valuable in understanding the dynamics of infectious diseases with respect to host-pathogen interactions. By direct application of model results, lesser clinical experiments is required and valuable information on the dynamics of pathogens is obtained helping in designing a more effective regimen. With the continuing absence of HIV/AIDS cure, the use of the current combination of ARV’s and vaccines have not been effective because of inadequate knowledge of the basic principles on the interaction of the immune system in response to the diverse set of pathogens that challenge humans. ARVs have been known to reduce the amount of human immunodeficiency virus type 1 in the blood plasma of infected patients to extremely low undetectable levels (see for instance Gulick, et al. (1996), Markowitz, et al. (1996), and Perelson & Nelson (1999)). However, a small percentage of infected patients experience viral rebound (Gulick, et al. (1996)). This could be associated with periodicity in viral load due to the time delay during interaction Li & Shu (2010).

Many mathematical models of HIV infection, notable among them is that of Perelson (1999), Kirschner (1996), and DeBoer, [14] studies the interactions between the immune system and free virus in the bloodstream. Their utility lies in the ability to predict an infected steady state and examining the effects that changes in parameters have on the outcome of the system over time, to determine which parameters are most important in disease progression, and further determine critical threshold values for these parameters. Secondly, treatment strategies can theoretically be simulated, allowing the design of clinical trials to be streamlined.

Various biological reasons lead to the introduction of time delays in models of disease transmission. Time delays are used to model the mechanisms in the disease dynamics (see for instance (Van-den Driessche & Watmough. (2002) and Arino, et al (2006)). Usually, the following several different
biological mechanisms have been modeled by the introduction of time delays in epidemiological models: (i) Delay due to temporary immunity (see for instance Kyrychko and Blyuss (2005) and Blyuss and Kyrychko (2010)) where delay is used to model immune period and varying immune period. (ii) Delay caused by the latency in a vector where some time is needed before the infective organism develops in the vector to the level that is sufficient to pass the infection further. (iii) Delay caused by latent period in host. Inclusion of time delay means that the models can be formulated as functional differential equations. One important aim is to investigate the effect of time delays on global properties of models. Lyapunov-LaSalle type theorem for delay differential equations Kuang (1993) provides a useful method to establish global stability by suitable Lyapunov functional. Huang et al. (2010) have considered two epidemiological models with the last two case delays and nonlinear incidence rate. Perelson et al (1999) modeled HIV-1 infection that include intracellular delays and showed that when the drug efficacy is less than perfect the estimated value of the loss rate of productively infected T cells, is increased. Krischner and Webb (1996) formulated a model to study treatment strategy in the chemotherapy of AIDS using AZT. They studied three types of qualitative clinical behaviour; namely, an uninfected steady state, an infected steady state (latency) and a progression to AIDS state. The effect of treatment to perturb the system from progression to AIDS back to latency was simulated and the following issues of chemotherapy were addressed (i) daily frequency of treatment (ii) early verses late initiation of treatment and (iii) intermittent treatment with intervals of no treatment. The simulation suggested the following properties of AZT chemotherapy. (i) the daily period of treatment does not affect the outcome of the treatment, (ii) treatment should not begin until after the final decline of T cells begins and (iii) a possible strategy for treatment which may cope with side effects and or resistance is to treat intermittently with chemotherapy. Apart from Kuang’s (1993) Lyapunov method, Forde (2005) studied stability of Delay Differential Equation Models in Mathematical Biology. They showed that varying the delay length can change the stability characteristics of a steady state. So, treating the length of the delay as a bifurcation parameter, a stable steady state can become unstable if, by increasing the delay, a characteristic root changes from having a negative real part to having positive real part, and this occurs only if this root traverses the imaginary axis.

In this paper, we formulate a biological model to describe the interaction of HIV retro viruses, the immune system and concentrations of therapeutic drugs in the human body. The models consist of a system of delay differential equations describing the interactions of HIV viral materials and immune system cells in presence of therapeutic drugs. The model is used to analyze the virologic effect of drugs on HIV viral load and to establish immunologic effects of periodic supply of therapeutic drugs on CD4+ T cells. The model studies the interaction of three groups of cells; CD4+T cells, virions and CTL cells in presence of antiretroviral drugs. Here, delay due to latency $\omega$ and delay during productive period $\tau$ is incorporated, with $\tau = \tau + \omega$.

This is how the paper is arranged. Section 2 we develop a model, and examine equilibrium points. Section 3 examines the effect of delay $\tau$ and periodic drug supply on their stabilities and CTL response in presence of treatment. We obtain theoretical results showing minimum bounds of periodic drug supply and bounds of time lag required for effective control of HIV viral population. The last section gives numerical results and a summary of our results and conclusion.

2. Theoretical Analysis
2.1 Treatment and CTL Model

The dynamics of the viral and immune system interactions is affected by drugs and CTL response. This is accounted for incorporating parameters measuring drug efficacy and CTL action in a mathematical model. Define the following variables to be used in modeling.

**Definition of Variables:**

(1) $T(t)$ Naive T cells containing cells produced and developed in the Bone marrow and the Thymus and through other proliferation terms; (2) $T_i(t)$ Infected and unproductive CD4+T cells which mature to become productive or remain unproductive and retained as memory cells;

(3) $T_2(t)$ Population of productive CD4+T cells; (4) $V(t)$ Population of free infectious virus;

**Model assumptions**

In order to have explicit dynamical relations we make the following model assumptions:

A1 The model does not distinguish infection by different viral strains.

A2 Only CD4+T cells are infected and up on infection, cells become latent for some fixed time then become productive for time $\tau = \omega + \tilde{\tau}$ units.

A3 There are only four interacting cell species $T(t), T_i(t), T_2(t)$ and $V(t)$.

A4 Mass action principle, where interaction is assumed to be a function of interacting populations is employed or in proportion to the product of abundances of T cells and viral load.

2.2. Model Equations

The definition of variables and assumptions stated result in the following Model Equations,

\[
\frac{dT}{dt} = s + rT\left(1 - \frac{T}{K}\right) - (1 - \gamma)(1 - \tilde{\alpha}(t))\beta e^{-\alpha T}V - \mu_i T
\]

\[
\frac{dT_i}{dt} = \gamma(1 - \tilde{\alpha}(t))\beta e^{-\alpha T}V - (1 - \gamma)(1 - \tilde{\alpha}(t))\beta e^{-\alpha T}(t - \omega)V(t - \omega)e^{-\mu_2\omega} - (\mu_i + h)T
\]

\[
\frac{dT_2}{dt} = (1 - \gamma)(1 - \tilde{\alpha}(t))\beta e^{-\alpha T}(t - \omega)V(t - \omega)e^{-\mu_2\omega} - (1 - \gamma)(1 - \tilde{\alpha}(t))\beta e^{-\alpha T}(t - \tau)V(t - \tau)e^{-\mu_1\tau} - (\mu_i + h)T
\]

\[
\frac{dV}{dt} = (1 - \gamma)(1 - \tilde{\alpha}(t))N \beta T(t - \tau)V(t - \tau)V(t - \tau)e^{-(\mu_1\tau + b)} - \mu V
\]

2.3. Model Description
The model is briefly explained as follows. The first term of the first equation of system (1) represents a constant source of new uninfected CD4+ T-cells from the Thymus. The next term represents a logistic growth of CD4 cells with $r$ as the growth rate and $K = T_{max}$ the carrying capacity, this is then followed by a term which represents the infection of CD4+ T-cells by the virus and is determined by the rate of encounters of CD4+ cells by the virus. This is based on the law of mass action with $\beta$ as the probability of infection and $(1 - \delta(t))$ measuring the proportion of infectious viruses that eludes the effect of combination therapy and $\gamma$ the proportion of HIV mutant strain that cannot be prevented by HAART. The term $e^{-a}$ represents the effectiveness of CTL to prevent infectivity. The last term $\mu_{T}$ is the natural death rate. The second equation models the population of latently infected unproductive CD4+ T-cells with an exposure latent period of $\omega > 0$ before they become productive. The probability that the infected cell survive until it becomes active and produce viruses after time $\omega > 0$ (incubation period) is given by $e^{-\mu_{T}\omega}$. The last term $\mu_{t}$ represents the natural death rate augmented by the accelerated death rate due to the action of CTL given by $h$. The third equation of system (1) models the rate of change of actively infected CD4+ cells with the probability $e^{-\mu_{T}\tau}$ that they continue surviving and actively producing viruses for time $\tau > 0$. The last term also represents augmented natural death rate due to the action of CTL. The last equation of (1) models the population of free virus in the blood plasma. It is assumed that only actively infected CD4 cells produce viruses at a rate $N$ per cell over the entire life time of the cell $1/\tau$ with $\tau > \omega$ representing the total time of latency and infectivity (production of virus). The parameter $b$ models the effectiveness of CTL in reducing the virus burst size. The equation monitoring the rate of change of HIV specific CTL population is not included. Here it is assumed that the first equation captures the total T-helper cells which later differentiate into CD4+T-cells, HIV specific CD8+T-cells and memory cells.

2.4 Model Preliminary Analysis

We begin by establishing some basic properties of solutions to the system (1) that given positive initial data, solutions remain positive and bounded for all time $t > 0$. In order to do the analysis stated above, we begin by defining the initial conditions and domain of solutions.

Initial Conditions

The initial conditions for the system (1) at time $t= 0$ are

$$T(0) = T_{0} \geq 0, \ T_{1}(0) = T_{10} \geq 0, \ T_{2}(0) = T_{20} \geq 0, \ V(0) = V_{0} \geq 0$$

(2)

In the following we define a positive quadrant as,

$$R_{+} = \{(T, T_{1}, T_{2}, V) | T \geq 0, T_{1} \geq 0, T_{2} \geq 0, V \geq 0\} \text{ and }$$

$$R_{+} = \{(T, T_{1}, T_{2}, V) | T > 0, T_{1} > 0, T_{2} > 0, V > 0\}$$

(3)
We then show that the variables in model (1) are non-negative for all time $t > 0$ and we prove that all solutions with positive initial data as defined in (2) will remain positive for all time $t > 0$ and are bounded.

2.5 Positivity and Boundedness of Solutions

Model (1) describes human cell population and therefore it is very important to prove that all the state variables $T(t), T_1(t), T_2(t)$ and $V(t)$ are non-negative for all time $t$. We prove that all solutions of system (1) with positive initial data will remain positive for all time $t > 0$ and are bounded in $R = R_+ + R_0$.

**Theorem 3.1**

Let the initial data be $T(s) = T_0(s) \geq 0, T_1(s) = T_{10}(s) \geq 0, T_2(s) = T_{20}(s) \geq 0, V(s) = V_0(s) \geq 0$

with $T_0(s) \geq 0, T_{10}(s) \geq 0, T_{20}(s) \geq 0$ and $V_0(s) \geq 0, s \in [-\alpha, 0]$ with $T_0(0) > 0, T_{10}(0) > 0, T_{20}(0) > 0$ and $V_0(0) > 0$. Then the solutions $T(t), T_1(t), T_2(t)$ and $V(t)$ of system (1) are positive and bounded for all $t > 0$. For the model system (1), the region $R$ is positively invariant and all solutions starting in $R_+ + R_0$ approach enter or stay in $R$.

**Proof.** First we prove that $T(t)$ is positive for $t \geq 0$. Assuming the contrary and letting $t_1 > 0$ be the first time such that $T(t) = 0$, by the first equation of system (1), we have $T'(t) = s > 0$, and hence $T(t) < 0$ for $t \in (t_1 - \varepsilon, t_1)$ and sufficiently small $\varepsilon > 0$. This contradicts the assumption that $T(t) > 0$ for all $t \in [0, t_1)$. It follows that $T(t) > 0$ for all $t > 0$ as long as $T(t)$ exists.

Similarly, by variation of constants formula, we can show that $T_i(t) > 0$ for all $t > 0$. Using the same argument, we can show that the third and fourth equation of (1) is positive and finite.

Next we show that positive solutions of (1) are ultimately uniformly bounded for $t \geq 0$. From the first equation of system (1), we obtain $T'(t) \leq s + rT(t)(1 - \frac{T(t)}{T_{\max}}) - \mu_T T(t)$ and

$$\limsup_{t \to \infty} T(t) \leq \frac{s}{\mu_T}. $$

Adding the equations one by one and following the same procedure, we find that $T(t), T_1(t), T_2(t)$ and $V(t)$ are ultimately uniformly bounded in $R$.

2.6 Basic Reproductive Number

The Basic Reproductive Number $R_0$ is defined as the expected number of secondary infections arising from a single individual during his or her entire infectious period, in a population of purely susceptible individuals. In our context, $R_0$ represents secondary infectious HIV viral particles produced by one virus introduced into the blood system of uninfected individual with purely naive and susceptible population of CD4+T cells. We compute the basic reproductive number, $R_0$ following the next-generation operator
approach by Dickmann et al, 1990, Van den Driesche and Watmough, 2002). This number is a measure of the potential for the development of AIDS since it serves as a threshold parameter that predicts whether free viral particles will increase thus reducing the CD4+T cell count. From this definition, it is immediately clear that when \( R_0 < 1 \), each virus produces, on average, less than one new free virus failing to replace themselves, and we therefore interpret to mean that viral pathogens will be cleared from the individuals’ system. If, on the other hand, \( R_0 > 1 \), the number viruses and so the infected CD4+T cells will increase with each generation and the pathogen will be able to invade the susceptible population. With the use of this parameter, we can determine which control measures, and at what magnitude, would be most effective in reducing \( R_0 \) below one, providing important guidance for public health initiatives [12]. The basic reproductive number \( R_0 \) is defined as

\[
R_0 = \rho(FV^{-1})
\]

where the matrix \( FV^{-1} \) is referred to as the next generation matrix (see for instance [15]) and \( \rho(A) \) denotes the spectral radius of a matrix \( A \) computed using the Euclidian norm. Using this method, we compute the basic reproductive number at the onset of the disease using linearization of (1) at Disease Free Equilibrium (DFE).

3.1 Equilibrium Point and Stability

The DFE of system (1) is given by \( E^0 = \{(T^0, T_1^0, T_2^0, V^0) | (T^0, 0, 0, 0)\} \) where

\[
T^0 = \frac{1}{2} \left\{ \frac{K(r - \mu_T)}{r} + \sqrt{\frac{K^2(r - \mu_T)^2}{r^2} + \frac{4sK}{r}} \right\}
\]

The reproductive number \( R_{0TC} \) is computed as defined in (4) to obtain

\[
R_{0TC} = \frac{(1 - \gamma)(1 - \delta(t))N \beta T^0 e^{-(\mu_T + b)}}{\mu_v}.
\]

Note that in absence of treatment that is \( \delta(t) = 0 \), the basic reproductive number in (5) reduces to

\[
R_{0C} = \frac{(1 - \gamma)N \beta T^0 e^{-(\mu_T + b)}}{\mu_v}
\]

and in absence of CTL response \( b = a = 0 \), the basic reproductive number reduces to

\[
R_0 = \frac{(1 - \gamma)N \beta T^0 e^{-\mu_T}}{\mu_v}.
\]
The basic reproductive number \( R_{0C} \) includes the effect of HIV specific CTL response to the infection and \( R_0 \) measures the reproductive number without any intervention. By comparison the three reproductive ratios satisfy the inequality \( R_{0T} \leq R_{0C} \leq R_0 \). This clearly shows that therapy and presence of HIV suppressive factors produced by CTL control the viral load during HIV infection. Other factors like the presence of HIV drug resistant mutant strain \( \gamma \) is mathematically seen to increase the value of \( R_0 \). In order to see this, define \( R_{0\gamma} := \frac{N \beta T^0 e^{-\mu T}}{\mu} \), then for all \( \gamma \in (0,1) \), \( R_{0T} \leq R_{0C} \leq R_0 \leq R_{0\gamma} \).

Figure 3.1 Comparison of values of Reproductive numbers

Source: Author

3.2 Stability

Stability of this system is determined by examining the sign of the dominant eigenvalue of the linearization of the model equations about the equilibrium point. The zero solution of the nonlinear system is asymptotically stable if and only if the zero solution of the linear system is asymptotically stable. We summarize stability with the following Theorem whose proof can be easily provided.

**Theorem 3.2** If \( R_0 \leq 1 \), then \( E^0 \) is the only equilibrium in \( \mathbb{R} \) and it is globally asymptotically stable. Here the Viral clearance is achieved. If \( R_0 > 1 \), then \( E^0 \) is unstable and there exist a carrier equilibrium, say \( E^* \) where the patient remains as an asymptotic carrier.

Following this theorem, we focus our attention to stability parameter \( R_0 \) and establish the parameters that affect its value. Notable among them is the drug efficacy and time delay. Time delay is known to destabilize once stable equilibrium (Li & Shu, (2010)) and since time delays are inevitable in life, we use the delay \( \tau > 0 \) as a bifurcation parameter and investigate the stability of Disease Free Equilibrium Point (DFE) \( E^0 \) when \( \tau > 0 \) is varied. We are interested in any critical values of \( \tau > 0 \) at which the basic reproductive number of equation (1) transitions from being less than one to being greater than one. If this
is to occur, there must be a critical value of $\tau > 0$, such that the Reproductive number $R_0$ is less than unity.

The illustration of the value of $R_0$ for various values of $\tau > 0$ and drug efficacy $\varepsilon > 0$ is given in Figure 3.2. We can clearly see that the determination of critical delay depends on the value of drug efficacy. For example, at $\varepsilon = 0.75$, the time delay must be greater than 30 hours for the reproductive number to be less than one.

![Fig. 3.2 Values of $R_0$ for various values of drug efficacy $\varepsilon$ and delay $\tau$.](image)

*Source: Author*

### 3.3 Periodic Supply of Therapeutic drugs

As stated earlier, drug efficacy $\varepsilon(t) \in [0, 1]$ is periodic rendering the basic reproductive number to be periodic as well. Of interest is the bound of the parameter $\varepsilon(t)$ which guarantees stability.

![Fig. 3.3 Drug Concentration in Blood Plasma C showing periodic intake at multiples of time.](image)

*Source: Author*
With periodic intake of drugs and the effect of decay, the concentration of drugs in the blood plasma is periodic as depicted in Figure 3.3 where it is assumed that the drugs are taken after every $L$ time units and the concentration fluctuates with amplitude of $b$ from an average concentration which stabilizes at $c$.

If we let $D(t)$ represent the periodic input concentration, we can represent as,

$$D(t) = \begin{cases} 
  c-b, & \text{if } 0 \leq t \leq t_1 \\
  c+b, & \text{if } t_1 \leq t \leq t_2 \\
  c-b, & \text{if } t_2 \leq t \leq L
\end{cases}$$  \hspace{1cm} (8)

The period $L$ is in hours. The concentration $D(t)$ can be represented in Fourier series of the form,

$$\dot{D}(t) = a_0 + \sum_{n=1}^{\infty} \left( a_n \cos \frac{2n\pi t}{L} + b_n \sin \frac{2n\pi t}{L} \right)$$  \hspace{1cm} (9)

Where $a_n$ and $b_n$ are the Fourier coefficients and $a_0$ is a constant term. Since $\dot{D}(t)$ depends on bioavailability of drugs and concentration in the required site, the graph of drug efficacy corresponds to the sketch in Figure 3.3. Since the graph is even, $b_n = 0$ while

$$a_0 = \frac{1}{L} \int_{0}^{t} \dot{D}(t) dt = c + b \left( \frac{(t_1 - t_2)}{L} \right).$$  \hspace{1cm} (10)

while $a_n = \frac{1}{L} \int_{0}^{t} \dot{D}(t) \cos \frac{2n\pi t}{L} dt = \frac{4b}{n\pi} \cos \left( \frac{n\pi}{L} (t_1 + t_2) \right) \sin \left( \frac{n\pi}{L} (t_1 - t_2) \right).$  \hspace{1cm} (11)

Hence Equation (9) reduces to,

$$\dot{D}(t) = c + b \left( 1 + \frac{2t_1}{L} - \frac{2t_2}{L} \right) + \sum_{n=1}^{\infty} a_n \cos \frac{2n\pi t}{L} dt$$  \hspace{1cm} (12)

Let $\dot{\alpha}^0 := c + b \left( 1 + \frac{2t_1}{L} - \frac{2t_2}{L} \right)$ and

$$\alpha(t) := \sum_{n=1}^{\infty} a_n \cos \frac{2n\pi t}{L} dt = \frac{4b}{n\pi} \sum_{n=1}^{\infty} \frac{1}{n} \cos \left( \frac{n\pi}{L} (t_1 + t_2) \right) \sin \left( \frac{n\pi}{L} (t_1 - t_2) \right) \cos \left( \frac{2n\pi t}{L} \right)$$  \hspace{1cm} (13)

we then have $\dot{D}(t) = \dot{\alpha}^0 + \alpha(t)$. From Equation (13) we observe that $|\alpha(t)| \leq \frac{4b}{\pi}$. The drug supply at any instant satisfy the inequality,

$$\dot{\alpha}^0 - |\alpha(t)| \leq \dot{D}(t) \leq \dot{\alpha}^0 + |\alpha(t)|.$$  \hspace{1cm} (14)

We know practically that $\dot{D}(t) > 0$. Therefore inequality (14) means that $\dot{\alpha}^0 - |\alpha(t)| > 0$ that is,
the amplitude of the drug concentration graph fluctuation about \( c \) must be small in comparison to \( \delta^0 \). From Equation (5) we see that viral eradication is possible only if

\[
\dot{\delta}(t) \geq 1 - \frac{\mu_0 e^{(\mu_0 t)}(t)}{(1 - \gamma)N \beta T_0^0}
\]

Comparing with inequality (14), we obtain the bounds that the amplitude of drug concentration must be within for the reproductive ratio \( R_0 < 1 \), a necessary condition for eradication of viral infection. We thus make the following proposition.

**Proposition 2** Viral Eradication is possible with the use of ARV’s if the drug efficacy \( \dot{\alpha}(t) > 0 \) satisfies the inequality

\[
\dot{\delta}^0 - |\alpha(t)| \leq 1 - \frac{\mu_0 e^{(\mu_0 t)}(t)}{(1 - \gamma)N \beta T_0^0} \leq \dot{\delta}^0 + |\alpha(t)|. 
\]

4. Numerical simulations

We use parameters in Table 1 to simulate the solutions of the model system (1) with the following initial data. \( T(0) = 100, T_1(0) = 0.01, T_2(0) = 0.01, V(0) = 0.001 \).

| Table 1. Data for the CD4, CTL and Viral cell Interaction with Therapy model |
|---------------------------------|-------|-----------------|
| Parameter definition            | Symbol | Value           |
| Constant recruitment rate of naive CD4 | \( s \) | 2 mm\(^{-3}\) |
| Constant recruitment rate of CTL clone | \( s_1 \) | 1 mm\(^{-3}\) |
| Maximum growth rate of CD4      | \( r \) | 0.035 mm\(^{-3}\)day\(^{-1}\) |
| Infection rates of CD4 by \( V \) | \( \beta \) | 0.39 mm\(^{-3}\)day\(^{-1}\) |
| Reduction of viral infectivity by CTL | \( a \) | 0.07 mm\(^{-3}\)day\(^{-1}\) |
| Natural death rate of naive CD4+T-cells | \( \mu_t \) | 0.02 mm\(^{-3}\)day\(^{-1}\) |
| Natural death rates of \( T_1, T_2, V \) | \( \mu_1, \mu_2, \mu_v \) | (0.032, 0.028, 2.64) mm\(^{-3}\)day\(^{-1}\) |
| HAART or ARVs’ drug efficacies (Variable) | \( \varepsilon(z) \) | [0.01, 0.99] mm\(^{-3}\)day\(^{-1}\) |
| Proportion of mutation during viral transcription | \( \gamma \) | [0.01, 0.99] mm\(^{-3}\)day\(^{-1}\) |
| Viral burst size                | \( N \) | 500 mm\(^{-3}\)day\(^{-1}\) |
| Effectiveness of CTL in reducing viral burst size | \( b \) | 0.05 mm\(^{-3}\)day\(^{-1}\) |
| CTL induced death rates of infected CD4+T-cells | \( h \) | 0.00002 mm\(^{-3}\)day\(^{-1}\) |
| Natural growth rate of CTL      | \( r_i \) | 0.025 mm\(^{-3}\)day\(^{-1}\) |
| Death rate of CTL              | \( \delta \) | 0.034 mm\(^{-3}\)day\(^{-1}\) |
| Time lag during exposure and infectiousness of CD4 | \( (\omega, \tau) \) | (1, 1.2) day\(^{-1}\) |

Using the parameters and variables defined in Table 1, we illustrate the general dynamics of HIV
virus and CD4+ T-cells for model (1) during infection in Figure 3.1. In absence of treatment and
CTL action \( a \ll 1 \) and \( b \ll 1 \), the cell interaction is oscillatory but eventually CD4+ T-cells drop much
below the levels of virus cells as shown in Figure 4.1.

\[ \text{Figure 4.1 Dynamics of cell populations without therapy.} \]

\textit{Source: Author.}

Under treatment, with minimum amplitude of drug supply as low as 40%, the virus stabilizes and
coexist within the host as illustrated in Figure 4.2. Increasing drug efficacy above 0.6, with the
action of CTL as low as \( a = 0.02 \) and \( b = 0.05 \) we notice that the viral population levels drop
drastically but still exist as depicted in Figure 4.3. Drug efficacy above 85% without the same CTL
response shows that CD4 cells is periodic and below the initial value (Figure 5.4) but with little increase
in CTL response, we see that the viral levels is encouraging even with lower drug efficacy. See Figure
5.5.

\[ \text{Figure 4.2. Coexistence of HIV within host at less than 40\% drug efficacy.} \]
Figure 4.3 Coexistence of HIV within host at less than 60% drug efficacy.

Source: Author

Figure 4.4 Coexistence of HIV within host at less than 70% drug efficacy.

Source: Author
5. Conclusion and Recommendation

From the analysis given we note that among the parameters which affect the management of HIV virus at very low levels, time delay and drug efficacy are the major contributors of stability condition. Since the lifespan of infected cell cannot be stretched beyond a certain limit, we give the minimum time delay before the infected cell become productive as $\tau_{\text{min}}$ and the maximum lifespan of the cell will be our $\tau_{\text{max}}$. Also at this range of time delay, the value of drug efficacy which is effective within an interval [50%, 70%]. Thus the administration dosages of treatment drugs must observe these critical levels. It is at this levels that the drug manufacturers must ensure that the concoction must contain ingredients necessary to cause the desired effects of prolonging the lifespan of infected cell to above $\tau_{\text{min}}$ and the ability of the drug to prevent infection and reduce burst size must be within the stated range. Although these measures are highly individualized, the guidelines can apply to most affected individuals and we recommend that further research on the same be done to include other necessary and significantly important parameters.

In our work, we did not consider other parameters which contribute to the dynamics of HIV virus and such extensions are recommended to suit the ideal situation. The dynamics of mutant virus was also ignored since they are drug resistant and cannot be affected by both time delay and drug efficacy which were fundamental to our study.

References


Culshaw, R. V. & Ruan, S. (2000). A delay-differential equation model of HIV infection of


**ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PLAN FOR JKUAT SWIMMING POOL CONSTRUCTION**

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JKUAT

**Abstract**

Construction activities are known for interfering with most of the environmental systems and life in general. This paper aims at presenting possible environmental impacts developed as a result of constructing the JKUAT swimming pool and there mitigation plan. Several impacts were anticipated and identified, and assessed thoroughly using observation and instrumental method generally in order to design a detailed and efficient management plan. The observation method involved site reconnaissance whereby we actually compared the state and condition of the site and the surrounding area before, during and after the construction. On the other hand, the instrumental way entailed sampling and collecting the environmental components during and after the onset of construction and finally assessed. The impacts on; Socio-economic, Flora and Fauna, Overburden Dump, Land, Noise and Vibration, Water Pollution and Air Pollution were identified and assessed. Local and international environmental regulations were cross referenced over the course of this study. The main objective was to determine the most limiting impacts and propose the appropriate environmental management plan to check and prevent health hazards against the people living in and around the vicinity.

**Executive Summary**
The primary objective of the proposed project is to construct a swimming pool that can accommodate 1,000 students in order to engage students in more extracurricular activities and develop their talents. The swimming pool will also help in reducing drug and alcohol abuse by making students more occupied.

The main design components of the project include, but not limited to the following:

- Construction of the swimming pool area.
- Development of external works/services – access roads, car parking lots, water supply, sewer, electricity supply etc.
- Site landscaping.
- Bathrooms, washroom and changing rooms.
- Shop (opened during national events)

This EIA Project Report addresses the following key specific objectives:

1. To review existing legal and institutional framework related to the proposed project.
2. To collect and collate baseline information relevant to the proposed development
3. To identify and assess positive and negative impacts of the proposed project.
4. To identify and analyze alternative options for the proposed project.
5. To develop mitigation measures and cost estimates for the negative impacts of project.
6. To design an Environmental Management Plan and a monitoring framework for the environmental impact of the project.

### Environmental Impacts and Mitigation Measures

The potential negative environmental impacts of the proposed project and possible mitigation measures are outlined below:

<table>
<thead>
<tr>
<th>Environmental impact</th>
<th>Mitigation measures</th>
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<tbody>
<tr>
<td>OHS</td>
<td>- Sprinkling water</td>
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<tr>
<td></td>
<td>- Construction during rainy season</td>
</tr>
<tr>
<td></td>
<td>- Provide workers with protective clothing e.g. earmuffs and dust masks.</td>
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<td></td>
<td>- Train staff workers on occupational health and safety.</td>
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<tr>
<td>Environmental Issue</td>
<td>Actions</td>
</tr>
<tr>
<td>-------------------------</td>
<td>---------</td>
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</tbody>
</table>
| **Soil Pollution**      | Good management and storage of used lubricants.  
                          - Good maintenance of machines to reduce/avoid oil and fuel leaks.  
                          - Good material handling practice to avoid or reduce spillage of oil, paint, thinners etc.  
                          - Good maintenance of machines to reduce leakage  
                          - Good usage of waste water system to avoid wastage  
                          - Regular checking and emptying  
                          All paints, lubricants, and other chemicals used on site will be stored in secure and banded location to minimize risk of spill. |
| **Water pollution**     | - Ensure that the septic tanks are checked and emptied regularly.  
                          - Good management of spent lubricants  
                          - Good maintenance of machines |
| **Air pollution**       | Water to be sprayed during construction phase of excavated areas.  
                          - Regular maintenance construction plant and equipment |
| **Noise pollution**     | Workers on site to wear ear muffs  
                          - Regulate the maximum speed of trucks  
                          - Locate generator away from offices and residential places |
| **Loss of vegetation**  | planting of trees near the fence after construction  
                          - planting of flowers in the compound to restore scenic value of the site |
| **Demographic change**  | Provide garbage collection vehicle or service.  
                          - Ensure that the septic tanks are checked and emptied regularly |
| **Solid wastes**        | - Sell timber remains as firewood  
                          - Recycle plastics and glass.  
                          - Backfilling |
<p>| <strong>Micro fauna habitat</strong> | - Excavation to be done only on the most important part |</p>
<table>
<thead>
<tr>
<th>Increase in traffic</th>
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</thead>
<tbody>
<tr>
<td>- Introduce gate passes for incoming vehicles</td>
</tr>
<tr>
<td>- Road warning signs</td>
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<tr>
<td>- Mark speed limits</td>
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<tr>
<td>- Provide adequate parking space</td>
</tr>
</tbody>
</table>

**Introduction**

**Background**

JKUAT, was started as the Jomo Kenyatta College of Agriculture and Technology (JKCAT) by the government of Kenya as an institution of higher learning with the generous assistance from the Japanese government.

Plans for the establishment of the JKCAT started in 1977. In early 1978, the founding father of the nation, the late Mzee Jomo Kenyatta donated 200 hectares of farm land for the establishment of the college. The foundation stone for JKCAT was laid by his Excellency the former president of the republic of Kenya, Hon. Daniel T. Arap Moi on 30th July, 1979 and the facilities officially handed over to the then minister for higher education on 30th April, 1981.

The first group of students was admitted by 4th May in 1981. H.E the former President Daniel T. Arap Moi formally opened the Jomo Kenyatta College of Agriculture and Technology (JKCAT) on 17th March 1982. The first graduation ceremony was held in April 1984. During the ceremony, diploma certificates were presented to graduates in Agricultural Engineering, Food Technology and Horticulture.

In November 1985, the full cycle of the college's training was completed when the first engineering Technician grandaunts joined the second group of Agriculture grandaunts to receive their certificates presided over by the then president Moi. On the 1st September 1988, H.E the former President Daniel Moi declared JKCAT a constituent college of Kenyatta University through a legal notice, under the Kenyatta University Act(Cap 210C). The Legal Notice appeared in the Kenya Gazette Supplement of 28th July 1989. The name of JKCAT officially changed to The Jomo Kenyatta University college of Agriculture and technology (JKUCAT). It was finally established as a University through JKUAT Act 1994 and inaugurated on 7th December 1994.

In 1996, the University identified the need of accelerated training in the Information Technology, so as to build the human capacity needed for the Kenya's ICT Sector. Several affiliated centers were established so as to enhance production of qualified graduates in IT within a short period of time. At the same time, the University sourced for donor support to improve its Wide Area Network to support learning, teaching, research, and specified outreach programmes to the community and adjoining schools. The donor support was provided by the Japanese Government to lay a fiber optic Internet backbone in the university. Both staff and students have access to the necessary Internet connectivity to enhance their learning and establishment of appropriate information management systems. In addition, the University has several
Institutes and Centers, which work in collaboration with the Faculties, the School and the Institute of computer Science, and Information Technology in academic and research programmes. These include, the Institute of Human Resources Development (IHRD), Continuing Education Programmes (CEP), Institute of Energy and Environmental Technology (IEET). The Institute of Human Resources Development offers service courses to students in all faculties and Continuing Education Programmes coordinates Information Technology courses offered in

The campus has proposed to put up a swimming pool facility in an undeveloped area behind hall 7. This is to have the students engage more in sports activities and produce and nature talents of would be professional swimmers. In this case an environmental impact assessment was be carried out to help predict the environmental impacts expected during the construction, commissioning, operation and decommissioning phase of the project.

**The Purpose of the Environmental Impact Assessment**

Investigate and predict the effects of the development project on the environment of the area before any decision is made to go ahead with the development

Introduce changes into the design process of the development project

Ensure that everyone is involved - the developer, the students learning nearby and studying in the area and the decision takers - understands the likely effects of the development to ensure that the final decision on the development project is taken with full knowledge of the environmental consequences.

Analysis of the alternatives including project site, design and technologies available and reasons for preferring the chosen project.

Come up with an environmental management plan proposing the measures for eliminating, minimizing or mitigating adverse impacts on the environment, including the cost, time frame and responsibility to implement the measures.

To have measures put in place that will ensure prevention of health hazards and also ensure security in the working environment for the employees and for the management of emergencies.

**Objectives of the Environmental Impact Assessment Study**

To ensure that environmental considerations are explicitly addressed and incorporated into the development decision making process

To anticipate and avoid, minimize or offset the adverse significant biophysical, social and other relevant effects of development proposals

To protect the productivity and capacity of natural systems and the ecological processes which maintain their functions and

To promote development that is sustainable and optimizes resource use and management opportunities.
**Approach and Methodology**

In accordance with EIA regulation 2006 agreed measures and activities the EIA process will involve:

- **Screening** - to determine whether or not a proposal should be subject to EIA and, if so, at what level of detail.

- **Scoping** - to identify the issues and impacts that are likely to be important and to establish terms of reference for the EIA.

- **Examination of alternatives** - to establish the preferred or most environmentally sound and benign option for achieving proposal objectives.

- **Impact analysis** - to identify and predict the likely environmental, social and other related effects of the proposal.

- **Mitigation and impact management** - to establish the measures that are necessary to avoid, minimize or offset predicted adverse impacts and, where appropriate, to incorporate these into an environmental management plan or system.

- **Evaluation of significance** - to determine the relative importance and acceptability of residual impacts (i.e., impacts that cannot be mitigated).

- **Preparation of environmental impact statement (EIS) or report** - to document clearly and impartially impacts of the proposal, the proposed measures for mitigation, the significance of effects, and the concerns of the interested public and the communities affected by the proposal.

- **Review of the EIS** - to determine whether the report meets its terms of reference, provides a satisfactory assessment of the proposal(s) and contains the information required for decision making.

- **Decision making** - to approve or reject the proposal and to establish the terms and conditions for its implementation.

- **Follow up** - to ensure that the terms and condition of approval are met; to monitor the impacts of development and the effectiveness of mitigation measures; to strengthen future EIA applications and mitigation measures; and, where required, to undertake environmental audit and process evaluation to optimize

In achieving the above the following tools were used:

- Reviewing existing site information
- Conducting survey and interviews
- Conducting site inspection

**Project need and Justification of the Project**
The main aim of the construction of a swimming pool in JKUAT is to provide a student recreational facility to enhance the services offered to the students.

Provide a sporting facility that is up to national standards to serve as a sports center.

**Description of the Project**

**Location of the Project**

The proposed project is located in Jomo Kenyatta University of Agriculture and Technology; Juja main campus next to BEED department. The pool will be the Olympic size of 25 m x 50 m and 2.5 m deep

**Neighbourhood**

The swimming pool neighbours BEED department on the left JKUAT water treatment plant to the right and a football field on the back side.

**Drainage Structures**

The entire area is relatively flat with a slope of about 1% towards hall 7. There is no culverts, drains in the area except the main drain that passes near hall 7. This is an open drain that runs through entire JKUAT campus and discharges the wastewater to gachororo treatment facility. This can be used to manage runoff and for discharging the wastewater and storm water from the access roads to be constructed and generated runoff. The gentle sloping terrain defines the direction of flow of storm water and this consequently reduces the cost of construction of the drainage structures.

**Baseline Information**

**Physical and Ecological Conditions**

JKUAT campus is located in JUJA along Thika road. The proposed site occupies an area of approximately 10000m$^2$. The plot consists of undeveloped field with mainly grass vegetation and scattered trees. The ground is gentle sloping towards the nearby hall 7 which consists of classroom.

**Geology and soils**

Soil type influences soil erosion and sediment transport. The soils in this area are black cotton soils. This means they have low water infiltration. The soil type and geology of the area will also influence rehabilitation of excavated sites. The propose site is about 4 meters below the surface. The water table relatively shallow about 20 meters deep.

**Population**

The population of the school is about 15 000 including students that are day scholars and those that leave off campus.

**Education, Economy and Social Welfare**
During the field survey, it was discovered that most of the residents and their workers are educated and can communicate well in both English and Kiswahili languages. They understand their human and political rights well and have both reading and writing skills. Most of the residents are students with a few staff employed in JKUAT.

**Health**

JKUAT has a clean environment with no pollution. This prevents the residents from contacting environment related illnesses. The project area is also accessible to numerous public and private health facilities that can help residents in case of medical emergencies this include JKUAT hospital.

**Vegetation** The area where the project site is located is characterized by dry semi-deciduous forest. This is dominated by Croton Megalocarpu, Acacia Xanthophloea (in open field), Grevillea Robusta(in open field), Podocarpus falcatus (near the main drain) and lantana camara (near jkut BEED fence).

![Fig: Acacia xanthoplea](image)

**Forestry**

The site is characterized by exotic trees and a few indigenous shrubs and trees. The trees are not used for commercial purposes.

**Commerce, Trade and Services**

The area is does not have a lot of commercial activities.

**Water Supply**

Water in the area is supplies by JKUAT treatment facility that treats water from Ndarugo River. The area does not experience water shortages as it has a dam that temporarily stores water pumped from the Ndarugo River.

**Energy Supply**

Energy supply is from KPLC and this is supplemented by standby generators near hall six.

**Environmental Impact Assessment and Mitigation Measures**

**Overview**
The project is expected to cause impacts of different types, magnitudes and characteristics. The impacts expected from the project include the biophysical (disruption and alteration of habitats, water pollution, soil pollution, air pollution and change of physical topography), social Most of these impacts will be experienced during the construction phase of the project. Others like the economic impact will continue to the operation phase of the project.

The pool will also include a pump house on its eastern end

Impact Assessment Process

The project impact assessment process was carried out through two main stages, screening and scoping. Screening process was the first to be carried out and was done by use of screening checklist. The main purpose to carry out screening was to determine whether the proponent’s project proposal required an Environmental impact assessment or not. It was also carried out to determine the level of Environmental impact assessment required. The visit to the site and consideration of questions in the checklist helped in answering the two essential questions; whether the proposal constituted a project requiring an Environmental Impact Assessment and what significant effects the project has on the environment. After screening, summary of features of the project and its location was done and indicated that there was a need for Environmental Impact Assessment. (See appendix 6 for the screening checklist)

Scoping was carried out to identify important issues to be considered in the EIA, the appropriate time and boundaries of the EIA study, the key issues and major impacts and come up with terms of reference. Scoping was carried out using the scoping checklist. Major environmental impacts were identified and their significance determined (See Appendix 6 for Scoping checklist).

Project Activities

The proposed project will have many activities taking place. These project activities were classified into two groups: project construction activities and project operation activities.

Project construction activities

Swimming pool

The pool area will be excavated using a small excavator. All material removed will be transported.

To a temporary site in juja farm there are few trees on the proposed excavation site. Trees falling within the pool area will be carefully removed and used in JKUAT RPE area as firewood. Some dewatering is expected in the deeper parts of the swimming pool area. Extracted water will be pumped back to the main drain in JKUAT Construction of the pool will require the operation of concreting machines and material. Concreting will be done on the site. The first stage of construction will involve construction of the pool. The second stage will involve construction of the pool house and the final stage will construct the pump house, wash rooms and changing rooms, ticketting lobby, and a canteen.

These are activities taking place during the construction phase of the project and they include:
**Workforce and Services**

- There will be about 20 workers during the construction stage. These workers will not be accommodated inside the campus.

- All workforce-related infrastructure and services will be provided in JKUAT.

**Utilities**

- Existing generator from Engineering workshop will be utilized for pumping water. Water and electricity will be connected from BEED department.

- Existing Sanitation facilities in JKUAT will provide service to the workers.

Table 5.1: Environmental Impacts of the project and mitigating measures

<table>
<thead>
<tr>
<th>Project Phase</th>
<th>Project Component</th>
<th>Activities</th>
<th>Positive Impacts</th>
<th>Affected Environment</th>
<th>Negative Impacts</th>
<th>Affected Environment</th>
<th>Mitigating measures of negative impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Site preparation</td>
<td>Site clearing</td>
<td>Employment creation</td>
<td>Socio-economic</td>
<td>Increased dust</td>
<td>Physical</td>
<td>Moisten surfaces to be worked on. Provide workers with dust masks</td>
</tr>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>Noise</td>
<td>Socio economic</td>
<td>Programme work to take minimum time Enforce workers discipline on site</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Increased dust levels</td>
<td>Physical</td>
<td>Excavate only necessary area Moisten surfaces to be worked on. Provide workers with dust masks</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Noise</td>
<td>Socio economic</td>
<td>Enforce workers discipline on site</td>
</tr>
</tbody>
</table>

**Construction Phase**
<table>
<thead>
<tr>
<th>Activity</th>
<th>Employment creation</th>
<th>Socio-economic</th>
<th>Soil erosion</th>
<th>Physical</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Restrict excavation to required area</td>
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<td></td>
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<td></td>
<td></td>
<td>Use as much soil as possible in backfilling operations</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Avoid working in rainy conditions</td>
</tr>
<tr>
<td>Leveling</td>
<td>Employment creation</td>
<td>Socio-economic</td>
<td>Noise</td>
<td>Socio-economic</td>
<td>Programme work to take least time</td>
</tr>
<tr>
<td>(150mm stone chips to cover site)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Workforce to observe discipline while working on site</td>
</tr>
<tr>
<td></td>
<td>Reduce erosion</td>
<td>Physical</td>
<td>Dust</td>
<td>Physical</td>
<td>Provide dust masks and other appropriate gear</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>Moisten surfaces to be worked upon</td>
</tr>
<tr>
<td></td>
<td>Employment creation</td>
<td>Socio-economic</td>
<td>Soil erosion</td>
<td>Physical</td>
<td>Programme work to take least time</td>
</tr>
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<td></td>
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<td></td>
<td>Excavate only required area</td>
</tr>
<tr>
<td></td>
<td>Employment creation</td>
<td>Socio-economic</td>
<td>Non</td>
<td>Non</td>
<td>Recover all debris and dispose properly</td>
</tr>
<tr>
<td>Perimeter wall</td>
<td>Digging foundation</td>
<td>Employment creation</td>
<td>Socio-economic</td>
<td>Debris deposition</td>
<td>Physical Recover all debris and dispose properly</td>
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<td></td>
<td>Laying of foundation</td>
<td>Employment creation</td>
<td>Socio-economic</td>
<td>Debris deposition</td>
<td>Physical Recover all debris and dispose properly</td>
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<td></td>
<td>Walling</td>
<td>Employment creation</td>
<td>Socio-economic</td>
<td>Debris deposition</td>
<td>Physical</td>
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<tr>
<td>Installati on of security fence</td>
<td>Employment creation</td>
<td>Socio-economic</td>
<td>Surface runoff</td>
<td>Physical</td>
<td>Programme work to take least time</td>
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<tr>
<td>Super Structure Developm ent</td>
<td>Walling Reinforcement beams and corrugation</td>
<td>Employment creation</td>
<td>Socio-economic</td>
<td>Debris deposition</td>
<td>Physical</td>
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<tr>
<td>Power supply</td>
<td>Undergrou nd channel</td>
<td>Employment creation</td>
<td>Socio-economic</td>
<td>Debris deposition</td>
<td>Physical</td>
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<tr>
<td></td>
<td>Connecti on of electricity</td>
<td>Employment creation</td>
<td>Socio-economic</td>
<td>Debris deposition</td>
<td>Physical</td>
</tr>
</tbody>
</table>

**Project operation activities**

These are activities that will be taking place during the operation phase of the project and they are:

**Operation and maintenance activities**

These are the activities that will be undertaken to ensure smooth operation of the project such as system servicing and repair, cleaning, machinery maintenance etc.

**Transportation**
Transportation of materials, workers and students in and out of the project location will be ongoing during the operation phase of the project.

**Waste management**

During operation, the project will be producing a lot of municipal waste which will need to be managed. Waste management activities such as collection, separation, storage and disposal will be taking place.

**Identification of environmental impacts**

The project is expected to produce major & minor, direct & indirect, short-term & long-term, positive & negative, and high, moderate & low significant impacts. For this reason, Environmental Impact Assessment was carried out using checklists. Major impacts identified were: soil pollution, air pollution, water pollution, noise pollution, loss of vegetation, and production of waste. Direct impacts were noise pollution, air pollution, change of demography, noise pollution etc. Positive impacts identified were: Improved living standards for the workers who will be working during construction and operation.

**Potential impacts of the project and proposed environmental mitigation measures**

**Potential impacts to the soil**

Site clearing, excavation and material transport affect the topsoil adversely but is unlikely to adversely affect the sub soil nor the parent rock.

During construction, vehicular visits to the site increase significantly leading to soil pollution by spilt oils and grease from machines. The soil is also susceptible to pollution during cement and paint mixing.

During construction excavation and concrete works affect soil structure while waste from site operations adversely affects the topsoil

**Mitigation**

These sources of pollution mentioned above are inevitable during construction works. However, since this is a small project, no serious negative impacts are expected beyond the pliability of the local ecosystem. Site clearing should however be limited to the project site.

Steps should be taken to ensure transportation of machinery and equipment is done within limited confined areas. Planting of trees and grass is recommended around the project site to mitigate against the grass and trees to be lost on the site.

Excavated sites beyond the actual site operations should be rehabilitated as per the landscape architectural instructions including landscaping to restore the aesthetic value of the site.

**Significance rating**

The significance rating is high during construction works. This should reduce after the construction is completed. The ecosystem disturbance becomes minimal due to reduced human traffic and operation activities.
Potential impacts on health

The possible environmental indicators include:

Dust particles

Noise pollution during early installation works

Possible accidents if precautions are not taken

These may cause onset and worsening of health complications especially respiratory complications

Mitigation

The workers should be provided with dust masks and safety precautions should be undertaken. Training of workers on safety should also be done. Limited dust can easily be managed by applying water on affected sites. Proper safety precautions are essential by ensuring the contractor follows the safety standards as recommended by the architect and the safety officer. Installation of electricity and water pipelines should be done as per the requirements of the relevant building and factory Acts.

Impacts on noise

This can be defined as undesired or unwanted sound that interferes with normal activities. Activities at the construction site are likely to give rise to noise and vibration. Noise levels are expected to lower after construction since the residents are not likely to cause any disturbance associated with noise.

Mitigation

The level of noise at construction stage is expected to be between 30 and 50 Decibels (Db) However, it is important carry out all construction works and related operations between the working hours between 0730 Hrs and 1830 Hrs Monday to Saturday so as not to interfere with students residing in hall six. Workers will be required to wear protective gear on site such as the helmet and gloves.

To reduce impacts of noise and also to avoid accidents during construction Proper safety precautions are essential by ensuring the contractor follows the safety standards as recommended by the architect and the safety officer.

Impacts from Waste

The project will produce waste during construction and operation phases. There will be solid wastes, biological wastes and municipal wastes.

Mitigation

Waste minimization will be put in place for wastes arising from construction debris. All materials arising from the construction activities will be sorted with the sole aim of selecting those that may be recycled/reused.
Potential impacts to vegetation

Destruction will occur to areas around the construction site during the construction phase. The project area has natural vegetation cover. The construction of the hostels will reduce plant cover. The loss of ground vegetation will in turn lead to loss of biodiversity.

Mitigation

There is no evidence of any endemic plant or animal species that can permanently be affected on and around the site. However steps should be taken to grow grass around the construction site after completion.

Significance rating

Medium rating during the construction phase but drops to low after completion of the project. The site rehabilitation is expected to reduce these impacts substantially.

Topography/Scenic effects

The project site is in a tranquil and lush neighborhood. The scenic view and the site topography may change due to the following activities: Site clearing, Excavation and material transport, Landscape change, Digging, walling, roofing and finishing, Drainage, Vegetation cover removal.

Mitigation

Planting of grass and flowers should be grown to help reduce the loss of original scenery. Excavated areas should be refilled with soil completely. Drainage patterns around the site should be restored to its original form.

Significance rating

High, but drops to low once compound beatification is completed and excavated sites are rehabilitated.

Analysis of alternatives

Overview

This section looks at alternative ways of undertaking the proposed project. Firstly, at the broad level there are two main options to undertake the project: (1) undertake the project or (2) not undertake the project. The environmental evaluation above has been conducted in view of the latter and this section will explore the no project option.

• No project option

• Alternative locations

• Reduced scale of redevelopment

No project option
The no project option takes the following into account.

- The existing land area proposed for the project remains as it is in its natural state.
- The proposed swimming pool facility will not be constructed and therefore the proposal will be abandoned.

Surveys and analysis carried out for EIA indicated that the proposed project will not have significant adverse effect on the environment. Mitigation measures and solutions have been identified to reduce any negative impacts on the environment from the project.

No project option would eliminate the opportunity of having the high standard recreational activities for the students and other interested individuals that will help generate income for the school.

Alternate Location

An alternative location for the proposed swimming facility would be an alternative option for the project.

Some of the disadvantages of the option are;

- Vegetation clearance impact may be higher. (Proposed location has been used as a recreational ground and there is no vegetation in the area).
- Distance to swimming facility will be greater compared to proposed location.
- Access to the swimming facility for the staffs may be difficult if it is located at a distance Far from the swimming pool area.

In terms of the practicality of the swimming facility, proposed location is a better option as the area is already cleared and the location is near the water treatment plant leading to reduced pumping costs.

Reduced Scale of Development

Since the proposed project involves only the construction of a swimming pool facility and potential impacts from the project is very minimal, reduced scale of the project is not recommended. **Environmental Management Plan**

**Overview**

EMP involves the protection, conservation and sustainable use of the various elements or components of the environment. The EMP for the proposed project provides all the details of project activities, impacts, mitigation measures, time schedules, costs, responsibilities and commitments proposed to minimize environmental impacts of activities, including, monitoring and evaluation and environmental audits during implementation and decommissioning phases of the project.

**Objectives**

The objectives of the EMP include the following:
Undertake daily assessment of the quantity of solid waste generated and keep records of its ultimate disposal.

To outline mitigating/enhancing, monitoring, consultative and institutional measures required to prevent, minimize, mitigate or compensate for adverse environmental and social impacts, or enhance the project beneficial impacts.

Monitoring during Operational Phase

Since the proposed project work is expected to have minimum impact on the environment, monitoring is only proposed for the water quality of the swimming pool. Important parameters such as total Free chlorine, Physical appearance, odour, TSS, Total coliform test are proposed which will be used to compare with WHO guideline for safe recreational water environment.

<table>
<thead>
<tr>
<th>Environmetal impacts</th>
<th>Environmental characteristics</th>
<th>Mitigation measures</th>
<th>Monitoring measures</th>
<th>Time frame</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>OHS</td>
<td>Emission of dust</td>
<td>-Sprinkling water</td>
<td>Daily checks</td>
<td>Construction phase</td>
<td>-project proponent</td>
</tr>
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<td></td>
<td></td>
<td>-Construction during rainy season</td>
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<td></td>
<td></td>
<td>-provide workers with protective clothing e.g. earmuffs and dust masks.</td>
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<td></td>
<td></td>
<td>- Train staff workers on occupational health and safety.</td>
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<tr>
<td>Soil pollution</td>
<td>-Spills and Leaks.</td>
<td>-Good management and storage of used lubricants.</td>
<td>-Regular inspection</td>
<td>Always</td>
<td>-project proponent</td>
</tr>
<tr>
<td></td>
<td>-Liquid Effluent</td>
<td>-Good maintenance of machines to reduce/avoid oil and fuel leaks.</td>
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<tr>
<td></td>
<td></td>
<td>-Good material handling practice to avoid or reduce spillage of oil, paint, thinners etc.</td>
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</tr>
</tbody>
</table>
| Water pollution | -Liquid Effluent discharge.  
  -Septic Tanks  
  -Spent lubricants  
  -Spills and Leaks. | -Good maintenance of machines to reduce leakage  
  -Good usage of waste water system to avoid wastage  
  -Regular checking and emptying.  
  -Regular maintenance of piping system.  
  -Ensure that the septic tanks are checked and emptied regularly.  
  -Good management of spent lubricants  
  -Good maintenance of machines | Always | -project proponent |
|---|---|---|---|---|
| Air pollution | Emission of dust from cement during construction | -Water to be sprayed during construction phase of excavated areas.  
  -Regular maintenance construction plant and equipment | Daily Checks | always | Project proponent |
| Environmental impacts | Environmental characteristics | Mitigation measures | Monitoring measures | Time frame | Responsibility |
| Noise pollution | -Vibration from machines on site, trucks & earthmovers | -Workers on site to wear ear muffs  
  -Regulate the maximum | Daily checks | Daily | contractor |
<table>
<thead>
<tr>
<th>Environmental impacts</th>
<th>Mitigation measures</th>
<th>Monitoring measures</th>
<th>Time frame</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Micro fauna habitat</strong></td>
<td>Destruction of the micro fauna habitat due to excavation</td>
<td>-Excavation to be done only on the most important part</td>
<td>Daily inspection</td>
<td>During Excavation</td>
</tr>
<tr>
<td><strong>Increase in traffic</strong></td>
<td>-air pollution -Noise pollution -human-vehicle conflicts</td>
<td>-Introduce gate passes for incoming vehicles -Road warning signs -Mark speed limits -Provide adequate parking</td>
<td>Daily checks</td>
<td>always</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Loss of vegetation</th>
<th>Mitigation measures</th>
<th>Monitoring measures</th>
<th>Time frame</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>any vegetation on the project area will be lost and the aesthetic value of the site will be lost</td>
<td>-planting of trees near the fence after construction -planting of flowers in the compound to restore scenic value of the site</td>
<td>Periodic checks weekly</td>
<td>contractor</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Solid waste</th>
<th>Mitigation measures</th>
<th>Monitoring measures</th>
<th>Time frame</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>-Timber remains and saw dust -Plastics -Glass -Stone and soil -Spills and leaks</td>
<td>-Sell timber remains as firewood - Recycle plastics and glass. - Backfilling.</td>
<td>Daily checks Weekly</td>
<td>Project proponent</td>
<td></td>
</tr>
<tr>
<td>Loss of recreation</td>
<td>Cutting of trees and Grass</td>
<td>Periodic check of the construction.</td>
<td>Always</td>
<td>contractor</td>
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</table>

**Decommissioning**

Decommissioning is an important phase in the project cycle and comes last to wind up the operational activities of a particular project. It refers to the final disposal of the project and associated materials at the expiry of the project lifespan. If such a stage is reached, the proponent needs to remove all materials resulting from the demolition/decommissioning from the site. Decommissioning of the proposed project will not take place in the near future. However during decommissioning, the following should be undertaken to restore the environment.

- Remove all underground facilities from the site
- The site should be well landscaped by flattening the mounds of soil
- All the equipment should be removed from the site
- Fence and signpost unsafe areas until natural stabilization occurs
- Backfill surface openings if practical

**Conclusion and Recommendations**

**Conclusion**

The likely environmental impacts expected from the implementation and operations of the project are minimal and will be restricted to construction stage. Appropriate mitigative measures have been put in place to take care of these both in the design of the project and recommendations elsewhere in this report. The project is therefore sound from technical, environmental and economic points of view and should be implemented. However, the proposed mitigation measures should be strictly adhered to so as to enable sustainable coexistence of the project and the surrounding environment.

**Recommendations**

Ensure that worker’s occupational health and safety standards are maintained through capacity building, proper training, providing protective clothing and managing their residential camps up to the required health standards.

Annual environmental audits should be carried out on the project in order to ensure compliance of the project with the mitigation measures outlined in the Environmental Management Plan (EMP).

All activities concerning construction and maintenance such as, work execution, site inspection, and material testing, shall be strictly monitored by an engineer or a designated official. This is important to ensure quality of maintenance works. Engineers and/or designated official shall be trained and
experienced enough to judge the appropriateness of the work executed in order to carry out the monitoring properly.

References


McCaull, J., The Black Tide, Environment, Vol. 11, No. 9, November


BUSINESS

AN EVALUATION OF THE CONTRIBUTION OF COMMUNICATION AND INFORMATION SHARING TO HIGH PERFORMANCE IN THE KENYAN BANKING SECTOR

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Jomo Kenyatta University of Science and Technology

Abstract

This study sought to examine how information sharing and communication contributes to high performance working practices in the Kenyan banking sector. The main objective of human resource management is to achieve high levels of organizational performance. According to Purcell (2003), intangible assets in an organization such as organizational culture, skills, competence, motivation, social interaction and ability to create teams and business units able to communicate and share information are key sources of strength in a firm which results in high performance. According to the 2006 World Bank Report on modern banking practices in Kenya, outsourcing, downsizing, re-engineering, reduced organizational levels, acquisitions, joint ventures, high management turnover, broadened spans of managerial control, technological changes and globalization have challenged the existing human resource and development practice. There is therefore need to adopt high performance working practices to create a great depth of human capital and skills formation which will translate to improvement in quality of work and service delivery.

The objective of the study was to identify how this could be achieved through enhanced communication and information sharing. The study employed descriptive study design. The study was conducted in Nairobi city with a target population drawn from selected banks. Non-probabilistic sampling method was used to arrive at ten banks; specifically convenience sampling. This was due to a report by Central bank of Kenya, 2007, that the selected banks were the best performers. The Human Resource Manager, three supervisors and six employees of each bank were the respondents. Data was analyzed using descriptive statistics. The study found that communication and information sharing in the banking sector contributed to high performance at 43%. The channels of communication were found to be well established but could be enhanced.

Key words: Communication, information sharing, high performance working practices (HPWP), Kenya Banking Sector

Introduction

For an organization to have a competitive advantage and produce value for the firm, high performance working practices have to be adapted. These are work practices that are deliberately introduced so as to improve organizational performance. Organizations that adopt HPWP's are referred to as ‘High performance work organizations (Ashton, 2002). This is done order to produce the greatest results within a complex system that is not easily imitated. High Performance organizations, sometimes known as high involvement or high commitment organizations are organizations that use distinctive managerial approaches that enable high performance through people (Barney, 2003). Different authors have emphasized different features and management practices in describing HPWS. However the essential
characteristics and key dimensions include employment security, selective hiring of new personnel, self-managed teams and decentralization of decision making. Others are comparatively high compensations on good performance, training and extensive sharing of financial and performance information throughout the organization (Pfeffer et al, 1999). Leaders in many organizations across the world posit that there is lack of this communication that then leads to lack of productivity, efficiency, failure to meet organizational budget requirements, failure to meet market demands as well as delivery of products to customers. These are out-of-the-box failures, and a whole host of departmental, team and interpersonal issues are all attributed to what has been referred to as a communication and information sharing problem (Smith, 2011).

Such high performance organizations first appeared in Japanese manufacturing companies in the 1990s with their “guarantee” of the lifetime employment. They later spread to the west, with the United States adopting the system at the risk of otherwise going under. When America and United Kingdom adopted HPWPs, Japanese moved in to modify these practices in their European and American transplants to enhance production (Becker et al, 2001).

Flow of information in the United Kingdom is long identified as an asset. It is hence facilitated in high performing organizations through the use of confidential attitude surveys amongst employees. These are conducted regularly and thereby help managers understand the employees’ perspective. Team leaders across shifts have a "shift hand-over" to help maintain communication and continuity of production. Feedback on individual performance is provided through appraisals that are conducted with employees to develop their skills, knowledge and awareness of the business. These also serve to review employee performance as individual members of their own team across the broader UK (Ashton, 2001). In German and Netherlands, the existence of highly trained and informed labour force has enabled companies implement high performance working practices with little resistance especially from skilled workers. Through well established communication networks, German apprentices learn to identify strongly with their trade departments and membership in the organization becomes an important part of their identity (Becker et al, 1998).

In South Africa, there’s a growing consensus that HPWP organizations show a concern of their employees by developing the labour-force and making use of work practices such as team-working, job redesign and employee involvement through persistent communication. According to the then South African Minister of Labour, Mdladlana (2003), the country has passed the stage of putting in place policies that form the building blocks for organizational transformation. There is now a move at embarking on the long road of ensuring that real changes happen, that organizations improve their ways of managing and developing their human resources through this persistent involvement and communication

Such Kenyan organizations as banks are at the forefront in delivering financial services to millions of Kenyans and are required to maintain and improve operational efficiency, portfolio, quality and capital reserves. Such organizations must militate against possible significant withdrawals of savings and deposits, declining flow of remittances and rising inflation. To meet these challenges and remain competitive, banks need to build and expand their distinctive capabilities through developing their talent to attain higher levels of performance through, among other strategies, information sharing (Kinosop,
It is in this light that this study attempts to evaluate high performance working practices and their contribution to performance in the Kenyan banking sector.

**Literature Review**

According to Allen (2007) of the Centre for Organizational Design, communication and sharing of information is the life-line of an organization whose focus is high performance. Although participation in decision making processes can be granted or attained in many ways, and at many levels, one pivotal international instance establishing the rights of individual employees to participate came via the Rio Declaration in 1992. In Principle 10, decisions are best handled with the participation of all concerned, who have appropriate access to information held by public or private authorities. These are then rightly afforded the opportunity to participate in decision-making processes for organization success (United Nations Department of Economic and Social Affairs, 1992).

It is therefore critical that the necessary systems are established early enough in the organizational transformation process. Leadership strategies, design decisions, and development plans all need to be well communicated; so there needs to be organization-wide system of communication and information. Furthermore, with the growth of internet technologies, knowledge transfer and management has become critical for many companies to stay competitive. This is one of the keys to empowerment, making people "contributing partners" in the business. When employees are informed of strategies and plans about the business in which they work, they become partners in helping build and improve the business since every employee knows the strategy of the business and where it is headed (Black, 1997).

They understand the most important measures of the business and how the business is performing against those measures. They know their customers and their key requirements. They understand the industry in which they work and are knowledgeable about changes in the organization's environment which impact them and the business itself. They are informed about major company events and what is going on within other parts of the organization. Such information sharing should be an ongoing process (ibid). It requires not only the mere sharing of the information that is required but also time with people to make sure they understand the and have the necessary information and training to interpret and use it correctly. Developing and managing this system pays huge dividends as people feel trusted and respected, and respond with greater commitment, personal initiative, and understanding to make better business decisions, hence high performance (Carmelli, 2009).

**2.1 Organizational communication and motivation**

Organizational communication could also be referred to as participative decision-making which is also the extent to which employers allow or encourage employees to share or participate in decision-making within the organization (Probst, 2005). The format of participative decision-making could be formal or informal while the degree of participation could range from zero to 100% in different stages of communication (Cotton et al., 1988). As one of the many ways in which an organization can make decisions, leaders must think of the best possible style that will allow the organization to achieve the best results. As posited by psychologist Abraham Maslow in his Maslow’s hierarchy of needs, workers need to feel a sense of belonging to an organization, hence the need to be kept well informed as part of the
organization. The basic concept here is arrangement in power sharing in which workplace influence is shared among individuals who are otherwise hierarchically unequal. Such arrangements entail various employee involvement schemes resulting in co-determination of working conditions, problem solving and decision-making (Locke et al., 1979). Here, the primary aim and benefit of organizational communication and sharing of information is seen as a benefit from the motivational effects on employees (Latham, as cited in Brenda, 2001).

2.2 Organizational communication and stakeholders

According to Probst, 2005, organizational communication is effective where a large number of stakeholders are involved from different walks of life. The stakeholders need to come together to get information and make a decision which benefits everyone, every stakeholder in and outside the organization. Some such examples are decisions for the environment and other similar situations. In this case, everyone should be involved, from experts, NGOs, government agencies, to volunteers and members of public. Further, participatory decision making by the top management team ensures completeness of decision making and increases team members' commitment to final decisions and organizational achievement (Carmelli et al., 2009).

2.3 Issues associated with lack of communication

Research by Robert Kaplan and David Norton, authors and developers of the balanced scorecard reveal that regardless of the choice of organizational strategy, effective communication with employees is critical to achieving a company’s strategy. A similar Wyatt Watson study determined that two important practices associated with the largest increase in shareholder value are a manager’s clear line of sight between a company’s business objectives and employees’ jobs and commitment to effective communication. The top priority of every executive and team leader should be to clarify, communicate, and assist workers in achieving their organization’s critical goal (Bruce et al., 2002).

Dr. Stephen R. Covey, vice chairman of Franklin Covey and author of ‘The 7 Habits of Highly Effective People’ posits that there is serious misalignment between the daily activities of the frontline worker and the organizational strategy. Indeed, many companies are falling short in communicating and connecting their organization’s goals with employees. In a survey of over 12,000 U.S. workers, only 44 percent of employees say their organization has clearly communicated its most important goals. The financial consequences of this communication failure can be sizeable. The Watson Wyatt study determined that companies with the most-effective employee communication programs realized a 26 percent total return to shareholders (TRS) from 1998 to 2002 compared to a 15 percent TRS for companies that communicated less effectively. The study also showed that a significant improvement in communication effectiveness was associated with a nearly 30 percent increase in market value (Schwieger, 2003).

2.4 Overall effects of communication and information sharing

Communication and information provides means whereby employees acquire the necessary knowledge about the organization and its operation (Kondrat, 2009). It includes; regular meetings of the entire workforce, consultative committees, staff attitude surveys within and across team’s communication, top bottom and bottom top communications and strategic information systems.
Lloyd (2000) in a research of South African Breweries (the largest manufacturer of alcoholic beverages in the world) pointed out that communication and information sharing were achieved in two ways; first by ensuring effective top-down and bottom up communication of strategy, global acquisitions, strategically aligned goals, concerns and suggestions. Teams, newsletters, newsflashes, and regional visits by directors were also used to facilitate this communication process. Bi-annual formal performance reviews also take place for individuals and teams.

A similar research was contacted in SAT Security Services (SSS) in Singapore. SSS is a wholly owned subsidiary of Singapore Airport Terminal Services (SATS) which is itself a subsidiary of the Singapore Airlines, a group of companies. The company customer satisfaction among clients increased from 44.2 percent in early 1990s to 81.9 percent in 1999 as a result of information sharing and business awareness. Consequently, the companies encourage upward flow of ideas and employee involvement in the decision making processes (Robinson, 2006).

2.5 The Kenyan Banking Sector

According to the Central Bank of Kenya supervision report, 2007, the banking sector was among the best performing sectors in the country. This was because of customer satisfaction, technology use (ICT adoption), product innovation and product marketing. The human resource practice in this sector supersedes the other sectors due to steep competition amongst the banks. There is rigorous recruitment process, special reward packages, work designed to achieve business objectives, good communication and information sharing, and good programs in training and human resource development.

Market intelligence survey ranked the best banks as Citibank, Standard Chartered bank, Equity bank, Stanbic, Habib bank and Barclays bank of Kenya (Kettely, 2007). The survey named CFC bank the best bank in customer satisfaction, Diamond trust the best bank in technology use, Barclays bank in product innovation followed by NIC and Citibank. The best product marketing was co-operative bank for its Jumbo junior account. Equity bank was credited for its growth momentum for the recent past of 71%.

Kittery survey however points out that the Kenyan banking sector still lags behind in modern human resource practices such as self managed team, development of high performance working philosophy, use of quality circles, work group autonomy, multi-skilling, team/group work and compensation and information sharing. Furthermore no comprehensive empirical research has been done locally about high performance working practices in the Kenyan banking sector in relation to communication and information sharing. It was therefore the intention of this study to evaluate communication and information sharing and their contribution to performance in the Kenyan banks.

3.0 Theoretical Framework

A theory is an asset of concepts or constructs and the inter relations that are assumed to exist among the concepts (Mugenda, 2003). Among organizational communications theory is the Information Systems theory that uses a somewhat mathematical model in its humanistic Approach. It displays interpretive tendencies in its efforts to use double interact when individuals communicate in an organization. The double interact model involves an act, a response and an adjustment between two people. This occurs between individuals in an organization, helping to illustrate that people in an organization create multiple
realities that may dictate organizational performance in accomplishing goals. Any action taken by an individual in an organization based on information availed is strength for the organization. More emphasis is placed on the actions taken by people, rather than on the planning of the actions in a systematic way. In the environment of the workplace, equivocal information cannot make sense unless acted upon to produce results for the organization, hence the importance of the informational interaction (Griffin, 2000).

Secondly is the critical theory that posits that communication is the transmission of information to perpetuate managerialism, discussions and the corporate interaction of every day corporate life. Language is the principal medium through which social organizational reality is produced and reproduced. Managers can further a company's health and democratic values by coordinating stakeholder participation in corporate decisions through communication.

Organizational communication is ongoing and comes from organizational reality. Individual meanings are shared in a communication model. Employees’ level of involvement with an organization, according to the theory, is critical for its performance. Rather than having a traditional bureaucracy, the organization should seek to improve its relations with the individuals who actually do the work. Like Japanese Management styles, critical theory's goal is to increase the feeling among employees that they have a stake in the company. This humanistic approach is the beginning of reconceptualization of the world of work for achievement (Anderson et al, 1998).

3.1 Conceptual Framework.

High performance practices such as communication and information sharing in this case meetings, consultations and attitude surveys enable organizations to recruit and retain high quality personnel with innovative and a good track records (Kondrat, 2009). Management creates a performing organization by developing and implementing knowledge management processes, providing training designed to improve communication and productivity and as much as possible, managing effects of organizational culture. Communication and information sharing that is poor can be frustrating for employees and may also be a source of organizational conflict. Managers, according to Kondrat (2009), should clearly be able to express their thoughts in meetings as well as ideas and demands through consultations with employees. Organizations should also carry out sufficient attitude surveys to rightfully assess the status of employees and access feed for improvement and productivity. Lack of this leads to their inability to perform well and in accordance with organizational demands.

Communication and Information Sharing

- Meetings
- Consultations
- Attitude surveys

Organizational Performance

- knowledge management processes
- training designed to improve communication and productivity
- effects of organizational culture
The Conceptual Framework of the study. Source: Researchers, 2011

4.0 Methodology

4.1 Overview

This chapter outlined the methodology that was used to conduct the study. The chapter is divided into the following sub-headings: Research design, population, sampling, data collection and instrumentation and pilot testing.

4.2 Research Design

A research design is the plan and structure of the investigation so conceived as to obtain answers to research questions (Cooper and Schindler, 2003). Kombo and Tromp (2006) perceive research design as 'glue' that holds all elements of research together.

The study used descriptive research design which according to Creswell (2002) is used to gather information about the present existing condition; the emphasis is on describing rather than on judging or interpreting. This method was used due to its appropriateness to gather first hand data from the respondents which helped to analyze the contribution of communication and information sharing to high performance in the Kenyan banking sector. The description method is advantageous for research due to its flexibility and can use either quantitative or qualitative data, giving the researcher greater options in selecting instruments for data gathering (Nassiuma and Mwangi, 2006).

4.3 Population:

The study focused on performing commercial banks whose headquarters are in Nairobi. The universe of this study is all the employees of commercial banks in Kenya while the study population was the employees of the ten selected best performing commercial banks with approximately 16000 employees.

4.4 Sampling

The sampling strategy used in this study to select the 10 banks was non-probabilistic. A sample of ten banks was selected using convenience sampling. The banks selected, according to central bank of Kenya supervision report 2007, claimed a greater percentage of market shares in profits due to their excellent performance in customer satisfaction, technology use, product innovation and product market.

Stratified sampling and simple random sampling methods were used to select one hundred respondents. The identified strata in each bank were Human Resource Manager, supervisors and supervisees. From each stratum one human resource manager, three supervisors and six employees were selected from their headquarters which all have similar number of employees at that level using simple random sampling technique. This gave the same characteristic and composition as the population (Kothari, 2003).

4.5 Data Collection and Instrumentation

Research instruments are tools used to collect data (Koul, 1984). The primary data was collected using structured questionnaires with closed and open ended questions. The issue under investigation was the
analysis of the contribution of communication and information sharing to performance in the Kenyan Banking Sector.

4.6 Pilot Testing

The main purpose of pilot-testing is to catch potential problems before they become costly; an established practice for discovery of errors in questions sequencing and instructions (Nueman, 1997). A pre-test in this study was conducted to field test the reliability and the validity of the instrument used. This was carried on 6 employees randomly selected from each of the 3 strata as follows: 1 human resource manager, 2 supervisors and 3 employees. The results were used to locate possible ambiguities in instrumentation requiring further attention and clarity.

5.0 Data Analysis and Presentation

The data collected was of both qualitative and quantitative in nature where the qualitative data was operationalised to quantitative information.

The raw data was cleaned, edited and coded through a predetermined coding scheme and responses analyzed according to the research question.

Descriptive statistics were used to analyze quantitative data and using. Linear relationship models were used to determine the relationship between the dependent variable (performance) and the predictor variable (communication and information sharing).

6.0 Findings and Discussions:

The study sought to assess the contribution of Communication and Information sharing to high performance in the Kenyan Banking Sector. The various findings are presented below:

Table 1: Banks performance in the last five years

<table>
<thead>
<tr>
<th>BANK</th>
<th>Year</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equity bank</td>
<td>500.5</td>
<td>4,757</td>
<td>5,570</td>
<td>9,312</td>
<td></td>
</tr>
<tr>
<td>Kenya commercial bank</td>
<td>1,909</td>
<td>5,394</td>
<td>6,426</td>
<td>11,538</td>
<td></td>
</tr>
<tr>
<td>National bank of Kenya</td>
<td>859</td>
<td>1,797</td>
<td>2,159</td>
<td>2,698</td>
<td></td>
</tr>
<tr>
<td>Cooperative bank</td>
<td>705.6</td>
<td>3,337</td>
<td>3,727</td>
<td>5,559</td>
<td></td>
</tr>
<tr>
<td>BANK</td>
<td>Regular Meetings</td>
<td>Consultation Meetings</td>
<td>Attitude Meetings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------</td>
<td>-----------------------</td>
<td>-------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NIC Bank</td>
<td>403.3</td>
<td>1,474</td>
<td>1,529</td>
<td>2,416</td>
<td></td>
</tr>
<tr>
<td>Stanbic</td>
<td>440</td>
<td>1,313</td>
<td>1,333</td>
<td>2,104</td>
<td></td>
</tr>
<tr>
<td>Citibank</td>
<td>1,295</td>
<td>3,353</td>
<td>3,055</td>
<td>2,879</td>
<td></td>
</tr>
<tr>
<td>Barclays bank</td>
<td>5,402</td>
<td>8,016</td>
<td>9,002</td>
<td>10,775</td>
<td></td>
</tr>
<tr>
<td>Standard chartered bank</td>
<td>3,500</td>
<td>4,709</td>
<td>6,726</td>
<td>7,668</td>
<td></td>
</tr>
<tr>
<td>Bank of Baroda</td>
<td>238</td>
<td>633</td>
<td>726</td>
<td>1,828</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>14,715.9</strong></td>
<td><strong>34,783</strong></td>
<td><strong>40,253</strong></td>
<td><strong>56,777</strong></td>
<td></td>
</tr>
</tbody>
</table>

**MEETINGS**

Table 2: The extent to which banks hold meetings and consultations per month
From table 2 above, it is evident that some banks hold more meetings, consultations and carry out attitude surveys more than others. Equity bank, Kenya commercial bank, Barclays bank and Standard chartered bank are the leading banks in communication and information sharing based on the three variables discussed.

![Figure 1: Performance for the 10 Banks](image)

The figure above shows the banks performances in profits. It was hence necessary to find out if the variables under study influenced the above shown performance.

**Table 3: ANOVA FOR THE 10 BANKS**

Hypothesis

\[ H_0: \mu_1 = \mu_2 = \mu_3 = \ldots = \mu_{10} \]

Vs

\[ H_1: \text{At least one of the } \mu_s \neq 0 \]

One way Anova
Significance of the overall model:

The P value=0.000 which is less than 0.005. Hence the conclusion that the model fitted is highly significant at 0.000.

**Table 4: Regression Coefficients**

**Coefficients**

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
</tr>
<tr>
<td>1 Regular</td>
<td>560.066</td>
<td>186.445</td>
</tr>
<tr>
<td>Consultation</td>
<td>543.321</td>
<td>280.667</td>
</tr>
<tr>
<td>Attitude</td>
<td>598.364</td>
<td>268.414</td>
</tr>
</tbody>
</table>

a. Dependent Variable: performance

Linear Regression through the Origin

The fitted model is as follows:

\[ Y = 560.066x_1 + 543.321x_2 + 598.364x_3 \]

where \( Y \) = Performance, \( X_1 \) = Regular meetings,

\( X_2 \) = consultation meetings and \( X_3 \) = Attitude surveys

From the model, it emerges that regular meetings is the variable that most strongly influences performance. Consultation and attitude surveys on the overall positively influences performance but to a lesser extent in comparison.
7.0 Conclusion

The study sought to examine how information sharing and communication contributes to HPWPs in the Kenyan banking sector. It was noted that there was a significant relationship (strong correlation) between performance, number of meetings held, number of consultations held and the number of attitude surveys carried out. The more the organizations embraced communication and information sharing by holding meetings, consultations, and carrying out attitude surveys, the better the organizational performance in terms of high returns to share holders and increase in market value. Therefore it can be concluded that effective communication and information sharing is pertinent in achieving organizational critical goals.

References


**ENTREPRENEURSHIP A MYTH OR REALITY: A CASE OF THE SMALL SCALE FISHERIES (SSFS)**

**IN THE LAKE VICTORIA BASIN**

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**Abstract**

How entrepreneurial are the Small Scale Fisheries (SSFs) of the Lake Victoria Basin? This paper examines the Entrepreneurial Orientation (E-O) of the SSF operators in Lake Victoria Basin (LVB). It focuses on SSFs which handle *Omena/mukene/dagaa* species of fish; this being what is commonly known as “the common man’s fish”. Entrepreneurship involves idea generation, opportunity seeking, risk taking and resource mobilization to supply goods or services in order to satisfy a need or fill a gap and to achieve set goals (Kibas, 2005). An individual with an entrepreneurial mindset or entrepreneurial orientation has the resolve, ability, and the desire to fulfil his/her vision towards wealth creation and hence poverty eradication. The paper attempts to answer the questions, ‘to what extent are the SSFs entrepreneurial in their activities; and how can they be enhanced to create wealth towards Vision 2030. The paper builds on the preliminary findings of a larger study entitled “A Gender perspective to enhancing Wealth Creation for Poverty Alleviation among Small Scale Fishers in the Lake Victoria Basin” being conducted jointly in Kenya and Uganda under the auspices of the Victoria Research (VicRes) Project. The study was conducted in the greater Suba District specifically in Mfangano and Rusinga Islands. Among the issues at stake given that fishing is the most important source of livelihoods for women (75%) in the area of study, is that men seem to control the fish industry from the actual fishing to selling in the market (Ngware and Ngware, 2004). This remains so even when most women in the region play a key role in providing for their household needs. The study used a descriptive survey approach involving both quantitative and qualitative research methods. The quantitative methods comprised of descriptive statistics on demographic and household data, incomes, fish quantities, and data on available organizations. The qualitative methods captured the data on attributes such as feelings, attitudes, and insights of the respondents’ perception on disparities on gender roles, resource ownership and decision making among others. The methods include participant observations, and interviews and the Focus Group Discussions (FGDs) using checklists, interview guides and unstructured study guides respectively. From the study findings, it is concluded that the SSFs in the selected landing sites on Mfangano and Rusinga Islands are engaged in some different forms of entrepreneurial activities. They are to a large extent taking moderate risks and
seeking new opportunities to create wealth and to achieve. However, it was noted that there are plenty of opportunities that are yet to be exploited in the fishing and related occupations. The culture and traditions of the people living in these Islands may need to be re-examined with the view of moving towards modernity in order to alleviate poverty and create wealth.

**Key words:** Small scale fisheries, gender perspective, entrepreneurial orientation, poverty alleviation

**Introduction**

"The entrepreneurial mind-set transcends the confines of family and tradition, opening individuals up to modern styles of consciousness and securing them a place in modern industrial society" (Brigitte Berger in Spinosa, Flores, Dreyfus, 1997, p.57)

This paper analyzes the Entrepreneurial Orientation (or mindset) of the Small Scale Fisheries operators in Lake Victoria Basin (LVB), with reference to the Kenyan scenario. It focuses on SSFs which mainly handle *Omena/mukene/dagaa* species of fish. The following landing sites which are the subject of an ongoing study were selected: Yokia and Masisi on Mfangano Island, and on Litare and Luanda-Rombo on Rusinga Islands. These landing sites are all gazetted by the Kenya Government. The paper thus builds on the preliminary findings of the study on “A Gender perspective to enhancing Wealth Creation for Poverty Alleviation among Small Scale Fishers in the Lake Victoria Basin” which is being conducted both in Kenya and Uganda under the auspices of the Victoria Research (VicRes) Project. It attempts to answer the question, ‘to what extent are the SSFs entrepreneurial in their activities’.

Yokia and Masisi on Mfangano landing sites were selected due to the large amount of *Omena* fish landed on the average compared to the other sites. They are both located on the eastern side of the greater Mfangano Island and are approximately two kilometres apart. Yokia landing site is measures 100 by 100 meters with a population that varies between 500 and 3000 during low and high fishing seasons respectively. Approximately 60% of the fisher folk are youth aged between 18 to 35 years. Gender is distributed fairly equally with approximately 50% of each of the population.

Rusinga Island is represented by Luanda-Rombo and Litare Landing sites as they also handled more *omena* than the other sites. Lwanda-Rombo has a population of over 1000 people during peak fishing periods and as low as 350 during off-season. This landing site owns over 40 boats. Though the land is productive, it appears that there is a problem regarding managing privately owned landing sites. The site sits on 1 ½ acres of land. Meanwhile Litare is much closer to Mbita Point and has a population of 29 boats
with 2 being owned by women entrepreneurs. Education wise, 70% of the population never went beyond Primary Level education. The main activities are fishing and operation of micro enterprises providing household goods and clothing.

The Small Scale Fisheries (SSF) operators, who have been engaged in fisheries since time immemorial, handle only small quantities as they have no or limited modern fishing technology and proper storage and preservation facilities as well as markets. When they get big catches they cannot easily access key markets to sell their products; hence they are forced to sell the fish to the factory agents and middlemen at low prices (Madanda, 2003 and Abila, 2003). Post harvest losses are common especially on remote landing sites, specifically in the Lake Victoria islands, during the rainy season. The overall result is that the locals are unable to adequately provide for their families and have continued to be poor (living at an average of 1 dollar a day according to Ogutu (1996). The question that begs to be answered is what will free them from this vicious cycle of poverty? Would entrepreneurship offer a solution?

Poverty and environmental degradation are the drivers of this study. An entrepreneurial mindset or orientation has been found to play a key role in revolutionizing the approach to wealth creation and poverty alleviation. Various case studies from developing countries including South Korea, Singapore and Central America have been cited in literature as role models for development. Hence there is need to identify and nurture the entrepreneurial spirit among the SSFs as a strategy out of poverty and wealth creation. The entrepreneurial spirit involves the desire to own a business or engage in an income generating activity by pursuing an opportunity for extra cash, career and/or the need to achieve (http://www.likisma.org/leesmith).

This paper is organized under the following topics: Characteristics of Small Scale Fisheries (SSFs), Role of entrepreneurship, Role of Entrepreneurship, Entrepreneurship Orientation and mindset, The extent to which SSFs in LVB are entrepreneurial, and Conclusion and Recommendations.

**Characteristics Small Scale Fisheries (SSFs) operators**

The characteristics of the SSFs analyzed comprise of: categorization of the SSFs under study, age, education and training, gender, occupation and incomes.

The study focused on all the key operators in the Small Scale Fisheries industry involved in mukene/omena fish in the area of study. These were classified as follows: Boat owners, Fishermen/Crew, Fish handlers/Processors, Traders/Transporters, Workers/Employees and Government workers. This gave
an overall total of 129 respondents from the selected landing sites in Kenya (Mfangano and Rusinga). The majority of the respondents comprised of Fish handlers/employees (41 out of 129) followed by fishermen/crew (39 out of 41). Males tended to dominate certain occupations such as the Actual fishing from the lake (98.5%) as well as in boat (and other assets) ownership (68.8%).

Females dominated as workers/employees at 80% overall. As for traders/transporters, Uganda had 85% being males while Kenya had 66.7%, leaving 15% and 33.3% as females for each country respectively. Table 3 gives a summary of the category of respondents by gender. The composition of SSFs in the study is as shown in Table 1.

**Table 1: Categories of sampled respondents by Gender (Kenya and Uganda)**

<table>
<thead>
<tr>
<th>Category</th>
<th>Kenya</th>
<th>Uganda</th>
<th>Total</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>Boat owners</td>
<td>12</td>
<td>08</td>
<td>10</td>
<td>02</td>
</tr>
<tr>
<td>Fishermen and Crew</td>
<td>38</td>
<td>01</td>
<td>26</td>
<td>00</td>
</tr>
<tr>
<td>Fish handling and processors</td>
<td>10</td>
<td>31</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>Traders/transporters</td>
<td>04</td>
<td>06</td>
<td>10</td>
<td>02</td>
</tr>
<tr>
<td>Workers/Employees</td>
<td>02</td>
<td>07</td>
<td>02</td>
<td>09</td>
</tr>
<tr>
<td>Government workers</td>
<td>05</td>
<td>01</td>
<td>04</td>
<td>00</td>
</tr>
<tr>
<td>Non- Governmental Organizations</td>
<td>03</td>
<td>01</td>
<td>01</td>
<td>02</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>74</td>
<td>55</td>
<td>63</td>
<td>26</td>
</tr>
</tbody>
</table>

The Marital status of the SSF operators tends to affect their life-style, entrepreneurial orientation and attendant risks. There were a significant number of SSF operators who are married – 80% among both the Boat Owners and Traders/Transporters. Female Fish processors also recorded a high percentage with 78% married. It was also noted that 11.1% of the workers/employees are separated. This could be attributed to kind of activities or other related issues such as life style and location of fishing activities. The fish processors families were fairly large with the majority having 3-5 children (47.4%) though 45% of the boat owner respondents had above 8 members in a family. The marital status of the SSFs is summarized in Table 2.

**Table 2 Marital Status of the respondents**

<table>
<thead>
<tr>
<th>Category</th>
<th>Single</th>
<th>Married</th>
<th>Separated</th>
<th>Widowed</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
<td>M</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>74</td>
<td>55</td>
<td>63</td>
<td>26</td>
<td>137</td>
</tr>
</tbody>
</table>
Age wise, the majority of the respondents are aged between 21 – 30 years of age apart from the fishing processors who were mainly between 31 – 40 years of age; a majority of the traders/transporters and boat owners were aged between 41 – 50 years. The mean age of the fish processors (comprising 46.2%) was in the range of 21-30. Hence most of the respondents are youthful.

As regards education, a large percentage (77%) were of primary school level with 94.1% of the fish processors being of primary school and only 5.9% secondary level. It was also noted all the respondents had undergone some form of formal education. The level of education has a direct implication in terms of the capacity and knowledge to expand the SSFs as well as to diversify sources of income.

The SSFs had also undergone capacity building as training offered by these organizations: AMREF, KIPPI, Africa Now. Most (95%) of the BMU members had all been trained on wide range of topics including environmental management, managing the units and social issues that arise. As regards training by gender, 76% of the females and 68% of the males had undergone various short term training programs on various topics regarding SSFs. A comment from the District Fishers Officer at Mbita during the preliminary findings dissemination workshop stated thus, “…these SSF operators and specifically the BMU committee members had been overstrained and yet there is little impact on the ground. Training seems to solve very little. What is needed is a complete overhaul of the mindset. ”

The overall scenario on incomes per week among the SSF indicated that a majority (65%) of the boat owners had the highest incomes ($26.6 to 40), as compared to the other players in the landing sites. There was none who earned less than $13.3 per week. The most common items of expenditure were: rent, entertainment, medical expenses and on food items. As noted minimum savings were made and hence little wealth creation
As regards distribution of incomes, Boat owners and Traders/Transporters had much higher incomes than the rest of the players ranging between $35 to over $45 per week. On the average, Female SSFs, the majority being Fish processors/Workers, earned far my less than their male counterparts – averaging $8 - $12 per week.

**Role of Entrepreneurship**

Entrepreneurship involves idea generation, opportunity seeking, risk taking and resource mobilization to supply goods or services in order to satisfy a need or fill a gap and to achieve (Kibas, 2005). An individual with an entrepreneurial mindset or entrepreneurial orientation has the means, ability, and the desire to materialize his/her vision. If any of those three pillars do not exist, and the entrepreneur cannot bring his or other peoples’ resources to create all three, then the entrepreneurial mindset does not exist. One can go further into exploring the allocation and utilization of resources in novel ways or realizing opportunities where others do not and those are all important but are subservient to and come out as a consequence of the above three entrepreneurial pillars. The Means represent capital – access to resources either from persona savings or through borrowing e.g. credit/loans. An entrepreneur will need be adept in organizing the resources available or accessed in novel ways to bring change; they will also have an intense desire to take calculated risk and invest in profitable enterprises and promote entrepreneurship.

Entrepreneurs create opportunities for themselves and others as well. Through establishing enterprises most have created jobs and hence incomes for themselves as well as for others. For example, take an individual, a Mr. Odongo Mang’ang’a who takes the risk of investing his retirement benefits and savings in a fishing boat. The boat will need a coxswain and at least two fishermen to operate it - thus giving direct employment to 3 otherwise unemployed individuals! Indirectly the other will include the boat builder, the fish buyers, processors and transporters to reach the market.

**Entrepreneurial Orientation and Mindset**

Entrepreneurship has become an important issue for policy. At one level, enterprise creation is recognized as important for employment growth and effecting structural change is another, there is concern to encourage existing firms (and individuals) to become more entrepreneurial as a means of enhancing international competitiveness. Entrepreneurial orientation (EO) reflected in recurring organizational behavior such as innovativeness, pro-activeness and risk-taking is important in the latter context (Quince, 2003). Entrepreneurial orientation could also be referred to an entrepreneurial mindset.
An entrepreneurial mindset can be described as a group of personal dispositions, also known as entrepreneurial spirit, which lead to the innovative practice of identifying and/or creating opportunities, then acting to manifest those opportunities in a productive way (Mueller & Thomas, 2001).

Hence this paper is examining the entrepreneurial mindset of the SSFs studied in Lake Victoria. An important aspect for entrepreneurship is the “creative mindset” (Faltin, 2007); this helps entrepreneurs to create new ideas and bring these to the market in a way appropriate to add value for an external audience. Studies in Psychology highlight that true creativity comes not from the kind of area in which one is active but whether one can conceive of something that is both “new and appropriate” (Amabile, 1996). In this way, an entrepreneurial mindset is a philosophy by which individuals engage in creative activities regardless of the type of work they are engaged in or culture they were brought up in. Hence the entrepreneurial mindset might exist in cooking, fishing, transporting, just as well as web designs and software development among others; it is the philosophy and the action it generates that matters and not the context. This includes the fishing process in its entirety – actual fishing using specific gear, processing the fish and marketing it.

The extent to which the SSFs in the LVB are Entrepreneurial

The level of entrepreneurship among the SSFs would be measured in terms of the key activities that the operators would be engaged in. Such activities include the key elements of entrepreneurial orientation as observed in consistent set of related activities or processes including risk-taking, innovativeness and proactively (Senge 2007, Lumpkin and Dess, 1997; Miles and Arnold, 1991; Morris and Paul, 1987).

From the key stakeholders perspective, including the Government fisheries officers (at Rusinga), most SSFs ‘suffer’ from an attitudinal problem. Most of Fisher folk have been reached through their BMUs, regarding opportunities to access various services including credit and business development services such as marketing, but they have not taken advantage of this.

As regards the overall other income generating activities among the SSFs sampled within the Islands, these were found to be limited. For example, out of the entire sample of 217 SSFs, 76% of the men and 90% women SSFs did not have any other sources of income in the study landing sites.

The common entrepreneurial activity was subsistence farming to provide food and vegetables – the surplus being for sale and others at a very low percentage as already given under objective two. Hence it appears that most of these people had very low level of entrepreneurial culture. They depended heavily
on the fishing activities with a handful engaging in other activities such as farming, trading, charcoal burning, transport (boda-boda) offering tuition (teaching), selling of food stuffs, handcraft, pool tables, charcoal and firewood. Barber and hair salons are also a common feature within the landing sites. Figure I displays a picture of the going-ons at the landing sites.

Figure 1: Litare Landing site street – Food and charcoal kiosk (Rusinga)

At Litare and Yokia landing beaches, the main source of income is from fishing and fish related activities; however, other sources of income (less than 25%) are from businesses like dealing with fried fish, shops and hotels/tea rooms. Residents of Lwanda Rombo and Masisi landing sites practice some limited agriculture/horticulture by growing vegetables and fruits. This is supplemented by keeping of domestic animals – few cattle, goats and chicken.

From the findings of the study indicated earlier, it appears that the SSFs (respondents in this study) displayed some limited entrepreneurial aspects – being innovative, creative and risk-taking. The SSFs operating on both Rusinga and Mfangano Islands appeared neither reluctant nor lacked entrepreneurial understanding. Specific examples of these include new strategies of fishing, slow adoption of new technology, fishing gear (nets and lamps) and new methods of drying fish. They had also been an attempt to diversify their sources of income to include horticulture, micro-farming and keeping livestock. For cooking and lighting, a number of the respondents had adapted new technologies as well as being slightly
innovative in terms of using diesel powered generators to produce electricity for lighting, powering their radios and television sets. This has been observed as a positive change in the mind shift of the SSFs towards being entrepreneurial.

Figure 2 indicates one of the gardens in Masisi serving as a source of green vegetables and fruits.

![Image of a garden](image)

Figure 2: Horticulture – Diversified source of other income activities at Masisi, (Mfangano Island)

Among all the respondents engaged in entrepreneurial activities, it was noted that over 95% were women as they involved themselves in other income generating activities. The operated retail kiosks selling grains, food, paraffin, charcoal, firewood, clothes and other household goods among others. The men who were more entrepreneurial are led by the boat owners who have invested in new fishing gear, commercial plots and transport vehicles.

**DISCUSSION AND CONCLUSION**

This study indicates that most of the artisanal SSFs appear to engage in some entrepreneurial activities; however, the extent is somewhat varying. Being entrepreneurial requires one to be innovative, creative, opportunity seeking, moderate risk taking and pro-activity among other attributes.

From the study findings, it is concluded that the SSFs in the selected landing sites on Mfangano and Rusinga Islands are engaged in some different forms of entrepreneurial activities. They are to a large extent taking moderate risks and seeking new opportunities to create wealth and to alleviating poverty among themselves. They also display some level of achievement-orientation compared to their contemporaries. However, it was noted that there are plenty of opportunities that are yet to be exploited.
in the fishing and related occupations. The culture and traditions of the people living in these Islands may need to be re-examined with the view of moving towards modernity in order to alleviate poverty and create wealth.

RECOMMENDATIONS

As a way forward, there is a need to re-orient the SSFs towards being entrepreneurial and the development of the enterprise culture. Targeted training and capacity building efforts such as, Awareness workshops, exposure educational trips, specific training and role modeling may be the sure way forward. Linkages and collaboration with other stakeholders providing suitable interventions both financial (ie loans and advise) and non-financial services (training, mentoring and marketing) should be developed and brought to closer to the landing sites.

REFERENCES


Miles and Arnold, 1991;

Morris and Paul, 1987;


EFFECTS OF ORGANIZATIONAL SUPPORT FOR CAREER DEVELOPMENT ON EMPLOYEE PERFORMANCE: A CASE OF KENYAN PUBLIC UNIVERSITIES

By Manyasi J1, Kibas P. B.2 and Chepkilot ,R.3

1 Masinde Muliro University of Science & Technology, 2 & 3 Kabarak University.

Abstract

Unprecedented changes have pushed organizations to undertake various initiatives to stay afloat. This has put pressure on organizations to maximally utilize the resources at their disposal for their benefit. As a result, the realization of the central role played by a firm’s human resources in giving it a competitive advantage has brought to the fore the need for emphasizing human resource development in organizations, universities included. Debate has raged on the party responsible for career development programmes. Whereas individual employees have initiated and funded such processes, consensus has been building on the need for organizations to take a prominent role in initiating, managing and enhancing such processes. This study sought to examine the effect of university support for career development on lecturers’ performance in public universities. Guided by the psychological contract theory, data was collected from 328 academic staff drawn from all the public universities in Kenya using questionnaires. It was analyzed using descriptive statistics and hypotheses tested using Pearson Product moment correlation coefficient. The results indicated that organizational support for career development of employees positively affected their performance in public universities. This support in terms of study leave, financial support for further studies as well as incentives such as salary increases and promotions on completion of such programmes enhanced organizational citizenship hence improved employee performance.

Key words: career development, organizational support, Psychological contract,, employee performance

Introduction

The globalised business world is undergone unprecedented changes that have pushed organizations to undertake various initiatives to stay afloat (Baruch, 2004; Greenhaus, Callanan and Godshark, 2002). This has resulted in organizational mergers and acquisitions, incorporation of technology in operations with other firms downsizing their operations.

Given the central role played by a firm’s human resources in giving it a competitive advantage, many organizations are turning to human resource development to increase their employees’ knowledge, skills and capabilities so that they can survive. This push has elevated career development programmes to become an integral part of many organizations’ strategic plans.
According to Thite(2001) and Kaye(2005), a well developed career development system enables organizations to tap into their wealth of in-house talent for staffing and promotion purposes. This ensures the knowledge, skills, experience and aspirations available are matched with the needs of the organization. Organizations that invest in their employees expect to get positive reciprocity from employees in terms of organizational citizenship (Crepanzo and Mitchell, 2005). Investment in employees’ career development is taking place both in the public and private sector with individual employees themselves or organizations they work for funding the exercise. This however is dependent on the needs of each individual or sector since individuals have different career aspirations and some sectors have been affected more than others by the changing global economic conditions.

In the higher education sector, the demand for a high calibre of employees to man the different sectors of the economy have put a premium of University education. World Bank (1994) and Sifuna (1998) note that education plays an important role in promoting the social and economic development of a country. In that light, Manyasi, Egessa and Warentho (2011) recognize the responsibility of Universities in equipping individuals with advanced knowledge, skills and competencies required for positions of responsibility in the public and private sector.

In Kenya, the number of people seeking university education has increased to the extent that public universities cannot absorb all the eligible candidates (Chacha, 2004; Kalai, 2009). The government has responded to this challenge by establishing more universities and university colleges, diversifying the programmes offered by these institutions (Vundi, 2009; Chacha 2004) as well as initiated self sponsored programmes. From an initial one university college in 1956, Kenya today boasts of seven full fledged public universities and thirteen university constituent colleges (CHE,2011). The number of private universities has also increased.

This rapid expansion of university education has led to a myriad of challenges especially for public universities. These include low funding from the exchequer forcing these institutions to operate under very tight budgets, increased student enrolment without commensurate improvement in available facilities as well as reduced research capacity (UNESCO, 1998; Chacha 2004; Kalai, 2009). A part from these, recent studies by Kalai (2009) and Kadenyi et al (2009) indicate a decline in effective teaching, research and publishing by lecturers, yet these are the critical measures of lecturers’ performance. This has been attributed to heavy workloads as a result of high students’ enrolment.

1.1 Statement of the Problem

Organizations can gain a competitive advantage from the resources they possess. They are therefore are expected to strive to improve the capabilities of their employees so as to enable them cope with changes in their environment. Such practices enable an organization to get superior performance from their employees. Kenyan Public Universities have career development programmes as part of their mandate and strategic plans. Such initiatives are expected to improve lecturers’ performance of duty.

The situation on the ground however paints a different picture with studies showing that the number of lecturers in these institutions undertaking career development programmes is on the decline (Chacha, 2004; Lewa, 2009). According to Lewa (2009), Kenyan Public universities have fewer PhD level staff
when compared to many countries in sub Saharan Africa. Those registered for these programmes are behind schedule in the race towards their completion. Organizational support, family support, perceived benefits and one understands of his strengths and weaknesses have been identified as predictors of the success of career development programmes and hence enhanced employee performance (Kraiger and Ford, 2007).

Studies have been done on the effect of organizational support on an employee’s career development programmes (Crawshaw, 2006, 2006; Kuo, 2006; Park, 2010). Such studies have however been done outside Kenya. This has presented university managers and policy makers with challenges of lack of empirical information on how to handle career management initiatives of staff. Kenyan public universities, with their unique challenges need an empirical study to guide them on how they should handle their organizational support for career development programmes of their academic staff.

This study sought to fill that empirical gap by finding out the effect of organizational support for career development on academic staff’s performance in Kenyan Public Universities.

1.2 Study Objectives

(i) To identify the forms of career development support that is given to academic staff by public universities in Kenya.

(ii) To examine the effect of the public universities’ management support for career development on academic staff performance in public universities in Kenya.

(iii) To examine the relationship between public universities’ incentives for career development and academic staff performance in public universities in Kenya.

1.3 Study Hypotheses

From the study objectives, two study hypotheses were formulated:

HO₁: There is no relationship between universities financial support for career development programmes and academic staff performance in public universities in Kenya.

HO₂: There is no relationship between universities’ incentives for career development and lecturers’ performance in Public Universities in Kenya.

1.4 Theoretical Framework

This study was guided by the Psychological contract Theory. This theory holds that employees and employers have beliefs and expectations of each other in the employment relationship but which are not expressly articulated in the employment contract (Robinson 1996; Armstrong, 2006). According to Armstrong (2006), a psychological contract is a system of beliefs that employees believe are expected of them and the responses they expect in return from their employer.

In most cases, the psychological contract is defined by individual employees. They define this through the expectations they have of their employers, for example in terms of fair treatment, employment
security, safe working environment and career development opportunities and growth. The employer on his part expects competence, effort, commitment and loyalty from the employee (Armstrong, 2006). Employees will reduce their performance when they feel the employer has violated the psychological contract, for example, when he downsizes, outsources labour, implements pay cuts or denies employees opportunities for career development. Employees will therefore execute their duties diligently and enhance their performance when they perceive they are being supported, treated fairly and appreciated by their employer.

1.5 Significance of the Study

This study was important because its findings would enable Kenya public universities to determine the effect of their support in academic staffs’ career development on their performance. It would also benefit academic staff in these universities by informing them on the need to develop their careers so as to improve their performance and career well being. It would also serve as a reference point for human resources practitioners in different organizations by providing them with empirical evidence on the benefit of organizations supporting career development initiatives of their employees.

Literature Review

Career development programmes are important in ensuring continuous updating and upgrading of employees’ knowledge, skills, attitudes and competence. According to Lee and Bruvold (2003), investing in the development of the careers of employees is central in the maintenance and development of skills, knowledge and abilities of both individual employees and the organization as a whole.

Debate has raged among scholars on the determination of the party responsible for career development. There are those who see it as being the responsibility of the employees (Puah and Anathram, 2006; Baruch; 2004; Cohen, 2003). There are others who see it as being the responsibility of the organization (Herr, 2001; Kulvisaechana, 2006). Baruch (2004) while supporting the individual effort perfective in career development also calls for organizational involvement in the career development of its employees. According to him, making it an individual’s responsibility reduces employee commitment to the organization. It also reduces their motivation and may result in employee turnover (Puah and Anathram, 2006). Employer support for Career development increases employee trust, job satisfaction, lowers turnover intentions and generally improves employer performance.

Public Universities can support lecturers career development initiatives through supportive leadership, creation of opportunities for organizational learning, funding career development programmes, offering incentives to those undertaking career development such as promotion upon completion, allowing such employees to be on study leave and organizing forums such as seminars, workshops and conferences for them disseminate new knowledge and innovations (Crawshaw, 2006; Tan, 2008; Park, 2010; Kuo, 2006). Promotion, when based on increased competence, goes a long way in motivating employees to undertake career development programmes.

An employee output greatly determines an organizations performance. According to Dessler (2005), employee performance can be defined as the extent to which the employee is contributing to the strategic aims of the organization. It is expected that with enhancement of employees’ capabilities through various
career development programmes such as undertaking further studies, participating in research, seminars, workshops, conferences and team learning in organizations, employees performance will improve. For this to be ascertained, employee performance ought to be measured. Measures of employee performance differ with one’s profession and workplace whereby measures of employee performance in the banking sector will differ from those used in the education sector (Kiriri and Gathuthi, 2009). In the university setup, university academic staff’s performance can be measured through the extent to which they effectively teach allocated workloads, attendance of learned conferences, publication of books and journal articles and furtherance of academic and professional qualifications (Kiriri and Gathuthi, 2009).

Scholars such as Kamoche, Nyambega and Mulinge (2004) argue that failure by organizations to systematically invest in training and development of its employees hurts industrial development and impedes improvement in labour productivity. There is therefore need for organizations to play a major role in supporting employees’ career development programmes to ensure reciprocal good performance from employees.

**Methodology**

The study used a descriptive survey design. The unit of analysis was the Kenyan public universities where respondents were academic staff teaching in these universities. From a population of approximately 4000 lecturers, a study sample of 357 lecturers was selected using the sample determination table proposed by Krecie and Morgan (1970) as cited in Kasomo (2007). Simple random and purposive sampling techniques were used in selecting the sample to ensure all cadres of academic staff were represented in the study.

Questionnaires were used as the main data collection method. It had two parts, with the first part seeking information on the respondents personal characteristics while the second part sought information on organizational support for career development and employee performance. The data collection tool were dropped at the respective universities and later picked by the researchers and their research assistants. Out of the expected 357 questionnaires, 328 were returned representing an over 90% return rate. The data was then coded and analyzed using the SPSS computer programme.

**Analysis of results**

The data collected was analyzed and reported with the analysis covering the demographics of the respondents, frequencies of the respondents and tests of hypotheses.

**Demographic characteristics of the sample**

The study got fairly the same number of respondents from all the public universities ranging from 44 – 50 respondents as shown on Table 4.1 of these respondents, most of them were male, 216 (65.9%) and a majority were aged between 30 and 40 years, 162 (49.4%).

**Table 4.1: Demographic characteristics of respondents**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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</table>

266
<table>
<thead>
<tr>
<th>University of respondent</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Jomo kenyatta</td>
<td>44</td>
<td>13.4</td>
</tr>
<tr>
<td>Egerton</td>
<td>50</td>
<td>15.2</td>
</tr>
<tr>
<td>Masinde Muliro</td>
<td>50</td>
<td>15.2</td>
</tr>
<tr>
<td>Kenyatta</td>
<td>49</td>
<td>14.9</td>
</tr>
<tr>
<td>Nairobi</td>
<td>40</td>
<td>12.2</td>
</tr>
<tr>
<td>Moi</td>
<td>49</td>
<td>14.9</td>
</tr>
<tr>
<td>Maseno</td>
<td>46</td>
<td>14.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>328</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>216</td>
<td>65.9</td>
</tr>
<tr>
<td>Female</td>
<td>112</td>
<td>34.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>328</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 30 years</td>
<td>76</td>
<td>23.2</td>
</tr>
<tr>
<td>30-40 years</td>
<td>162</td>
<td>49.2</td>
</tr>
<tr>
<td>41-50 years</td>
<td>61</td>
<td>18.6</td>
</tr>
<tr>
<td>Above 50 years</td>
<td>29</td>
<td>8.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>328</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Highest academic qualification</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor’s degree</td>
<td>64</td>
<td>19.5</td>
</tr>
<tr>
<td>Masters degree</td>
<td>170</td>
<td>51.8</td>
</tr>
<tr>
<td>Doctor of philosophy(PhD)</td>
<td>94</td>
<td>28.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>328</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Current Position</th>
<th></th>
<th></th>
</tr>
</thead>
</table>


Graduate Assistant 42 12.8
Tutorial fellow/Assistant Lecturer 117 35.7
Lecturer 107 32.6
Senior Lecturer 39 11.9
Associate Professor 16 4.9
Professor 7 2.1
Total 328 100

<table>
<thead>
<tr>
<th>Teaching experience at university</th>
<th>f</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 5 years</td>
<td>158</td>
<td>48.2</td>
</tr>
<tr>
<td>5-10 years</td>
<td>95</td>
<td>29.0</td>
</tr>
<tr>
<td>10-15 years</td>
<td>47</td>
<td>14.3</td>
</tr>
<tr>
<td>Above 15 years</td>
<td>28</td>
<td>8.5</td>
</tr>
<tr>
<td>Total</td>
<td>328</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Research study, 2011

On these respondents, a majority of them had a Masters degree, 170 (51.8%) as their highest academic qualification with most of them, 266(81.1%), holding the lecturer position and below.

Descriptive Statistics

The study also elicited descriptive data that was summarized in frequencies. The respondents gave varied responses to questions seeking to find out their views on the level of universities support on career development programmes and the extent to which it affected academic staff’s performance. This is summarized in Table 4.2

Table 4.2: Descriptive staff responses on university support for career programmes

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>Strongly agree f</th>
<th>%</th>
<th>Agree f</th>
<th>%</th>
<th>Undecided f</th>
<th>%</th>
<th>Disagree f</th>
<th>%</th>
<th>Strongly disagree f</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. My university offers study leave to academic staff pursuing further</td>
<td>144</td>
<td>43</td>
<td>134</td>
<td>40.9</td>
<td>26</td>
<td>7.9</td>
<td>23</td>
<td>7.0</td>
<td>1</td>
<td>0.3</td>
</tr>
</tbody>
</table>
2. My university pays fees for academic staff pursuing further studies.  

<table>
<thead>
<tr>
<th>Rating</th>
<th>Agree</th>
<th>Mostly Agree</th>
<th>Neutral</th>
<th>Mostly Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>59</td>
<td>18</td>
<td>107</td>
<td>32.6</td>
<td>71</td>
<td>21.6</td>
<td>63</td>
<td>19.2</td>
<td>28</td>
</tr>
</tbody>
</table>

3. My university pays participation fees and upkeep for academic staff attending conferences seminars, workshops and other career development programmes.  

<table>
<thead>
<tr>
<th>Rating</th>
<th>Agree</th>
<th>Mostly Agree</th>
<th>Neutral</th>
<th>Mostly Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>79</td>
<td>24.1</td>
<td>114</td>
<td>34.8</td>
<td>66</td>
<td>20.1</td>
<td>54</td>
<td>16.5</td>
<td>15</td>
</tr>
</tbody>
</table>

4. The university management encourages academic staff to undertake career development programmes.  

<table>
<thead>
<tr>
<th>Rating</th>
<th>Agree</th>
<th>Mostly Agree</th>
<th>Neutral</th>
<th>Mostly Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>98</td>
<td>29.9</td>
<td>162</td>
<td>49.4</td>
<td>42</td>
<td>12.8</td>
<td>24</td>
<td>7.3</td>
<td>2</td>
</tr>
</tbody>
</table>

5. My university has a fair way of nominating academic staff to undertake career development programmes.  

<table>
<thead>
<tr>
<th>Rating</th>
<th>Agree</th>
<th>Mostly Agree</th>
<th>Neutral</th>
<th>Mostly Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>68</td>
<td>20.7</td>
<td>139</td>
<td>42.4</td>
<td>74</td>
<td>22.6</td>
<td>46</td>
<td>14</td>
<td>1</td>
</tr>
</tbody>
</table>

6. Academic staff of my university who successfully undertake career development programmes are given additional responsibilities.  

<table>
<thead>
<tr>
<th>Rating</th>
<th>Agree</th>
<th>Mostly Agree</th>
<th>Neutral</th>
<th>Mostly Disagree</th>
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<th>Strongly Disagree</th>
<th>Mean</th>
<th>SD</th>
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</thead>
<tbody>
<tr>
<td>74</td>
<td>22.6</td>
<td>187</td>
<td>57</td>
<td>35</td>
<td>10.7</td>
<td>22</td>
<td>6.7</td>
<td>10</td>
</tr>
</tbody>
</table>

7. My university gives salary increments to academic staff upon successful completion of the career development program.  

<table>
<thead>
<tr>
<th>Rating</th>
<th>Agree</th>
<th>Mostly Agree</th>
<th>Neutral</th>
<th>Mostly Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Mean</th>
<th>SD</th>
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</thead>
<tbody>
<tr>
<td>133</td>
<td>40.5</td>
<td>106</td>
<td>32.3</td>
<td>34</td>
<td>10.4</td>
<td>39</td>
<td>11.9</td>
<td>16</td>
</tr>
</tbody>
</table>

8. Academic staff in my university who successfully complete further studies.  

<table>
<thead>
<tr>
<th>Rating</th>
<th>Agree</th>
<th>Mostly Agree</th>
<th>Neutral</th>
<th>Mostly Disagree</th>
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<th>Strongly Disagree</th>
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</thead>
<tbody>
<tr>
<td>90</td>
<td>27.4</td>
<td>145</td>
<td>44.2</td>
<td>44</td>
<td>13.2</td>
<td>44</td>
<td>13.2</td>
<td>5</td>
</tr>
</tbody>
</table>

9. My university prioritizes internal appointments and promotions for the staff who have successfully completed further studies.  

<table>
<thead>
<tr>
<th>Rating</th>
<th>Agree</th>
<th>Mostly Agree</th>
<th>Neutral</th>
<th>Mostly Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>99</td>
<td>30.2</td>
<td>162</td>
<td>49.4</td>
<td>45</td>
<td>13.7</td>
<td>22</td>
<td>6.7</td>
<td>0</td>
</tr>
</tbody>
</table>

10. The support given by my university on career development to staff has had a positive influence on the academic staffs performance.  

<table>
<thead>
<tr>
<th>Rating</th>
<th>Agree</th>
<th>Mostly Agree</th>
<th>Neutral</th>
<th>Mostly Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>94</td>
<td>28.7</td>
<td>151</td>
<td>46</td>
<td>57</td>
<td>17.4</td>
<td>21</td>
<td>6.4</td>
<td>5</td>
</tr>
</tbody>
</table>
Tests of Hypotheses

Two hypotheses were developed for the study. They were tested using Pearson’s product moment correlation test at 95% confidence level. The results are presented in Table 4.3 and 4.4 respectively.

4.3.1 Hypothesis One:

HO$_1$: There is no relationship between universities financial support for career development and academic staff’s performance in public universities in Kenya.

Table 4.3: Correlation between universities’ support and lecturers’ performance

<table>
<thead>
<tr>
<th>Universities’ support</th>
<th>Lecturers’ Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson correlation(r)</td>
<td>.714**</td>
</tr>
<tr>
<td>Sig.(2-tailed)</td>
<td>.000</td>
</tr>
<tr>
<td>N</td>
<td>328</td>
</tr>
</tbody>
</table>

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

Source: Research study, 2011

The results show that there is a positive relationship between universities support for career development and academic staff’s performance in public universities(r=0.714, p=0.000). Financial support here was seen from the perspectives of the universities paying fees for tuition for those pursuing further studies and participation fees and upkeep for those attending seminars, workshops and conferences. The null hypothesis is therefore rejected and the alternative hypothesis confirmed.

4.3.2 Hypothesis 2

HO$_2$: There is no relationship between public universities incentives for career development and academic staff’s performance in public universities in Kenya.

Table 4.3: Correlation between universities’ incentives and lecturers’ performance

<table>
<thead>
<tr>
<th>Universities’ incentives</th>
<th>Lecturers’ Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson correlation(r)</td>
<td>.430**</td>
</tr>
<tr>
<td>Sig.(2-tailed)</td>
<td>.000</td>
</tr>
<tr>
<td>N</td>
<td>328</td>
</tr>
</tbody>
</table>

** Correlation is significant at the 0.01 level (2 tailed)
Source: Research study, 2011

The results show that there is a strong positive relationship between public universities incentives for career development and academic staff performance in public universities ($r=0.430$, $p=0.000$). Incentives for career development are seen in terms of salary increments and promotions for those successfully completing career development programmes such as furthering one’s studies. The null hypothesis is therefore rejected and the alternative hypothesis confirmed that there is a strong positive relationship between public universities incentives for career development and academic staff performance.

Discussions

The results of the study show that a majority of the academic staff are male 216(65.5%), painting a picture similar to other sectors of the economy in Kenya where a majority of employees are male (Sikueya, 2007). This calls for affirmative action to bridge the gender gap. Most of the respondents were aged below 40 years (72.6%) and had a Masters degree, (71.3%) as their highest academic qualification. This points to the need for career development programmes to be enhanced since university academic staff are expected to be holders of a PhD degree (Lewa, 2009). Most respondents had also worked for at least 10 years in their universities, indicating a relative stability of employment tenure. Under such circumstances, meaningful career development programmes can be initiated and sustained so as to manage talent within the universities. Of all the respondents, only 63 (18.9%) were above the rank of senior lecturer. This indicated that since many of the academic staff did not possess a PhD degree, they could not go beyond the lecturer position since ascending the ladder beyond this level requires the employee to possess a PhD degree as well as being involved in publishing and research. The demographic data therefore painted a picture of the need for academic staff to pursue career advancement programmes to enable them ascend career ladder.

The study identified various forms of career development programmes undertaken by academic staff. This included pursuit of further academic studies such as attainment of Masters or Doctor of Philosophy (PhD) degrees, writing of scholarly articles for publication in books and journals, conducting empirical research in various fields of study, participation in seminars, workshops and conferences where research findings were disseminated and new knowledge shared by the participants. Others undertook higher professional studies.

The study also established that the public universities supported career development initiatives of its academic staff through giving financial assistance to those pursuing further studies, payment of participation fees and subsistence expenses for those taking part in workshops, seminars and conferences, granting of time off duty and study leave for those undertaking such initiatives as well as providing incentives such as salary increments and promotions to those who successfully complete these initiatives. These were confirmed by a majority of the respondents 264 (79.6%) who strongly agreed and agreed respectively with the statement that academic staff who successfully undertake career development programmes are given additional responsibilities. The level of the universities contribution towards meeting financial costs of career development was however average given the 166(50.6%) respondents who strongly agreed and agreed with the statement that the university paid fees for academic staff pursuing further studies. The same was noted in the response towards the question on whether the
universities paid participation fees and subsistence allowances for those attending conferences workshops or seminars where 79 (24.1%) and 114 (34.8%) of the respondents strongly agreed and agreed respectively with the statements.

The study found that the public universities management encouraged academic staff to undertake career development programmes as was confirmed by 98(29.9%) and 162(49.4%) of the respondents who strongly agreed and agreed respectively with the statement. This greatly affected university academic staff performance since it made the staff to embrace career development initiatives. As a result, a majority of the respondents were in agreement that the support given by the universities to academic staff’s career development programmes greatly affected their performance as was confirmed by 94(28.7%) and 151(46%) of the respondents who strongly agreed and agreed respectively with the statement.

The inferential analysis of data using Pearson’s product moment correlation also confirmed the study hypotheses. It showed that there existed a strong positive relationship between universities incentives for career development and academic staff’s performance in public universities. It also confirmed the first alternative hypothesis that held that the organizational support (financial assistance/support) given by public universities towards career development programme for academic staff had a positive relationship with academic staff performance. These results tally with those of Hung & Wong (2007) and Mudor and Tooksoon (2011) who also confirmed the importance of organization support for career advancement in enhancing employee performance and retention.

**Conclusion**

The study therefore concludes that organizational support for career development is an important ingredient in enhancing employee performance. This is because it improves an employee’s morale hence increasing their output. It will also make employees to feel that the employers have fulfilled their part of the psychological contract.

**Recommendation**

Based on the findings, the study, recommends that affirmative action be undertaken in public universities in Kenya in a bid to ensure that more women are engaged as academic staff and offered opportunities for career advancement. This will enhance gender balance and workforce diversity.

Public universities in particular and organizations in general also ought to come up with policies to guide the modes and the degree of organizational support for career development. This is because organizational support for career development programmes greatly influences employee performance. They should also come up with various incentives that encourage employees to undertake career development activities. These incentives can be both financial and non financial in nature.

The organizations should also be generally involved in career planning and development of their employees’ careers instead of leaving it to be an employee’s initiative. This will ensure that the psychological contract from the employees’ perspective is fulfilled hence eliciting loyalty, organizational citizenship and superior performance from them.
Limitations and suggestions for further research

The sample size of this study was limited hence could contribute to the non generalizability of the findings. The study was also carried out in public universities in Kenya, leaving out the constituent colleges of these universities. Further research should therefore be conducted using a larger sample and covering both public universities and constituent colleges.

The study did not also include intervening or moderating variables yet these variables could have played a role in influencing the results of the study. Future research should take into consideration the effects of these variables.

References


CHE(2011)9th Exhibition by Kenyan Universities, Golf Hotel, Kakamega,17-19th March


ENTREPRENEURIAL INTENSITY AND PERFORMANCE OUTCOMES AMONG KENYAN FIRMS

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Kenya Methodist University

Abstract
Given shrinking markets, price pressures and the need to survive and excel in a highly competitive business environment, firms have to continually renew themselves in order to remain relevant in their chosen markets. Corporate entrepreneurship is one of the ways to enhance innovative and entrepreneurial activity of employees and to increase firm performance through the creation of new products, services, strategy and organizational conditions (Bau and Wagner, 2010). It is therefore necessary to understand the intensity of entrepreneurial activity in firms and how this influences performance outcomes. By reviewing literature, an instrument was developed based on four descriptors of an organisational climate for successful Corporate Entrepreneurship, namely entrepreneurial mindset, support for innovation, rules for an innovative environment, and intrapreneurial environment. The instrument was tested for reliability and validity on a Kenyan sample and used to investigate how entrepreneurial intensity (how much the enabling climate exists in a firm) influences performance outcomes (entrepreneurial outcomes). An exploratory survey of 39 respondents’ from firms in Kenya was conducted using structured questionnaires as data collection instruments. Data was analysed using descriptive statistics to determine the entrepreneurial intensity and regression analysis to discern the influence of the intensity on performance outcomes. The results suggest that there is low entrepreneurial intensity leading to moderate performance outcomes. The results of this study are of practical significance in two ways. First, they reveal a low entrepreneurial intensity in the studied firms and point to areas that need improvement. Secondly, the relative influence of the entrepreneurial intensity dimensions on performance outcomes are revealed to aid in the prioritisation of actions necessary to achieve better performance. This is the first attempt at investigation of entrepreneurial intensity using an instrument developed using a Kenyan sample.

Key words: Entrepreneurship intensity, mindset, innovation, intrapreneurial environment, performance

INTRODUCTION

Background
In a reality characterized by intensified global competition, dynamic change and increasing uncertainty, the need for organizations to become more innovative in order to survive and grow is increasing rapidly (Pasapia, 2009). The measure of entrepreneurial activity in an organisation is the level of creativity and innovation across all its operations. How intense the creative and innovative disposition is determines the success of organizations as reflected in performance outcomes.

Given the dynamic nature of the business environment-turbulent and unpredictable; and that only a few of the new enterprises that are started grow to become large corporations, it is necessary that existing organizations keep renewing themselves through multiple venture activities internally, such as establishment of new lines of business, and through external cooperative strategies which include joint ventures and venture capital investment activities. All these strategies are collectively referred to as
corporate entrepreneurship where businesses engage in opportunity seeking and exploitation. It is against this background that a perspective has emerged within the field of entrepreneurship, calling for the integration of strategic advantage-seeking and entrepreneurial opportunity-seeking behavior. This perspective, called Strategic Entrepreneurship (SE) emphasizes the importance of managing entrepreneurial resources or activities strategically in order to obtain competitive advantage (Hitt, Ireland, Camp, and Sexton 2001; Ireland, Hitt, & Sirmon 2003).

Further, the need for superior performance, such as acceptable growth by firms and recognition of the time to change tact by anticipating market dynamics and taking appropriate action cannot be overemphasized. This calls for the effort of all organizational members where top management provides support to other members for innovation through experimentation. According to Wolcott and Lippitz (2007):

*CEOs talk about growth; markets demand it* (Gulati, July-August, 2004). *But profitable organic growth is difficult.* When core businesses begin to flag, research suggests that fewer than 5% of companies regain growth rates of at least 1% above gross domestic product (CSB, 1998). Creating new businesses, or corporate entrepreneurship, offers one increasingly potent solution. According to a recent survey, companies that put greater emphasis on creating new business models grew their operating margins faster than the competition (Pohle & Chapman, 2006).

Consequently, firms should have a clear focus on the future through a compelling vision of the unfolding market place while being alert to opportunities in the context of a satisfactory corporate entrepreneurship disposition.

**Corporate entrepreneurship**

The question on every business executive’s mind is how established organizations can build successful new businesses on an ongoing basis yet the road is littered with failures (Wolcott & Lippitz, 2007). The recognition of the importance of entrepreneurial dynamics in corporate context is increasingly acknowledged in both entrepreneurship and strategic management literature, as firms today face a reality in which frame-breaking innovation is an important element of survival (Lassen, 1989).

Corporate entrepreneurship (CE), is defined “as the process by which teams within an established company conceive, foster, launch and manage a new business that is distinct from the parent company but leverages the parent’s assets, market position, capabilities or other resources” (Wolcott and Lippitz, 2007, p.75). Thus CE comprises initiatives in established organizations for different purposes. These include establishment of strategic business units to deal with disruptive technologies, or acquiring a marketing firm to rapidly commercialize innovations from the acquiring firms R&D efforts. “CE activities are aimed at fostering profitability, firm performance, innovativeness, strategic and organizational flexibility, and new product-market arenas” (Covin & Miles, 1999; Kuratko et al. 2005, cited in Bau & Wagner, 2010). Further, corporate entrepreneurs are not just creating a new product or service but changing the way a company develops, builds, markets and supports its offerings.

According to Blau and Wagner (2010) corporate entrepreneurship is one of the ways to enhance innovative and entrepreneurial activity of employees and to increase firm performance through the
creation of new products, services, strategy and organisational conditions. Besides an entrepreneurial orientation, “CE supports a firm’s capabilities to discover market changes as well as competitor and consumer behaviour to create new products and services” (Blau & Wagner, 2010, p.2).

**Kenyan Context**

The role of small and micro-enterprises (SMEs) to economic development of emerging markets has been widely acknowledged in literature. According to a study in Kenya (Bowen et al., 2009):

*Small and Micro Enterprises (SMEs) play an important economic role in many countries. In Kenya, for example the SME sector contributed over 50 percent of new jobs created in 2005 but despite their significance, SMEs are faced with the threat of failure with past statistics indicating that three out five fail within the first few months.*

Within the overall context of structural adjustment programmes (SAP) of the late 1980s, the 1990s saw the liberalization of the economy, followed by the privatization of State corporations and emergence of competition in all sectors of the economy. Consequently, many organizations have been started for various reasons: to create wealth, to create employment for the owners, and most importantly to align existing organizations with the new business environment realities. Some of the firms are by former employees of the privatized and or liberalised sectors of the economy. In essence, all these firms face stiff competition which calls for strategies to navigate their course to success. Similar to the situation described for South Africa van Wyk and Adonisi (2008), economic sensitive period that Kenya continues to experience including “the down turn of the world economy, with resultant high levels of unemployment, necessitates the application of corporate entrepreneurship strategies to enhance business growth”(p.3048). The challenges leading to the high rate of failure seem to change (evolve) according to different macro and micro conditions.

**Problem statement**

Against the backdrop of high failure rate of SMEs and recognition of the need for creativity and innovation through entrepreneurship among firms, government policies have been promulgated to move the entrepreneurial process forward. However, it is not clear whether the entrepreneurial climate in Kenyan firms is intense enough or what the relationship between that intensity and firm performance outcomes which we refer to entrepreneurial outcomes is.

We now present the outcome of an empirical investigation of entrepreneurial intensity and its influence on entrepreneurial outcomes. The dimensions of entrepreneurial intensity are: entrepreneurial mindset (EM), support for innovation (SI), rules of innovation (RI) and intrapreneurial environment (IE). We first develop a reliable measurement instrument for the constructs in the Kenyan context then we proceed to test the relationships.

**Operational definition of terms and concepts**

*Corporate entrepreneurship:* Multiple internal and external ventures in which an organisation is involved for purposes of enhancing its performance.
Entrepreneurial intensity: The extent to which an organisation adopts a mindset, supports innovation and has enforceable guidelines that work toward promotion of organizational renewal.

Entrepreneurial mindset: A set of beliefs and assumptions held by someone, a group of people or an entire organisation which creates an outlook which causes them to act in a certain way (Pisapia, 2009) in the promotion of entrepreneurship including setting and pursuing clear goals.

Intrapreneurial environment: An organizational disposition that encourages members to engage in all activities required to enhance entrepreneurship within that organisation.

Support for innovation: The way an organisation encourages behaviors that lead to creation of new products and services and commercialization of these products or services.

Rules of innovation: Guidelines that an organization can follow in keeping its entrepreneurial spirit and activity alive.

Entrepreneurial outcomes: performance that is achieved arising from the practice of entrepreneurship within and by the firm.

THEORY AND HYPOTHESIS

In this section, we present a review of literature on the key concepts in this study namely entrepreneurial intensity, entrepreneurial mindset, support for innovation, rules for an innovative environment, entrepreneurial environment, and entrepreneurial outcomes. The key theoretical orientation is that entrepreneurial intensity directly influences organisational performance.

Entrepreneurial intensity

The concept of “degrees of entrepreneurship” was first introduced by Cooper and Dunkelberg (1986) to illustrate how the different ways of becoming a business owner exhibited different levels of entrepreneurial intensity. More recently, Davidsson (2004), built on this idea and stressed the importance of studying “why, when and how do individuals, organizations, regions, industries, culture, nations (or other units of analysis) differ in their propensity for the discovery and exploitation of new venture ideas” (Davidsson, 2004, p. 29).

In this study, entrepreneurial intensity construct comprises four dimensions, namely entrepreneurial mindset (EM), support for innovation (SI), rules for an innovative environment (RI), and intrapreneurial environment (IE). Though there is no single accepted definition of CE, a healthy intrapreneurial (entrepreneurship is one of the CE definitions) climate requires the evaluation of rewards, management support, time resources, macro-level organizational structures, and acceptance of risks (Marvel et al., 2007).

Entrepreneurial mindset

Mindset drives every aspect of our lives, from work to sports, from relationships to parenting (Dweck, 2006). It refers to a set of beliefs and assumptions held by someone, a group of people or an entire
organisation which creates an outlook which causes them to act in a certain way (Pisapia, 2009). Consistent with this view, Dweck (2006) posits that the world is divided between people who are open to learning and those who are closed to it; and this trait (Pisapia, 2009, p.38) “affects everything from your worldview to your interpersonal relationships”. Just like people, organizational mindset will determine whether an organisation can achieve success in the face of a dynamic business environment or not because the mindset will dictate the choices it makes regarding the direction of the business. Examples of indicators of entrepreneurial mindset are existence of set explicit goals, creation of a system of feedback and positive reinforcement; and emphasizing individual responsibility. Consistent with this argument, we propose the first hypothesis:

**Hypothesis 1. Entrepreneurial mindset directly and positively influences entrepreneurial outcomes of a firm**

**Support for an innovative environment**

Depending on the perspective taken, innovation can be perceived as either the firm performance achieved through entrepreneurial behavior, or as the grounds on which entrepreneurial behavior grows (Lassen, n.d.). According to Hannan and Freemann (1984 cited in Luokkanen & Rabetino, 2005), organizational changes can be divided into two types, which both include strategic elements: core feature changes (such as stated goals, forms of authority, core technology, and marketing strategy) and peripheral feature changes (for instance, horizontal and market-extension mergers, joint ventures, and interlocking directorates). These changes are necessary when an organisation is faced with the need for frame-breaking change which leads to radical innovations or for frame-sustaining change which may lead to incremental innovations such as modifications to products, repositioning among others (Pisapia, 2009). These changes must be supported by firms otherwise there will be little success in attainment of organizational goals.

In this study support for innovation is conceived in the context of actions such as providing ways for innovators to stay with and share their ideas in the organizations, encouraging entrepreneurial thinking, evolving quick and informal ways of accessing resources to try new ideas; and developing ways to manage many small and experimental innovations. “In the early stages, all innovations are defined by uncertainty. “If no uncertainty exists, then an organization is simply not innovating” (Wolcott & Lippitz, 2007, p.82). Consequently, we propose the second hypothesis as follows:

**Hypothesis 2. Support for innovation directly and positively influences entrepreneurial outcomes of a firm**

**Rules for an innovative environment**

Sykes and Block (1989) suggested some guidelines which they called “rules of innovation” to assist organizations in navigating through a constantly changing environment where creativity and innovation is the rule and not an exception. Among these ‘rules’ are: encouraging action, using informal meetings whenever possible, tolerating failure and using it as a learning experience, and persisting in getting an idea to market. Indeed, organizations that are intolerant of failure do not support experimentation yet this is necessary for bringing about innovations. Consistent with the role that adherence to laid down rules for an innovative environment plays in improving firm performance, we propose the third hypothesis:
Hypothesis 3. Implementation of rules for an innovative environment directly and positively influences entrepreneurial outcomes of a firm

Intrapreneurial environment

Conditions that can cause an individual, a group of people and ultimately the whole organisation to engage in entrepreneurial activities such as creativity, opportunity identification and exploitation are considered to be an ‘entrepreneurial environment’. Early identification of potential intrapreneurs, top management sponsorship of intrapreneurial projects, and creation of both diversity and order in strategic activities are some of the conditions that comprise an entrepreneurial environment in an organisational setting (e.g. Kuratko, 2004; Wyk & Adonis, 2010). Our fourth hypothesis deals with the influence of an entrepreneurial environment on entrepreneurial outcome.

Hypothesis 4. Existence of an intrapreneurial environment directly and positively influence the performance of a firm

Entrepreneurial outcomes

Organisational effectiveness (OE) has been widely discussed in literature and there is no agreement on its definition. However, one of the perspectives to its understanding is the framework suggested by Quinn and Rohrbaugh (1983, 1988) which is based on Campbell’s (1977) initial criteria. They conceptualised organisational effectiveness and created three axes of competing values that reflect the paradoxes of real-world management: focus (internal-external), structure (control-flexibility), outcomes (means-ends). According to this framework, organisations can be effective if they balance these three competing value demands through creative and innovative approaches that underpin and are at the heart of any entrepreneurial activity – including corporate entrepreneurship. Some of the descriptors of organisational effectiveness are rapid commercialization of new innovations and quick adaptation to unanticipated changes.

It is suggested that entrepreneurial intensity should lead to desirable outcomes which can take the form of development of new products and services, creation a work force that can help the enterprise maintain its competitive posture, promotion of a climate conducive to high achievers and helping the enterprise motivate and keep its best people, quickly recognizing new opportunities, ability to exploit the identified/recognized opportunities; and expansion and growth of the business.

In the context of corporate entrepreneurship (CE), the argument in this study is that entrepreneurial intensity leads to positive entrepreneurial outcomes which should be reflected in the performance of the firms. CE seen as a competitive and market oriented process also includes the discovery and recognition of opportunities, information search and the acquisition and accumulation of resources (Blau & Wagner, 2010).

METHODOLOGY

Research Design and Setting

A descriptive survey of a random sample of 39 participants from firms was conducted using a structured questionnaire to collect data. The questionnaires were self-administered and were delivered to
respondents by email and through drop-and-pick later method. Research constructs were operationalised through multiple items that were discerned from literature: entrepreneurial mindset (five items), support for innovation (nine items), rules for an innovative environment (10 items), and entrepreneurial environment (five items); and entrepreneurial outcome (six items). In total there were 29 measures for independent variables and six for the dependent variable. The questionnaires were tested for reliability and validity prior to their use.

Questions on the item measures of the five research constructs were pre-coded on a seven-point Likert type scale where 1 represented “strongly disagree”, 2 was ”disagree” 3, “slightly disagree”, while 4 represented “neutral”; 5 was the code for “slightly agree”, 6 for “agree”, and 7 for “strongly agree”. Categorical questions on position/role of the participant in the organisation and on business activity were also coded with numbers as appropriate.

Since surveys often have missing data which can arise from various reasons such as due to lack of time on the part of the respondent, it is necessary that the collected data is edited and managed appropriately. Kamakura and Wedel (2000, p. 491) reported that item non-response can amount to as much as 50% of the data in marketing research. Vriens and Melton (2002) report that missing data can vary a lot variable by variable, and can be as low as 0% and as high as 80% or more (http://srmo.sagepub.com/view/the-handbook-of-marketing-research/n10.xml).

On receipt of the online questionnaires, the questionnaires were checked for completeness and the respondents requested to complete any areas that were left blank. Where it was not possible to reach the participant, the questionnaire was omitted from the analysis. Data was analysed with the help of Statistical Package for Social Scientists (SPSS) version17 to obtain descriptive statistics, correlation coefficients, regression coefficients, and reliability measures and principal component extraction was also done to obtain a parsimonious set of factors which were used in structural equation modeling.

Research Variables

The dependent variable was entrepreneurial outcome which is an antecedent of performance and was measured by, for example, observing retention of qualified staff, growth of the businesses; and identification and exploitation of new opportunities. Entrepreneurial mindset, support form innovation, rules for an innovative environment and intrapreneurial environment comprise the independent variables; these are collectively referred to as entrepreneurial intensity. The variables and their associated descriptors (or factors) are presented in Appendix I.

RESULTS AND DISCUSSIONS

The results of the analysis of data are presented in the following tables, discussed and interpreted.

Description of the participants

The means of the responses on item measures of constructs are reported in Table 1.

Table 1 Descriptive statistics
While there was slight agreement on entrepreneurial outcome and entrepreneurial mindset, there the participants reported that the support for innovation and entrepreneurial environment existed to a low extent with a mean of 3.7 on a scale of one to seven. The participants were undecided whether on the existence of the entrepreneurial intensity according to the constructs (independent variables) studied (mean = 4.03; neutral). In a decreasing order, the disposition of the firms on the four dimensions of entrepreneurial intensity is entrepreneurial mindset (mean = 5.1), rules for innovation (mean = 4.4), support for innovation (mean = 3.96) and lastly intrapreneurial environment (mean = 3.7). There were no respondents from tourism and hotel industries.

**Reliability tests**
Testing for reliability and validity for data collection instrument is crucial in ensuring that the data collected is credible. Both internal consistency (Cronbach alpha) and convergent validity (squared multiple correlation, SMC) were investigated for the data collection instruments. The results of reliability tests are presented in Table 2.

Table 2 Reliability tests

<table>
<thead>
<tr>
<th>Item-TOTAL Statistics</th>
<th>Scale Mean</th>
<th>Scale Variance</th>
<th>Corrected Item</th>
<th>SMC</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrepreneurial mindset</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EM1</td>
<td>15.82</td>
<td>11.26</td>
<td>0.28</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>EM2</td>
<td>16.79</td>
<td>7.64</td>
<td>0.45</td>
<td>0.22</td>
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</tr>
<tr>
<td>EM3</td>
<td>16.10</td>
<td>10.04</td>
<td>0.35</td>
<td>0.23</td>
<td>0.594</td>
</tr>
<tr>
<td>EM4</td>
<td>17.36</td>
<td>5.55</td>
<td>0.51</td>
<td>0.29</td>
<td></td>
</tr>
<tr>
<td>Support for innovation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SI1</td>
<td>20.81</td>
<td>43.21</td>
<td>0.56</td>
<td>0.35</td>
<td></td>
</tr>
<tr>
<td>SI2</td>
<td>19.73</td>
<td>41.26</td>
<td>0.74</td>
<td>0.60</td>
<td></td>
</tr>
<tr>
<td>SI3</td>
<td>20.00</td>
<td>38.39</td>
<td>0.77</td>
<td>0.70</td>
<td>0.860</td>
</tr>
<tr>
<td>SI4</td>
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<td>42.47</td>
<td>0.68</td>
<td>0.58</td>
<td></td>
</tr>
<tr>
<td>SI5</td>
<td>20.84</td>
<td>39.31</td>
<td>0.72</td>
<td>0.56</td>
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</tr>
<tr>
<td>SI6</td>
<td>21.57</td>
<td>46.47</td>
<td>0.43</td>
<td>0.31</td>
<td></td>
</tr>
<tr>
<td>Rules for innovation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RI1</td>
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<td>56.44</td>
<td>0.53</td>
<td>0.39</td>
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</tr>
<tr>
<td>RI2</td>
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<td>51.28</td>
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<td>RI3</td>
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<td>0.65</td>
<td>0.780</td>
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<td>0.37</td>
<td>0.45</td>
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<tr>
<td>RI5</td>
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<td>50.23</td>
<td>0.58</td>
<td>0.42</td>
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<tr>
<td>RI6</td>
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<td>51.02</td>
<td>0.51</td>
<td>0.46</td>
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</tr>
<tr>
<td>RI7</td>
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<td>51.83</td>
<td>0.44</td>
<td>0.40</td>
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</tr>
<tr>
<td>RI8</td>
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<td>50.80</td>
<td>0.50</td>
<td>0.40</td>
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</table>
Intrapreneurial environment

<table>
<thead>
<tr>
<th></th>
<th>IE1</th>
<th>IE2</th>
<th>IE3</th>
<th>IE4</th>
<th>IE5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15.55</td>
<td>15.42</td>
<td>14.61</td>
<td>15.16</td>
<td>14.84</td>
</tr>
<tr>
<td></td>
<td>31.17</td>
<td>30.14</td>
<td>29.38</td>
<td>29.00</td>
<td>26.95</td>
</tr>
<tr>
<td></td>
<td>0.62</td>
<td>0.85</td>
<td>0.75</td>
<td>0.72</td>
<td>0.89</td>
</tr>
<tr>
<td></td>
<td>0.42</td>
<td>0.74</td>
<td>0.63</td>
<td>0.57</td>
<td>0.79</td>
</tr>
</tbody>
</table>

Entrepreneurial outcome

<table>
<thead>
<tr>
<th></th>
<th>EO1</th>
<th>EO2</th>
<th>EO3</th>
<th>EO4</th>
<th>EO5</th>
<th>EO6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>33.58</td>
<td>32.12</td>
<td>35.64</td>
<td>29.51</td>
<td>30.37</td>
<td>29.90</td>
</tr>
<tr>
<td></td>
<td>0.72</td>
<td>0.71</td>
<td>0.71</td>
<td>0.88</td>
<td>0.86</td>
<td>0.79</td>
</tr>
<tr>
<td></td>
<td>0.73</td>
<td>0.77</td>
<td>0.61</td>
<td>0.86</td>
<td>0.87</td>
<td>0.85</td>
</tr>
</tbody>
</table>

Except for entrepreneurial mindset (EM), the Cronbach alpha values for support for innovation (SI), rules of innovation (RI), intrapreneurial environment (IE) and entrepreneurial outcome (EO) meet the acceptable criteria of at least 0.7 (Nunally, 1978). However, it is noted that the reliability value for EM is 0.594 which is close to the 0.6 threshold for a new instrument (Nunally, 1978) but it is still low. It is necessary that data be collected from a larger sample and the measures of entrepreneurial mindset be purified more to make it acceptably reliable.

Variation in responses

One-way analysis of variance (ANOVA) was done to determine whether there was significant variance in responses by participants across business activity and across position of the participant in the organisation. Results of this analysis are presented in Table 3 and Table 4 respectively.
Table 3 One-way ANOVA for business activity

### ANOVA

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Entrepreneurial Mindset (EM)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>2.54</td>
<td>6</td>
<td>0.42</td>
<td>0.59</td>
<td>.735</td>
</tr>
<tr>
<td>Within Groups</td>
<td>22.91</td>
<td>32</td>
<td>0.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>25.45</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Support for Innovation (SI)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>3.57</td>
<td>6</td>
<td>0.60</td>
<td>0.51</td>
<td>.795</td>
</tr>
<tr>
<td>Within Groups</td>
<td>37.29</td>
<td>32</td>
<td>1.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>40.87</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rules for innovation (RI)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
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<td>6</td>
<td>1.36</td>
<td>1.96</td>
<td>.102</td>
</tr>
<tr>
<td>Within Groups</td>
<td>22.20</td>
<td>32</td>
<td>0.69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>30.35</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Entrepreneurial Environment (EE)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>13.38</td>
<td>6</td>
<td>2.23</td>
<td>1.30</td>
<td>.284</td>
</tr>
<tr>
<td>Within Groups</td>
<td>54.70</td>
<td>32</td>
<td>1.71</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>68.08</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Entrepreneurial outcome (EO)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>12.36</td>
<td>6</td>
<td>2.06</td>
<td>1.93</td>
<td>.107</td>
</tr>
<tr>
<td>Within Groups</td>
<td>34.25</td>
<td>32</td>
<td>1.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>46.61</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

According to these results the responses were independent of the business activity of the participants since the variance is not significant between and within the groups ($p > 0.05$).
Table 4 One-way ANOVA for position in firm

<table>
<thead>
<tr>
<th>ANOVA</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrepreneurial Mindset (EM)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>5.49</td>
<td>3</td>
<td>1.8</td>
<td>3.21</td>
<td>.035</td>
</tr>
<tr>
<td>Within Groups</td>
<td>19.96</td>
<td>35</td>
<td>0.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>25.45</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Support for Innovation (SI)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>7.73</td>
<td>3</td>
<td>2.6</td>
<td>2.72</td>
<td>.059</td>
</tr>
<tr>
<td>Within Groups</td>
<td>33.14</td>
<td>35</td>
<td>0.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>40.87</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rules for innovation (RI)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>4.45</td>
<td>3</td>
<td>1.5</td>
<td>2.01</td>
<td>.131</td>
</tr>
<tr>
<td>Within Groups</td>
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<td>35</td>
<td>0.7</td>
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<td></td>
</tr>
<tr>
<td>Total</td>
<td>30.35</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intrapreneurial Environment (IE)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>10.82</td>
<td>3</td>
<td>3.6</td>
<td>2.20</td>
<td>.105</td>
</tr>
<tr>
<td>Within Groups</td>
<td>57.26</td>
<td>35</td>
<td>1.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>68.08</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entrepreneurial outcome (EO)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>2.72</td>
<td>3</td>
<td>0.9</td>
<td>0.72</td>
<td>.544</td>
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<tr>
<td>Within Groups</td>
<td>43.88</td>
<td>35</td>
<td>1.3</td>
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<td></td>
</tr>
<tr>
<td>Total</td>
<td>46.61</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

On the whole there was no significant variation in the reporting by the participants on all variables except on entrepreneurial mindset (p<0.05). The results imply that the perception of entrepreneurial mindset varied according to the position of the participants in the firms.

**Relationship between variables**

It was hypothesized that the dimensions of entrepreneurial intensity were each directly related with entrepreneurial outcome. Pearson correlation analysis was done to investigate the relationship between research constructs; the results are presented in Table 5.
Table 5 Correlation analysis

<table>
<thead>
<tr>
<th>Correlations</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
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<td>Entrepreneurial Mindset (EM)</td>
<td>Pearson Correlation</td>
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<td></td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>39</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Support for Innovation (SI)</td>
<td>Pearson Correlation</td>
<td></td>
<td>.663**</td>
<td>1</td>
<td></td>
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<tr>
<td>Sig. (2-tailed)</td>
<td></td>
<td>.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>39</td>
<td>39</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rules for innovation (RI)</td>
<td>Pearson Correlation</td>
<td>.632**</td>
<td>.727**</td>
<td>1</td>
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</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td></td>
<td>.000</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
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<td>39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intrapreneurial Environment (IE)</td>
<td>Pearson Correlation</td>
<td>.676**</td>
<td>.749**</td>
<td>.766**</td>
<td>1</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td></td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>39</td>
<td>39</td>
<td>39</td>
<td>39</td>
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</tr>
<tr>
<td>Entrepreneurial outcome (EO)</td>
<td>Pearson Correlation</td>
<td>.683**</td>
<td>.490**</td>
<td>.519**</td>
<td>.630**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td></td>
<td>.000</td>
<td>.002</td>
<td>.001</td>
<td>.000</td>
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<td>39</td>
<td>39</td>
<td>39</td>
<td>39</td>
</tr>
</tbody>
</table>

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

Multi-collinearity occurs when independent variables overlap with respect to the information they provide in explaining the variation in dependent variables. The correlations between the independent constructs were high but below the threshold for multi-collinearity of 0.8 and were all significant ($p < 0.01$). All correlation coefficients among independent variables were very significant ($p < 0.001$). Similarly, the correlation coefficient between entrepreneurial mindset and entrepreneurial outcome ($r = 0.683$) and intrapreneurial environment and entrepreneurial outcome ($r = 0.630$) were significant very significant ($p < 0.001$). The correlation between rules for innovative environment ($r = 0.519$) and entrepreneurial outcome and between support for innovation ($r = 0.490$) and entrepreneurial outcome were both significant ($p < 0.01$).

According to these results, there is a positive and significant relationship between entrepreneurial mindset, support for innovation, and implementation of rules for an innovative environment,
entrepreneurial environment and entrepreneurial outcome. These results confirm all the research hypotheses.

Influence of entrepreneurial intensity on performance

Multiple linear regression analysis using ordinary least squares (OLS) method was done to determine the relative influence of entrepreneurial intensity dimensions and entrepreneurial outcome. The results are presented in Table 6.

Table 6: Coefficients

<table>
<thead>
<tr>
<th>Coefficients*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Model</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>1 (Constant)</td>
</tr>
<tr>
<td>Entrepreneurial Mindset(EM)</td>
</tr>
<tr>
<td>Support for Innovation(SI)</td>
</tr>
<tr>
<td>Rules for innovation(RI)</td>
</tr>
<tr>
<td>Intrapreneurial Environment (IE)</td>
</tr>
</tbody>
</table>

a. Dependent Variable: Entrepreneurial outcome) EO

The coefficients indicate a negative but insignificant relationship between both support for innovation ($\beta = -0.142, p = 0.0497$) and entrepreneurial outcome; and rules for an innovative environment ($\beta = -0.001, p = 0.997$) and entrepreneurial outcome. The results suggest that there is insufficient support for innovation at the studied firms and that the rules for an innovative environment are not adequately implemented at the firms. These results are consistent with the descriptive statistics where the mean scores on support for innovation (mean is 3.96) and for rules for an innovative environment (mean is 4.4) were low. These mean scores indicate the participants were undecided whether indeed there was support for innovation or an implementation of rules for an innovative environment existed in the firms. However, it also important to note that the correlation between support for innovation and rules for innovative environment is high ($r = 0.727$) and significant ($p < 0.001$). This may partly explain the observed behavior in the regression model.

Due to the inconsistency between the sign correlation coefficients and the regression coefficients, support for innovation and rules for an innovative environment; and that the corresponding regression coefficients
are insignificant, the two variables were dropped and the research model re-estimated. The reduced regression model which excludes the insignificant variables is presented in Table 7.

**Table 7: Reduced model**

<table>
<thead>
<tr>
<th>Coefficients&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
</tr>
<tr>
<td>(Constant)</td>
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<td>.852</td>
</tr>
<tr>
<td>Entrepreneurial Mindset(EM)</td>
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<td>.212</td>
</tr>
<tr>
<td>Intrapreneurial Environment (IE)</td>
<td>.256</td>
<td>.130</td>
</tr>
</tbody>
</table>

<sup>a. Dependent Variable: Entrepreneurial outcome) EO</sup>

The coefficient of determination was 0.52 which implies that entrepreneurial mindset and entrepreneurial environment explain 52% of the variation in entrepreneurial outcome among the studied firms. Only entrepreneurial mindset significantly influence entrepreneurial outcome at p = 0.05; intrapreneurial environment is only significant at p<0.1. These results suggest that the regression analysis results are not stable; further found that entrepreneurship mindset alone accounted for 46.6% (\( R^2 = 0.466 \)) of the variation in entrepreneurial outcome.

**Principal component analysis**

Principal components analysis (PCA) which is a procedure for finding hypothetical variables (components) which account for as much of the variance in multidimensional data as possible (Davis 1986; Harper 1999) was used to extract principal factors from among the multiple factors that were used to operationalise the research constructs. These new variables are linear combinations of the original variables. The principal components are reported in Table 5.

**Table 8: Principal components**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Extracted items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrepreneurial Mindset(EM)</td>
<td>EM4, EM5</td>
</tr>
</tbody>
</table>
Support for Innovation (SI)  SI3, SI9, SI7
Rules for an innovative environment (RI)  RI6, RI2, RI7
Intrapreneurial Environment (IE)  IE5
Entrepreneurial outcome (EO)  EO4

As presented in Table 8, two components were extracted for entrepreneurial mindset ("do not punish failures [EM4]" and "give rewards based on results [EM5]"); and three components for support for innovation ("has evolved quick and informal ways to access the resources to try new ideas [SI3]", "it is easy to form functionally complete autonomous teams in the firm’s corporate environment [SI9]", and "people are they constantly stopping to explain their actions and ask for permission [SI7]"). Further, three components for rules for an innovative environment ("plan the physical layout of the enterprise to encourage informal communication [RI6]", "use informal meetings whenever possible [RI2]"; and "expect clever bootlegging of ideas—secretly working on new ideas on company time as well as personal time [RI7]"); one for entrepreneurial environment (development of collaboration between intrapreneurial participants and the organization at large [IE5]); and one component for entrepreneurial outcome ("promote a climate conducive to high achievers and help the enterprise motivate and keep its best people [EO4]").

**Structural Equation model**

The extracted factors were used to model the relationship between entrepreneurial intensity dimensions factors and entrepreneurial outcome. Table 9 presents the resulting model diagnostics.

**Table 9: Model diagnostics**

<table>
<thead>
<tr>
<th>Model</th>
<th>NPAR</th>
<th>CMIN</th>
<th>DF</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default model</td>
<td>14</td>
<td>12.044</td>
<td>14</td>
<td>0.603</td>
</tr>
<tr>
<td>Saturated model</td>
<td>28</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Independence model</td>
<td>7</td>
<td>77.404</td>
<td>21</td>
<td>0</td>
</tr>
</tbody>
</table>

**RMR, GFI**

<table>
<thead>
<tr>
<th>Model</th>
<th>RMR</th>
<th>GFI</th>
<th>AGFI</th>
<th>PGFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default model</td>
<td>0.174</td>
<td>0.925</td>
<td>0.85</td>
<td>0.463</td>
</tr>
</tbody>
</table>
Baseline Comparisons

Consistent with the approach adopted by Justo, Mayedu and de Castro (2005), we provide an assessment of the goodness of fit of our proposed model, and we propose linear combinations of the entrepreneurial intensity indicators that can be used as valid proxies of the latent continuous variables in our model. Generally there is a good model fit between organisational effectiveness and motivation for KM implementation with Chi-square to degrees of freedom ratio of $0.86 < 3$ and a significance of $0.603$ which is much greater than 0.05). This implies that there is no significant difference between the full/saturated model and the parsimonious model. Further, model diagnostics showed an acceptable model fit with goodness of fit index (GFI) of 0.925 and an adjusted Goodness of fit index (AGFI) of 0.85 which are respectively above the threshold values of $\text{GFI} > 0.9$ and $\text{AGFI} > 0.8$ (Segars & Grover, 1993)

Structural equation model parameters

Slope parameter estimates for the model is presented in Figure 1 along with their standard errors.

Figure 1: Slope parameters for relationship between corporate entrepreneurial intensity and outcomes indicators.
Normed $\chi^2 = (\text{CMIN}/\text{DF}) < 3$, $p=0.603$, GFI>0.9, AGFI>0.8.

Note: Digit 1 in the SEM indicates that the parameter was fixed at a value of 1 for identification purposes only.

**Testing of hypotheses**

We proposed four hypotheses for this study. We then tested them based on the results of correlation analysis; all the hypotheses were supported as follows:

*Hypothesis 1* was supported by the result of correlation analysis between *entrepreneurial mindset* and *entrepreneurial outcome* ($r = 0.683$, $p< 0.001$, [Table 5]).

*Hypothesis 2* was supported by the result of correlation analysis between *support for innovation* and *entrepreneurial outcome* ($r= 0.490$, $p= 0.002<0.01$[Table 5]).

*Hypothesis 3* was supported by the result of correlation analysis between *rules for an innovative environment* and *entrepreneurial outcome* ($r= 0.519$, $p= 0.001<0.01$[Table 5]).

*Hypothesis 4* was supported by the result of correlation analysis between *entrepreneurial environment* and *entrepreneurial outcome* ($r = 0.630$, $p<0.001$[Table 5]).

The structural equation model path coefficients, significance and direction are as hypothesised, positive and significant suggesting that entrepreneurial mindset, support for innovation and entrepreneurial environment directly influence entrepreneurial outcomes.

**CONCLUSION**

**Summary of findings**

We reviewed literature and identified four continuous latent variables that determine the corporate entrepreneurial intensity of organisations, namely *entrepreneurial mindset*, *support for innovation*, *rules for an innovative environment* and *entrepreneurial environment*. We then operationalised these constructs using multiple measures as proxies and explored them on a Kenyan sample.

We found that there was a low corporate entrepreneurial intensity which appeared to result in moderate performance – entrepreneurial outcome. There was also a positive and significant relationship between each of the four variables and entrepreneurial outcome. However, the mean scores on a scale of one to seven for all the factors were only four implying that the disposition of the explored firms was low. Consequently, it is suggested that the corporate entrepreneurial intensity of the firms on these factors be improved in order to achieve better performance outcomes.

Further, we developed a valid and reliable instrument to measure *support for innovation* (Cronbach alpha, $\alpha =0.860$, *rules for an innovative environment* ($\alpha = 0.780$), *entrepreneurial environment* ($\alpha = 0.900$) and *entrepreneurial outcome* ($\alpha = 0.920$). The instrument for *entrepreneurial mindset* just almost met the criteria for a reliable new instrument ($\alpha = 0.6$).

Lastly, Mulaik’s (1993) suggests that the factor structures based on theory should be set up prior to conducting a factor analysis which would prove or disprove that theory. Consistent with this suggestion,
we reviewed literature and identified factors (descriptors) of the research variables (constructs). We started with the following factors: entrepreneurial mindset (five), support for innovation (nine), rules for an innovative environment (10), entrepreneurial environment (five) and entrepreneurial outcome (six). However, since the nature of this research was exploratory, the data ultimately suggested the factor structure comprising a total of 29 factors (Table 2) from the original 35 identified from literature. The factors were further reduced to a parsimonious 10 factors using principal factor extraction (Table 8) comprising entrepreneurial mindset (two), support for innovation (three), rules for an innovative environment (three), entrepreneurial environment (one) and entrepreneurial outcome representing all the five continuous latent variables (constructs) in the study.

**Implication of the findings**

We found that there was inadequate support for innovations and that the entrepreneurial environment was not conducive for corporate entrepreneurship (CE) among the surveyed firms. Similarly the CE intensity was low. The practical implication is that firms need to improve across all the dimensions of CE intensity namely entrepreneurial mindset by setting appropriate goals, support for an innovative environment by providing resources and encouraging experimentation among other actions targeting rules for innovation and creation of an entrepreneurial environment in order to improve the performance outcomes.

**Limitations and suggestion for further study**

Since this was an exploratory study, the results are not conclusive for two reasons: the sample that was surveyed was small and this limits the generalizability of the results and that for some firms there was a single respondent and this introduces response bias. In view of these limitations, it is suggested that more participants be included in the study and that multiple respondents be obtained from each firm in order to improve the generalizability of the findings. In addition, the inconsistency between the signs of the correlation coefficients and regression coefficients between support for innovation and entrepreneurial outcome; and between rules for an innovative environment and entrepreneurial outcomes need to be investigated further using a larger sample. Further, since we found measures of variables to be reliability and valid, a study focussing on specific sectors the economy such as in banks, and in telecommunications of using the developed instruments will benefit firms in the studied sectors.

**REFERENCES**


FACTORS CONTRIBUTING TO THE EMPLOYEE TURNOVER IN PHARMACEUTICAL COMPANIES IN KENYA: A CASE STUDY OF RANBAXY LABORATORIES LIMITED

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Abstract

The objective of the study was to investigate employee turnover problem in Pharmaceutical industries in Kenya with a case study of Ranbaxy Laboratories limited. The study specifically investigated on staff retention measures utilized by the management, whether exit interviews are conducted, and the competitiveness of reward program and whether the conduciveness of the work place environment as factors that may contribute to workforce turnover in this sector.

The study adopted a descriptive research design to identify the employee turnover factors and a sample size of 50 employees were selected using a simple random sampling since the population for the purpose of this study was regarded as homogeneous. The study collected both primary and secondary data using semi-structured questionnaire and review of empirical and theoretical literatures respectively. The instruments were pilot tested for reliability checks. Statistical software SPSS was used for data analysis and generation of charts and graphs. Analysis took both descriptive and inferential dimensions where some elements of measure of central tendency and regression analysis were employed respectively.

The study revealed that organization lacked effective staff retention strategies, where exit interviews were not regularly and effectively conducted, the employed reward program was not competitive and existence of unfriendly work place environment influenced most employees to leave the organization. Thus it was concluded that lack of effective strategies to manage these factors influenced most pharmaceutical companies to continue experiencing high staff turnover rates that lower the total organization productivity and increase running costs by recurrent recruitment costs, production disrupting and broken clients relationships. The study recommended that these factors should be part of the organization business strategy rather than being left to managers to act.

Key Words: Employee turnover, Retention strategies, Exit interviews, Work environment and, Compensation.

Introduction

Turnover is the rate at which workers are replaced with new staff members in an organization. Turnover rate is calculated by dividing the number of resignations by number of staff in a given period of time usually a calendar year. Gberevbie, (2008) refers to frequent labor turnover as a state of affairs in an organization whereby employees for reasons best known to them based on their perception of personnel policies and practice of an organization resign or leave their job. Employees switch organizations for several reasons. These reasons could be either organization related or job related. Managers would readily agree that retaining the top performer’s results in higher customer satisfaction, quality improvement, effective succession planning and a considerable increase in organization knowledge and learning. Smith
(2001) discusses companies with work environments that attract and retain people and where people are willing to give their best. These environments aren’t expensive. In fact, they save money. In most cases, they improve retention and productivity without lavish salaries or bonuses. And they certainly lower the expense of continually hiring and training new people. Estimates suggest that separation, replacement and training costs are 1.5 to 2.5 time’s annual salary for each person who quits, which means that the departure of a middle manager usually costs an organization around $75,000 (Dalton et al., 1993). Employees who perceive relationships with customers provide better service. Customers who receive better service express fewer complaints and thereby create fewer problems for employees. Employees in turn react more favorably to encounters with customers. These reactions result in better service which again leads to higher customer satisfaction. Providing adequate health care to the populations remains a major challenge for governments in Africa. Access of drugs is dependent on both affordability and quality. The pharmaceutical sector is Kenya is dominated by multinational companies and generic companies who either import ready products or locally manufactured products.

The domestic pharmaceutical industry shows considerable strength and has significant opportunities for growth. Imported generics make 28% of the market share (UNIDO survey, 2009). The reports go on to say exports to Tanzania and Uganda are growing and still more potential for Kenya to establish itself as a major source in Southern Sudan. For purpose of this study, the researcher focused on Ranbaxy Laboratories Limited, an integrated, research based, international pharmaceutical company producing a wide range of quality, affordable generic medicines, trusted by healthcare professionals and patients across geographies, the company has a unique model of applauding and recognizing individual and team effort through (APPRECIATE) program designed to motivate performance (www.ranbaxy.com). The Company’s business philosophy is based on delivering value to its stakeholders by constantly inspiring its people to innovate, achieve excellence and set new global benchmarks.

Statement of the Problem

The private health sector in Kenya contributes around 13% to the GDP and has largely remained unchanged since 1995 (KPPB, 2007). Out of this, Pharmaceutical industries account for a whopping 10.3% in its contribution to the GDP. Although on average this is seen as stagnation, it is considered as one of the largest in East and Central Africa. Nevertheless, due to increased development of conventional medicines and awareness about preventive culture in the urban population, the industry has registered a high level of growth and innovation that has turned the sector into a vibrant business domain. This has seemingly attracted the attention of many entrepreneurs resulting to massive investment both at large and retail scale levels.

Empirical studies (Wilson and Peel, 1990) on pharmaceutical industries have indicated that the industry is characterized by a stiff competition. In Kenya, the proliferations of the biotechnology marketplace have greatly revolutionized the industry operations. Organizations are increasingly at risk of losing key sales personnel to competitors and new market entrants. In a recent benchmarking study, Best Practices found that the 2006 aggregate annual turnover of employees for the pharmaceutical and biotech industries in Kenya is 14.2%. According to (Paul and Anantharaman, 2003), increasing turnover of sales people is particularly problematic for the larger pharmaceutical companies as smaller market entrants, particularly biotechnology firm keep on attracting their employees. This resulted into massive exodus of employees.
from the pharmaceutical subsector into these upcoming biotechnology firms since the skills required is the same in both sub sector.

This has evidently affected the Pharmaceutical industries since they responded to these pressures by focusing on its innovative segment and increasing its R&D expenditures by means of in-house innovation, technological and therapeutic market specialization, and mergers and acquisitions of companies within and outside the pharmaceutical industry resulting to declining profits and stagnation (Kundu & Malhan, 2007). Most studies (Delaney and Huselid,1996) done of the employee turnover sought to establish preliminary indices for employee turnover situations in different subsector hence making many statistics that describes the turnover of employees as abundant. In spite of having many studies undertaken on staff turnover in pharmaceutical companies, none of the studies have managed to come up with an effective solution on how pharmaceutical companies should employ effective staff retention measures, conduct exit interviews, employ effective rewards programs and provide better working environment. This has therefore created a wide knowledge gap on staff turnover management and hence created a need to conduct a study on factors contributing to the employee turnover in pharmaceutical companies in Kenya.

Ranbaxy Laboratories Limited, which is one of the largest and leading chains in the pharmaceutical laboratories with highest turnover according to the preliminary indices, (Delaney and Huselid, 1996) its recent employee satisfaction survey of 2009 indicated that 50% of the employees felt they would not be in the company for the next two years and 69% felt their intention to quit is influenced by management not peers. Considering Ranbaxy Laboratories Limited as a case, this study therefore sought to investigate the factors that contribute to employee turnover in pharmaceutical industries in Kenya.

OVERALL OBJECTIVE OF THE STUDY

The general objective of the study is to investigate factors contributing to the employee turnover in pharmaceutical companies in Kenya, a case study of Ranbaxy Laboratories Limited.

SPECIFIC OBJECTIVES

The study aimed to:-

To investigate employee retention actions as a factor contributing to employee turnover in Ranbaxy Laboratories Limited.

To find out whether exit interviews affect employee turnover in Ranbaxy Laboratories Limited.

To find out the competitiveness of reward program as a factor contributing to employee turnover in Ranbaxy Laboratories Limited.

To establish whether the work place environment affect employee turnover in Ranbaxy Laboratories Limited.

Research Question

The study sought answers for the following questions:
Does employee retention actions as a factor contributing to employee turnover in Ranbaxy Laboratories Limited.

Do exit interviews affect employee turnover in Ranbaxy Laboratories Limited.

Does competitiveness of reward program as a factor contributing to employee turnover in Ranbaxy Laboratories Limited.

Do the workplace environment affect employee turnover in Ranbaxy Laboratories Limited.

**Scope of the Study**

In the literature, the variables that influence the turnover of the employees in an organization is vast. Since human resource management is also a socially complex process which is intertwined with an array of organizational factors, it further diversifies the reasons as to why employees leave their organizations. Thus, this study focused only on retention actions employed by the organization, exit interviews, competitiveness of reward program and status of workplace environment as factors influencing the employee turnover investigated. The study will limit itself to the case of Ranbaxy Laboratories Limited only.

**Literature Review**

Both the theoretical and empirical reviews on employee turnover and its variables were conducted. This resulted into an array of constructs (retention strategy, exit interviews, reward strategy, workplace environment and employee turnover) and their relationships which was conceptualized in the following schematic diagram below. This was used as the Conceptual framework which guided the study.

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**Conceptual Framework**

- **Independent Variables**
  - Retention Strategy
  - Exit Interviews
  - Reward Strategy
  - Workplace Environment

- **Dependent Variable**
  - Employee Turnover

---

**Research Methodology**

This chapter focused on research design, sampling, instrumentation, data collection, data analysis and interpretation.

**Research Design**
The research adopted descriptive approach. This is because, the study aim to describe employee turnover phenomena using different set of independent variable cluster. Descriptive research is used to obtain information concerning the current status of the phenomena to describe what exists, with respect to variables or conditions in a situation (Mugenda and Mugenda, 1999).

**Population and Sampling**

The study focused on pharmaceutical industry in Kenya which is the target population regarded as the larger population on which the findings were generalized to. The study population was employees of Ranbaxy Laboratories Limited. A target population is the total collection of elements about which one wishes to make some inferences (Mugenda and Mugenda, 1999). Stratified random sampling was used to select a sample size of 50 employees out of the total 75 employee of the study population. Since most variables under investigations are related to motivation, stratification is necessary to consider the different cadres of employees which pose motivation implications. This is equivalent to 66.67% sample size. According to Dempsey, (2003) a sample size of 50% is appropriate for generalization of the gathered findings in descriptive research. This therefore surpasses the threshold suggested by Dempsey, (2003) for generalization purposes and thus, regarded as adequate. The list sourced from the Human Resource department of Ranbaxy Laboratories Limited was used as a sampling frame.

**Data Collection and Instrumentation**

Primary data collection was through the questionnaire using a semi structured questionnaire that was interviewer-administered. Secondary data was through review of the theoretical and empirical literatures sourced from books and scholarly journals, Internet and conference papers among others.

**Pilot Test**

A pilot study was conducted to test reliability of the instrument (questionnaire). This involved selecting 2 respondents from each strata and issuing them with the questionnaires. Data was obtained using the questionnaires and after evaluating and identifying the response, reliability analysis using Kunder-Richardson 20 formulae was conducted. The results were applied to modify or drop the items whose thresholds were low. Data reliability also plays an important role towards generalization of the gathered data to reflect the research objective.

**Data Analysis and Presentation**

Descriptive statistics data analysis method was applied to analyze quantitative data where data was scored by calculating the percentages and means. The Statistical Package for Social Sciences (SPSS) computer software was used specifically for the purpose of analyzing the quantitative data and presenting it in form of table, figures and graphs. Linear Regression analysis was also used to show the relationship between research variables. Qualitative data analysis method was employed to analyze qualitative data gathered using open end questions.

**Summary of the Major Findings**

**Response Rate**
The response rate was 80%. This is regarded adequate in line with the literature by Mugenda and Mugenda, (2003) which recommends 70% as a good response rate in descriptive studies.

Respondents Demographic Profile

Majority of the respondents (50%) were within the age bracket 31-40 years, 24% within the age bracket of 18-30, and 13% within the age bracket of 41-50 years and 51 years and above. On the education level, majority of the respondents (62%) had attained university education level and 25% had attained college education level. Regarding working experience most of the respondents (35%) had a working experience of 3-5 years, 25% 6-7 years, 18% 3-5 years, 20% had a working experience of less than 2years and 20% had a working experience of 8 years and above. This indicated that most of the study respondents were experienced and educated and hence expected to give relevant information for this study.

Employee Retention Strategies

Majority (58%) of the respondents indicated the organization lacked effective employee retention strategies while 42% felt otherwise. The 58% felt management lacked understanding on retention strategies. This concurs with Ruth (2004) that managers who have greater understanding on causes of employee turnover are likely to employ effective employee retention strategies in order to retain competent and most skilled employee. Further 80% of the respondents felt that the strategies employed do not minimize employee turnover. Using Likert scale method rating 4 - very effective,3-effective,2-Moderate and 1 not effective 5-very effective, (50%) rated the effectiveness of the employed employee retention strategies as being moderate, 18% effective, 20% not effective and 12% very effective. From this we can infer majority of the employee rated average. This concurs with findings by Baker (2004) that organization that lacks very effectives employee retention strategies faces cases of high employee turnover rates that contributes to loss of the most skilled and competent employee. The low standard deviation indicates that there was negligible error during the analysis and the variance results demonstrates that respondents gave similar answers as the answers variation was close to each other and hence giving a clear indication that the answers given were reliable. From the findings, it can be concluded that lack of effective employee retention strategies contributed to high employee turnover rates in the organization.

Exit Interviews

Majority of the respondents (68%) were of the opinion that employees leaving the organization were not subjected to exit interviews. However, 32% of the respondents expressed that the employees were subjected to exit interviews. This agreed with suggestion by Armstrong (2006) that presence of exit interviews in organization assists human resource management to establish the core causes of high employee turnover. Concerning whether exit interviews help the organization to find out the reasons for employee turnover (83%) answered no indicating that exit interviews did not help to establish reasons why employees left the organization and (37%) felt otherwise. The majority who answered no explained that the organization lacked effective exit interview program that helped in capturing the organization problems influencing high employee turnover. Regarding the frequency of conducting exit interviews respondents (47.5%) stated that exit interviews were rarely conducted, 40% stated sometimes, 7.5% never
and only 5% who stated exit interviews were always conducted. Exit interviews were rarely conducted since the management was not conscious on the reasons contributing to high employee turnover rates and this agreed with Nelly (2002) that human resource managers who are not mindful about employees’ turnover do not carry out exit interviews and instead concentrates on employing new employees. The study hence concluded that conducting exit interviews could help human resource management in pharmaceutical to effectively manage high employee turnover rates. The table shows that a low standard deviation was obtained in all questions, indicating that the answers given were accurate. A low variance in all the questions shows that the respondents answered the questions in a similar way and hence the responses given were reliable.

**Reward Program**

The study sought to find out competitiveness of the reward program. 73% of the respondents felt the reward program was not competitive and it was one of the reasons that influenced employees to leave. This agrees with Nzuve (2007) that absence of competitive rewards in the organization lead to low level of employee motivation that influences most employee to leave the organization hence increasing the rate of employee turnover. 85% of the respondents indicated absence of competitive reward programs in the organization contributed to high employee turnover while 15% felt otherwise. As can be observed from the table a mean of 1.27 and 1.85 was obtained in the two questions indicating that organization lacked competitive reward programs and absence of competitive reward programs contributed high employee turnover rates.

**Work place Environment**

An overwhelming (80%) of the respondents felt their work environment was not conducive while 20% felt it was conducive. The majority 80% felt that the work environment contributed to employee turnover. Using Likert Scale where 5 -very large extent, 4-large extent, 3-moderate extent, 2-small extent and 1- not at all, majority of the respondents (60%) stated that work place environment contributed to employee turnover to a very large extent, 20% large extent, 10% moderate extent and 5% small extent and not at all respectively. A mean of 1.20 indicates that organization work place environment was not conducive, a mean of 1.80 shows that work place environment contributed to high employee turnover rate and a mean of 4.25 indicated that work place environment contributed to employee turnover to a large extent. A low variance and a low standard deviation demonstrate that the answers given by the respondents were accurate.

**Regression Analysis**

A regression equation to show the relationship between the independent variables and dependant variable was derived

$$Y = a + bX_1 + bX_2 + bX_3 + bX_4 + e=r^2$$

The values for $b_0, b_1, b_2, b_3$ and $b_4$ are .569, .330, .095, .160 and .132 therefore the equation

$$Y = .569+.330+.095+.160+.132$$
This indicates that there is a strong relationship between, employee retention, exit interviews, reward program, work place environment and employee turnover. A coefficient of .330 indicates that application of effective employee retention strategies reduces employee turnover by 0.330, a coefficient of .095 indicates application of exit interviews reduces employee turnover by 0.095. A coefficient of .160 presents that application of effective reward programs reduces employee turnover by 0.16. A coefficient of .132 indicates that conducive workplace environment helps to reduce employee turnover by 0.132.

**Conclusion**

Based on the findings of the study, it can be concluded that employee retention strategy was a major factor that greatly contributed to high employee turnover rates in the organization. The study also found out that one of the critical parameter of collecting data form the exiting employees, exit interviews were not regularly conducted whenever employees left the organization. And this hampered the organization human resource management to identify the core reasons that influenced employees to leave the organization. Lack of competitive reward program greatly contributed to high employee turnover rates in the organization since the organization’s reward package was not competitive and also lacks the elements of totality in its reward system. Finally it can be concluded that the organization working environment was not conducive to most of the employees and this contributed to high employee turnover. This is expected since; laboratories like workshops are characteristically identified with the workplace environments which they offer.

**Recommendations**

Employee turnover should not be left to be handled by the human resource department alone rather it should be looked at as part of the overall business strategy since human capital is one of the major factors of production. This way, factors that are causing employee turnover will be handled and top management level and action will be taken to minimize employee turnover. Thus the study suggests the need to investigate on the role played by the top management in the alleviating employee turnover investigation as necessary. The study also recommends the need for the managements to be vigilant with their exit interviews so as to get insights of why the employees are leaving while redoubling their efforts in streamlining the motivation package.

**References**


**PREFERENCE OF PUBLIC PROCUREMENT AND DISPOSAL ACT IN PROCUREMENT OF CONSTRUCTION CONSULTANCY SERVICES IN KENYA**

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**Abstract**

The Chapter 525 of the laws of Kenya (Architect and Quantity surveyors Act) has for many years spanning from independence governed the conduct of professionals in the construction industry specifically, the rules of engagement of Architects and Quantity Surveyors, their remuneration, and practice generally. This has ensured protection to the Clients through regulation of conduct of the professionals and also providing basis for solving disputes and reprimanding errant professionals. By standardizing the fees charged by the professionals in the scale of fees, the Act has fostered harmony in the industry. Despite the gains made with Cap 525, the enactment of Public Procurement and Disposal Act 2005 (PPDA Act) has seen a paradigm shift with Clients (especially public entity) preferring the Act over other legislations, for example Cap 525. There has been numerous concerns and complaints
raised in the last three years by Architectural Association of Kenya concerning the shift. The overall objective of the study was to investigate the factors contributing to the preference on the PPDA over Cap 525. The study focused on whether PPDA Act permits flexibility in pricing for consultancy services, promotes competition in bidding for consultancy services and enhances accountability in procurement of construction consultancy services.

The study employed an exploratory design to investigate the research question. The target population is the entire construction industry in Kenya. A simple random sampling was used to select 50 respondents from whom the data was collected using a semi-structured questionnaire. The data was analyzed both qualitatively and quantitatively. The study found out that the PPDA Act is believed to peg the pricing on the quality of output and consider the customer satisfaction element thus creating freedom. It is also preferred due to its customized bidding process which sets new standards and dimension of competition based on the human factor. While the Act values the government business and provides high quality services, the same magnitude is not apparent in its effort to promote accountability and objectivity among the procurement Professionals. Either the act does not engage the procurement officials at high levels of efforts. The study recommended the need for streamlined and harmonized procurement legislation that integrates both private and public procurement paradigms.

Key words: Public procurement, consultancy services, price flexibility, competitive bidding, accountability, PPDA Act

Introduction

The Public Procurement system in Kenya evolved from a crude system with no regulations to an orderly legally regulated procurement system. In the past decades, the public procurement system in Kenya has undergone significant developments. From being a system with no regulations in the 1960s, and a system regulated by Treasury Circulars in the 1970s, 1980s and 1990s, the introduction of the Public Procurement and Disposal Act (PPDA) of 2005 and the Procurement Regulations of 2006 has introduced new standards for public procurement in Kenya. In line with the country’s public procurement reform agenda, Kenya in 2006 committed itself to become one of the 22 countries participating in the pilot testing a new Methodology for Assessment of National Procurement Systems (version 4) developed by the OECD-DAC Joint Venture for Procurement. A milestone was achieved in this area with the enactment of the Public Procurement and Disposal Act, 2005 and Public Procurement and Disposal Regulations, 2006. This Act was given commencement date of 1st January 2007 via Legal notice no.171 of 29th December, 2006 (Wittig, 1999). With the enactment of the PPDA (2005) and Procurement Regulations, Kenya today has in place a sound and comprehensive legal framework for public procurement with a clear hierarchical distinction.

The PPDA, (2005) clearly establishes the procurement methods to be applied, advertising rules and time limits, the content of tender documents and technical specifications, tender evaluation and award criteria, procedures for submission, receipt and opening of tenders, and the complaints system structure and sequence. CAP 525 of Laws of Kenya provides for rules of engagement and the scale of fees for Architects and Quantity Surveyor but several public entities have tended to ignore the provisions of CAP 525 while procuring for those services (AAK 2009). The construction sector is an important sector of the economy and contributes significantly to Gross Domestic Product (GDP). The United Nations Environment Programme (UNEP) has noted that about one-tenth of the global economy is dedicated to
constructing and operating homes and offices. Kenya’s construction industry has several stakeholder comprising, Architects, Quantity Surveyors, Engineers, Contractors and Clients both Public and private.

**Statement of the Problem**

Procurement of construction consultancy services involves many professionals, colossal sums of money, and complex documentation among others. The process is very different from the normal procurement of goods and services which mostly comprises of few documents and a short period of time (Mitullah et al, 2003). In Kenya, Chapter 525 laws of Kenya stipulate conditions of engagement and scales of fees for consultancy services (Architects & Quantity Surveyors) in the construction industry. The provisions of Cap 525 have prevailed in guiding procurement of Architects and Quantity Surveyors in the public domain for many years spanning before independence. The introduction of the Public Procurement and Disposal Act (PPDA) of 2005 and the Procurement Regulations of 2006 has introduced new standards for public procurement in Kenya. The PPDA (2005) establishes the procurement methods to be applied, advertising rules and time limits, the content of tender documents and technical specifications, tender evaluation and award criteria, procedures for submission, receipt and opening of tenders, and the complaints system structure and sequence. The PPDA and Regulations cover goods, works and services for all procurement using national funds. Despite the Chapter 525 outlining how consultants (Architects and Quantity Surveyors) should be procured, in the last one year about 36 Public entities have shown some preference to the PPDA in procurement of these consultancy services (see appendix A). Owing to this, the Architectural Association of Kenya in 2009 wrote several letters to numerous public entities complaining about what is seen by many construction experts as a paradigm shift. In addition, the Ministry of Roads and Public works echoed to the outcry by reminding the various Ministries that while using PPDA they should also take into consideration the provisions of CAP 525 laws of Kenya. Appendix A of the study outlines some of the letters of Complaint by the Architectural Association of Kenya. This study therefore investigates the factors contributing to the public entities preference to the PPDA Act over other Acts regulating construction industry particularly Chapter 525 laws of Kenya.

**Overall Objective**

The aim of the study was to investigate the factors contributing to preference of PPDA (2005) on the procurement of consultancy services in the Kenyan construction industry.

**Specific Objectives**

To establish whether the PPDA Act permits flexibility in pricing of construction services

To find out whether PPDA Act promotes competition in bidding of consultancy services

To investigate whether PPDA Act enhances accountability in procurement of construction consultancy services

**Research Questions**

Does the PPDA Act permit flexibility in pricing of construction services?
Does PPDA Act promote competition in bidding for consultancy services?

Does PPDA Act enhance accountability in procurement of construction services?

**Scope of the Study**

The study focused on public procurement of consultancy services in the construction industry only. This is further limited to procurement of consultancy services as outlined in PPDA Act and Cap 525 which affect the procurement of architectural and quantity surveying services in particular. Further the study focused on the preference of PPDA Act from the perspectives of flexibility in pricing, whether the Act promotes competition in bidding and whether it enhances accountability in procurement of construction consultancy services.

**Literature Review**

**Conceptual Framework**

Conceptual Framework is defined as the result of when a researcher conceptualizes the relation between variables in the study and shows the relationship graphically or diagrammatically. It is therefore a linked set of variables that are backing up in the critical analysis. It is made of the dependent and independent variables. The dependent variable in this study is preference for Public Procurement and Disposal Act. The independent variables of this study will be flexibility in pricing, competition in bidding and Accountability. These constructs and relationships are presented in the following hypothetical framework as conceptualized by the researcher.

<table>
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<tr>
<th>Independent Variables</th>
<th>Dependent Variable</th>
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**Theoretical Review**

**Procurement of Consulting Services**

The procurement of services is an activity of increasing importance. Expenditures on services by commercial firms, Non profit organizations and Government increase each year. In some cases, service procurement represents more than 25 percent of the organization’s expenditures. Purchased services play key roles in the successful operation of these organizations. In many instances, the impact of the services themselves on the success of the organization’s operation is far greater than the impact of money spent (Donald and David 1996). Services ranging from architectural, engineering, promotion and advertising,
and software development to the maintenance and repair works are of critical importance to the operation of an organization.

**Procurement of Architectural and Engineering Services**

The procurement of Architectural and engineering services is a much specialised type of procurement. Before an Engineer is selected scope of work has not been entirely defined to provide a basis for a price estimate. Therefore it is impossible to obtain bids for professional service under conditions where the participants are basing their quotations on different interpretations or evaluations of a published scope or range of services to be rendered (ACEC, 1992). Price bidding moves only when there is clearly specified product. Buildings, bridges and highways are not clearly defined products.

**Public Procurement and Disposal Act, 2005**

The Public Procurement Reform in Kenya was jointly initiated in 1997 by the Kenya Government and the World Bank. The government decided to review and reform the existing procurement system with a view to enhancing efficiency, economy, accountability and transparency in public procurement. After the review, it led to the formation of the PPDA 2005. Public procurement and disposal act 2005 establishes procedures for efficient public procurement and for the disposal of unserviceable, obsolete or surplus stores, assets and equipment by public entities and to provide for other related matters. Under section 29 of the Act specifies the use of open tendering in each procurement as outlined in sec 51, 52, 53, 54 and 55 this is in an endevour to create transparency and accountability of the procedures. Use of different procedures is applicable if that procedure is allowed in part VI of the Act.

Section 34(1) of the act states that “the procuring entity shall prepare specific requirements relating to the goods, works or services being procured that are clear, that give a correct and complete description of what is to be procured and that allow for fair and open competition among those who may wish to participate in the procurement proceedings” from this section it is clear that the act enhances fairness and promotes competition in procurement processes. Section 52(2) of the act recommends that tender documents shall contain enough information to allow for fair competition among those who may wish to submit tenders. Sec 54(1) of the Act promotes transparency in procurement process by advocating for advertisement so as to bring the invitation to tender to the attention of those who may wish to submit tenders. The flexibility in pricing for consultants services is evident in Sec 81(2)c where request for proposals shall include for financial proposal. In addition Sec 82 (3) and Sec 84 (1) clearly promotes the paradigm of price flexibility. Generally the Public procurement and disposal act 2005 is seen to govern public procurement to foster transparency, accountability, fairness and value for money, this is by even specifying offences in case of contravene with the provisions in matters edging to corruption and or malpractices.

**Chapter 525 on Procurement of Consultancy Services**

Cap 525, Laws of Kenya on engagement and scales of fees for professional services in Building and Engineering works states that “…Architects in Kenya are governed by the Architects and Quantity Surveyors act (Cap 525) and by the by-laws made there under”. Cap 525, Section 45(3) laws of Kenya provides that “…an architect or quantity surveyor may be deemed by the Board of Registration of
Architects and Quantity surveyors (BORAQS) to be guilty of unprofessional conduct or professional misconduct if he; Advertises or publicly offers his services by means of circulars or otherwise or make paid announcements in the press except to publish in the press and notify his correspondents by post once of any change of address, opening of a new firm or branch office or alteration in the partnership or constitution of a firm. Take part in any architectural competition limited or otherwise, unless the conditions thereof have been approved by the Board of Registration of Architects and Quantity surveyors and conform to the regulations governing promotion and conduct of architectural competitions as laid down by the Royal Institute of British Architects in so far as they apply. Submit a financial proposal with fees contrary to stipulations of Cap 525.

**Preference in Procurement methods**

It has been recognized that one of the principal reasons for the construction industry’s poor performance is the inappropriateness of the procurement systems that have been chosen for the construction projects (Maizon, 1996). Selecting an appropriate procurement system is a complex and daunting task for both the client and the client’s advisers. The common criteria concerning the choice of procurement methods include time, certainty, flexibility, quality, complexity, risk, price competition, responsibility, and dispute and arbitration (NEDO, 1985; Skitmore and Marsden, 1988; Love et al., 1998). Furthermore, the increasing complexity of buildings, the need for greater financial management, the need to reduce design and construction periods and the increasing burden of contract administration have put pressure on the clients to seek alternative approaches to the traditional method (Maizon, 1996). Thus, alternative procurement methods are used due to the increasing awareness of most clients especially in terms of the project performance criteria of time, cost and quality. Basically, clients can be divided into two types. There are the public clients and private clients. The Public clients consist of Government-funded development agencies and Local Authorities. The Private clients consist of property developers, owner-occupiers and investors.

**Pricing of Consultancy Services**

Procurement expert DeRose writes “the competitive process is not truly efficient in services markets” it is constrained by three forces and factors of supply. One of the strongest factors influencing competition and prices, a continuing or cumulative supply is absent. Secondly interchangeable services generally are not available due to the personal effort and involvement of the supplier. Lastly the supply of services is more easily restricted or restrained than it is for commodity or products. It is for this reason DeRose says “that buyers must negotiate service agreements” yet there are some situations where competitive bidding is an effective method of determining both source and price. In many instances negotiation often results in better pricing and the supply of more satisfactory service. Too frequently the pricing of consultancy service contracts are not tailored to motivate the supplier to satisfy the organization’s principal objective (James R Stock, 1987). Once the primary requirement (artistic excellence, timeliness, low cost, and so on) is identified, the buyer must ensure that the resulting contract motivates the consultant to meet the need.

According to Alan Weiss’s Million Dollar Consulting (McGraw-Hill, Inc., 1992). Consultancy fees should be based on the value of the outcome to the client, the consultant’s contribution to the outcome, the relationship with the client, and the consultant’s costs to complete the assignment. Weiss points out
that various factors should determine the level of pricing for consultancy services. First the relationship with the client is very important. One should be aware of trying to buy a client’s loyalty by charging a lower fee. Many consultants have learned (to their dismay) that they have been dropped by a low-paying client in favor of a firm that is "more experienced." At the same time, a consultant who has a pleasurable, ongoing relationship may want to hesitate before raising prices too much or too often. Secondly more senior people in a field generally earn higher fees. Professionalism is another valued aspect, some consultants see themselves as helpers who take detailed directions from the client. Lastly barriers to entry in a certain profession may have a bearing in determining pricing for consultancy services. If a field requires a hard to obtain licence or certificate that requirement is a barrier to entry and consultants having it can charge more for their services e.g CPA gets a higher fee than do accountants without the designation (Ronn Zemke, 1997).

**Competitive Bidding in Consultancy Services**

Government buyers generally are not able to restrict the number of bidders to only eight. Rather, all suppliers of services desiring to bid are permitted to do so (for large projects, the numbers are literally in hundreds). Under competitive bidding, industrial buyers generally, but not always, award the job to the lowest bidder. By law, government buyers are routinely required to award the order to the lowest bidder, provided the lowest bidder is deemed qualified to perform the contract (Jack Reddy and Abe Berger, 1983). Unlike general procurement, procurement of consultancy services differs. Participants in a variety of service markets often choose non competitive bidding (that is, interaction with a single bidding firm) over competitive bidding (that is interaction with multiple bidding firms) (Ettredge and Greenberg, 1990). However, while the immediate costs of selecting a consultant are likely to increase with the number of bids solicited, economic theory and empirical evidence suggest that audit clients can achieve improved service quality and/or reduced prices by soliciting competitive bids. Holt (1975) shows that the best possible prices are obtained as a number of bidders increases, and White (1975) shows that quality improves with competition.

According to Elitzur and Falk, (1996) reduced consultancy fees is more likely when consultancy services are exposed to competitive bidding and the quality might decline correspondingly. In past studies it has been established that the winning bidder in a public bid mostly is characterized by both lowest price and lowest estimated hours of competing firms. In addition charging reduced fees in initial engagements and subsequent quasi-rents can impair service delivery with negative implications of quality of the service (Dopuch and King, 1996). Economic theory asserts that in competitive equilibrium, the selling price that a producer receives is equal to the marginal cost of production (Henderson and Quandt, 1980). This implies that competitive consultancy fees should equal the long-term costs of performing the engagements, including a normal return to the consultant’s effort and capital. Thus, surplus rents that accrue to producers in noncompetitive bidding situations should be eliminated in competitive situations.

**Accountability in Procurement of consultancy Service**

Maintaining integrity in public procurement is one of the most important pillars of modern national procurement systems (Arrowsmith, Lineralli & Wallace, 2000; Kelman, 1990; Schooner, 2002). Ensuring the accountability of procurement officials is perhaps the most essential aspect of this goal. The
accountability of procurement officials is not only important from a public or administrative law perspective, but also has economic implications. These economic implications have three main dimensions. In the terms of the principal-agent terminology used above, a lack of accountability means that the (procurement) agent is more likely to engage in a low level rather than a high level of effort when performing his tasks. The challenge faced by public procurement regulators therefore, is to ensure that the agency costs which rise when procurement agents carry out tasks for the benefit of their principal, do not exceed the benefit derived from such a delegation of decision-making authority.

**Empirical Review**

There are countries that have procurement laws that clearly spell out the need for government institutions to favour local companies. For example Swaziland, South Africa, Malaysia, China and USA (in some states) public contracts are awarded to local companies based on local preference (Friedrich, 1997; Diane, 1996; Dave, 2009; McCrudden, Stuart and Gross: 2006). Even some donor partners support the idea of domestic preference. The developing partners of developing countries also support this idea. For instance, in Malawi the Sector Wide Approach (SWAp) clearly support this where domestic bidder are eligible for 15% margin of preference where they supply goods which has 30% of its production cost made up of Malawian resources (Malawi SWAp Agreement 2004). The objectives of most of the countries for using local preference in public procurement are: to empower the small and medium enterprises (SMEs), create and/ or protect jobs for local populace and increase local revenue base. In Malawi, the Public Procurement Act 2003 Section 28 encourages the procuring entities (PEs) to promote the participation of SMEs. The domestic price preference has to be used as prescribed by Director of Public Procurement from time to time. The legislation says this preference has to be used only for the qualified domestic bidders not just because a bidder is a Malawian. The objective behind this is to ensure quality of services, goods and works because there are some SMEs that are not up to the standards. In enhancing the implementation of the domestic price preference there is a pres identical directive that public institutions have to ensure that the participation of SMEs in public procurement is accelerated. The directive is under ‘Buy Malawi Campaign’ and there is a task force that was established to come up with the strategy on how this would be achieved in which ODPP is a stakeholder. This directive is supported by both PPA 2003 and PPR 2004. In exercising his powers, as is in PPR 2004: 163 and 164 which allows the Director to consult and cooperate with concerned Ministries for the matter of policy to come up with programmes and measures to promote SMEs, directed that a “bid securing declaration” should be used in addition to bid security. This was done after it was observed that some SMEs were finding it hard to provide a bid security when participating in public procurement. In the ‘bid securing declaration’ SMEs are only required to declare that they will abide to all conditions governing the particular public procurement process and are liable for punishment in case of the breach of the same. In United States of America (USA) state of Virginia, San Francisco and others have procurement legislations that state the percentages that are given to state/city suppliers when evaluating bids. The legislation also defines what an in-state/city and outside-state/city Company is. The definition is based on the number of employees that reside in the city; the location of the company within the city among others. For example, the company has to be determined if it is within designated industrial area or not for it to be considered for the application of the domestic preference (Dave, 2009).
In a case Setzer & Sons v. South Carolina Procurement Review Panel, the complainant lodged a complaint that it was not awarded a contract despite offering the lowest bid price. The court passed a judgment that the city was justified because an econometric study done by the state showed that although South Carolina could save $50,000 by purchasing Smith Seltzer’s product, the state’s economy would suffer an overall economic loss of $2.1 million if it did so. This was in terms of lost jobs, tax revenue, and other things. The learned judge said the state was justified to discriminate in favor of local or in-state firms when they act as “market participants”, that is, when they themselves were the customers (Dave, 2009). This justifies the implementation objective of local preference in different countries.

In the Republic of China, Government Procurement Law expresses an open preference for domestic suppliers. In 2008 the government announced an RMB 4 trillion (Four Trillion Renminbi) stimulus package in response to the global financial crisis. Government institutions were instructed to prioritize local/domestic companies when procuring services, goods and works using these funds. In May 2009 the government issued a Circular 1361.1 which is also known as ‘Buy Chinese’ policy to emphasize its preference for local companies in public procurement. Chinese government is not the signatory of the WTO’s GPA which discourages discrimination of foreign companies in public procurement. The WTO and European Union (EU) are currently negotiating with China to sign the non-discriminatory trade legislation with an aim of leveling business opportunities in public procurement between local companies and international ones (Etgen and Seeber, 2009). Paul, (2009) pointed out the challenges of implementation of local/domestic preference when a country is a signatory of international trade agreements like WTO procurement legislations. He pointed out the possibility of legal challenges by the company that has been disadvantaged by such domestic legislations on local/domestic preference in public procurement. In the case of USA states and cities within states, Dave (2009) presents a case whereby well spelt procurement legislations are in place in support of local/domestic preference and being justified by the judiciary. Paul, (2009) states that countries that are signatory to international trade agreements (i.e. WTO’s GPA) and want to implement local/domestic preference have to critically analyze their trade agreement if it is not in conflict with the agreement. Therefore, implementation of ‘domestic price preference’ and ‘Buy Malawi Campaign’ in Malawi has been done after a fair consideration of these areas. The PPA 2003 and PPR 2004 have section and regulations respectively on implementation of ‘domestic price preference’.

However, the fact that PPA 2003 states that PEs have to do ‘all reasonable action’ to promote participation of SMEs there is a need to properly defined the reasonableness of an action a PE has to take in promoting SMEs in public procurement. This is crucial as it may limit unprofessional public procurement actions in the name of promoting SMEs. Recently, Ministry of Trade indicated that SMEs in Malawi employ a good percentage of our workforce (about 70%). This can be translated to a good revenue base for government through pay as you earn (PAYE) tax, registration fees among others which are used for national development. In reference to econometrics, Virginia State of USA generated $2.1 million (in terms of jobs, tax revenue, etc.) by denying a business to an out-side-state company a contract that could have saved $50,000.00 only (Dave: 2009:2). This means Malawi can protect and create more jobs and increase tax revenue base by using ‘domestic price preference’ and ‘Buy Malawi Campaign’. However, what is needed is to have public procurement laws that are explicit and not in conflict with the
international trade agreements Malawi is a signatory. On the other hand, the local business owners should know what is required from them to enjoy ‘domestic price preference’.

Critique of the Review

Researchers, in the past have undertaken some studies in Kenyan construction industry. Ramboll (2007), in the study titled “Assessment of the Procurement system in Kenya” suggested some strengths and weaknesses in the Public Procurement. Ramboll argued that PPDA (2005) lacks fair and transparent rules of participation which are key elements of a sound procurement framework. Access to participation should be based solely on qualifications and preferably be determined on a pass/fail basis in order to avoid arbitrariness in the decision making process. In Kenya, the PPDA and the Regulations establish that Public Entities (PEs) may apply pre-qualification procedure. In relation to the procedure for pre-qualification spelled out in the Regulations, it is determined that in selecting among those pre-qualified persons, who will be asked for quotation, the PE shall ensure a “fair and equal rotation”. However, the concept of “fair and equal rotation” is not adequately explained and illustrated, and may therefore result in misinterpretation among the PEs.

The study also found out that while the Standard Tender Documents (STDs) for selection of consultants provide for the opportunity to use technical capacity as a criterion in the selection, neither the PPDA (2005) nor the Regulations elaborates on this procedure. The lack of clear procedures causes some confusion as to when and how to apply technical capacity as a key criterion. This confusion may be eliminated by spelling out procedural instructions in the guidelines to be developed.

According to Arrowsmith, Lineralli & Wallace in accountability in public procurement they attributed accountability as one of the most important pillars in procurement. However a problem of accountability in the context of public procurement stems from the fact that achieving professionalism requires the delegation of decision-making authority from elected representatives to procurement officials. This is necessary because procurement officials have greater experience and superior knowledge as to what kind of goods; services or works are best suited for the public authority's purposes and how to obtain these requirements on the best possible terms (Trepte, 2004). The problem of accountability in public procurement is, in principle, no different from the one often appearing in private settings, where principals employ expert agents to perform certain profit-enhancing tasks. In both cases, principals confer a certain degree of discretion on agents who, in the absence of sharply defined or measurable goals, may exploit the granted discretion to make at least some decisions in their own interest, rather than in the interest of their principal. The difference between the case of public and private agents however lies in the availability and quality of potential control mechanisms (Bishop, 1990; Ogus, 1994).

Benefits of pricing and competitive bidding for consultancy services have been discussed in the theoretical review. However adoption of such variables have their negative impacts on procurement of consultants, as consultants are subjected to competition the price for their services is reduced, which may lead to de motivation. Too often industry and government alike err in using competitive bidding to buy highly technical products with vague specifications. This practice leads to faulty cost estimates and contingency pricing. It is also an error to use competitive bidding for purchases involving engineering set up and testing costs (Donald & David, 1996). Competitive bidding improperly used is not buying wisely.
Review Gaps

In the past research work it is clear much has been written on matters pertaining to public procurement in construction industry. Nevertheless this research works have left out gaps which require further investigations. For instance competition is said to be one of the key factors affecting price for consultant’s services. It is also argued that this may lead to in experienced consultants bidding for those services. There is need therefore to carry out research so as to establish what the required level of competition is and price which shall guarantee that quality of services are obtained in the bidding process. In addition studies need to be conducted to come up with ways of motivating professionals. The studies have established that there is no clear relationship between quality of services and competitive bidding. Contrary to a majorities belief that competition results to improved quality, some scholars have also established that competition can also result to reduced quality (Elitzur and Falk, 1996) .Another gap is also seen on how to measure level of accountability in public procurement. There might be a possibility of various players colluding and hence deceiving the public on transparency and accountability. Moreover in public procurement act there’s need to investigate on the concept of fair and equal rotation as this borders on perception rather than reality. In the past study it has been established that the standard tender documents in selection of consultants provide for the opportunity to use technical capacity as a criterion in the selection, neither the act nor the regulations elaborate on this procedure. There’s need therefore to spell out procedural instructions in the guidelines

RESEARCH METHODOLOGY

Research Design

The study adopted exploratory design in answering the research questions. This was because the problem lacked a clue as to why there is preference of certain legislation in procuring consultants. There is no adequate empirical investigation which was done on this area. This therefore warrants the need to develop concepts more clearly, establish priorities and develop operational definitions. According to Cooper and Schindler 2003, exploratory design is useful when the area of investigation is so new or so vague that a researcher needs to do an exploration just to learn something about the dilemma facing the situation researched. Since the problem is centered on a specific piece of legislation, adequate relevant literature is not available.

Population

The target population of this study was the entire construction industry in Kenya. The list from which the sample was selected was sourced from Client Ministries, State corporations, local government, Board of Registration of Architects and Quantity Surveyors and Architectural Association of Kenya.

Sample and Sampling Technique

The study employed Simple Random Sampling without Replacement (SRSWR) technique to select 50 organizations from the sampling frame sourced from the from Client Ministries, State corporations, local government, Board of Registration of Architects and Quantity Surveyors and Architectural Association of Kenya which totals to 150 organizations. The sample of 150 was arrived at considering 63 State
corporations based in Nairobi, Local Government and 84 reputable firms selected from AAK and BORAQS list.

This is a probabilistic sampling approach which according to Zikmund, (2003) every element in the population has a known non-zero probability of selection and the bias inherent in non-probability sampling procedures is eliminated. Each and every company was given a number from 1 to 150 and thirty percent of this was selected using computer generated random numbers. According to Mugenda and Mugenda (2003), at least 10% of the total accessible population is regarded as an adequate sample for a study which uses descriptive research design. Therefore, based on this rationale, 50 organizations which form approximately 33.33% of the target population was regarded as adequate representative sample for this study.

**Data Collection Procedure**

The study collected both primary and secondary data. Primary data was collected using questionnaires which were interviewer administered. Primary data was collected using a questionnaire comprising both open ended and closed ended questions; this is in order to collect a detailed and all round data which provides a rich base for the descriptions of the variables under consideration. It will also provide sufficient, complete and accurate information without bias to maximize reliability of the data. It is also easier to analyze such data and hence more economical (Mugenda & Mugenda, 2003). Secondary data was collected from review of existing literature. Secondary data was collected by assembling the available literatures both from the empirical and theoretical perspectives which were used for the purpose of building a conceptual framework and later support or contradictions of the findings to position the research findings among the plethora of literary ideas.

**Data Analysis and Presentation**

The study generated both qualitative and quantitative data using Statistical Package for Social Science (SPSS), which is a computerized statistical environment used to organize the raw data into an array such that frequencies, percentages and other statistical functions that facilitated the data processing were generated. The descriptive statistic generated was used to analyze the quantitative data. The qualitative data was analyzed by describing, structuring, categorizing, and combining into relevant themes. The data was then presented using frequency tables of percentage counts and various figures. This makes the data user friendly (Mugenda and Mugenda, 2003)

**DATA ANALYSIS, PRESENTATION AND DISCUSSION**

**Respondents Characteristics**

**Level of Education**

The results (Table 4.1) indicate that majority (52.1%) of the respondents have a post graduate level of education, while 39.8% are bachelor degree holders and a paltry (1.8%) completed Diploma level. This indicates the majority of the respondents have a university level of education with a sizeable amount with
diploma level of education. This forms a good population who is highly educated and therefore is in better position to answer questions and give a technical opinion on the subject of the study.

**Gender of Respondent**

A simple majority (51.2%) of the respondents were male while the remaining (48.8%) are females as indicated in figure 4.1. This is an indication of well balanced workforce in terms of gender orientation. This could perhaps be an indication of the organizations embracing the equal employment opportunity. This is good for this study since the opinion of both genders is equally presented.

**Respondents Years of Experience**

Respondents were asked to give the years they have worked for their organizations. Majority (67%) of the respondents have worked for the company for over 15 years, 21% worked between 10 to 15 years while the rest (12%) have less than 10 years experience as shown in figure 4.2. This is a good characteristic of respondents since majority have adequate working experience in this industry. This is good for this study because they have adequate information about the nature of the problem being investigated.

**PPDA Act and Flexibility in Pricing of Consultancies**

Procurement of Professional consultancy Services

This question was meant to establish whether organizations procure professional consultancy services. An overwhelming (91.2%) confided that they do procure services offered by professional consultancy firms while a paltry (8.8%) revealed that they do not seek the procurement of such services as shown in figure 4.3. This is a strong indication that like any other goods and services, professional consultancy is also a service which organizations require from time to time and hence not a new phenomenon to procurement officials in these organizations. This therefore will increase the objectivity of the findings of this study since all almost all organizations have experience with the procurement of services of this nature.

Legislation guiding Procurement of Professional Consultancy

Respondents were asked whether they are being guided by any legislation in the process of procuring of professional consultancy services. Majority (97.9%) admitted that they are strictly guided by laws while a handful (2.1%) declined to answer the question. For respondents whose procurement of this service is guided by law majority (86.3%) identified public procurement and disposal (PPDA) Act as their main guiding legislation, 10.6% gave chapter 525 while a paltry 3.1% identified organizational policies and procedures as shown in table 4.3. This is a clear pointer to the fact that organizational procurement exercise is guided by law and that there is a clear biasness for the preference of PPDA Act in procuring professional consultancy services across the organizations.

Choice of Procurement Legislation

This question sought to establish why majority of the respondents preferred PPDA Act to guide their procurement activities. Majority (51%) of the respondents hinted that consultancy fees are based on the choice of the output. Others (49%) cited customer satisfaction and customer quality as person flexibility
as their main reasons why they choose PPDA Act as shown in figure 4.4. This is a sign of the PPDA Act permitting more flexibility that makes business sense such as delight of the customers and negotiations.

PPDA Act and Pricing

Respondents were asked whether PPDA Act permits control of prices in procurement of professional consultancy services. Majority (73.9%) confided that the Act do not control on the pricing mechanisms while the rest (26.1%) felt otherwise as shown in figure 4.5. Majority of those who admitted that PPDA Act does not control pricing gave their reason as the level of qualification and professionalism as the main control variable of pricing. This shows that the characteristics of the professionals and their perceived ultimate output are the main price control factors which are independent of the PPDA Act itself.

Request for Proposal

This question sought to find out whether respondents include financial proposal as part of their request for proposal. There was an equal divide of opinion where 50% of the respondents include financial proposal in their request for proposal unlike the other 50% who do not include. However, it is interesting to find out that majority (81.1%) of the respondents still believe their actions as promoting negotiations for the fees.

PPDA Act and Competitive Bidding of Consultancy Services

Search for Potential Suppliers

Respondents were asked whether PPDA Act recognizes searching for potential suppliers in the bidding process. Most (91.6%) of the respondents believe that PPDA Act permits searching for potential suppliers while a paltry (8.4%) felt otherwise as presented in table 4.4. This is a clear indication that the Act in more democratic and gives the clients freedom to source competitively.

Number of Bidders Allowed

This question sought to establish whether there is specific number of people accepted as bidders. Majority (69.2%) revealed that there are specific numbers with a minimum of 4 and maximum of 8 which is allowed. They further revealed that the rational of this is to reduce the number of many bidders which will consume a lot of time and resources. The rest (30.8%) felt that there are no limitations of the number of bidders and cited competitive markets as their reason as shown in the figure 4.7. Ideally, this is expected since different organizations may have different approach based on their resource capacities and even priorities.

Quality in Bidding of Professional Consultants

Respondents were asked whether PPDA Acts considers quality of the professional consultants in its bidding process. All (100%) of the respondents agreed the Act promotes quality of professional sourced as shown in figure 4.8. The reasons advanced here was that the Act provides flexibility of basing their choice on credentials and other goodwill where the customers attach importance rather than having the price as the ultimate determinants.
Competitive Bidding in Procurement of Consultants

This question sought to investigate whether respondents prefer competitive bidding in selecting professional consultants. Majority (61.8%) do not prefer competitive bidding in this type of procurement. The reason given is that most competitive bidding process are pegged on competitive quotations in terms of prices which is they argue compromise the actual quality and credentials of the professional procures. The rest (39.3%) prefer competitive bidding of professional consultancy service. Interestingly the reasons given concur with responses which contradict competitive bidding. Respondents prefer the option on condition that prices are not the sole determinant.

PPDA Act and Accountability in Procurement of Consultants

Objectivity and Accountability of Procurement Officials

This question sought to investigate whether the PPDA Act promotes objectivity and accountability of procurement officials. Majority (70%) of the respondents do not agree that the Act promotes accountability and objectivity of the procurement officials while the rest (30%) believe the Act promotes objectivity and accountability as in figure 4.9. However, this response is expected since accountability and objectivity is an attribute which is highly personal and depends on integrity of individuals which is sometimes hard to measure.

Valuing of Government Business

Respondents were asked whether PPDA Act encourage potential suppliers to value government business and provide high quality goods and services. Most (58%) believe that the Act value the government business and provide high quality services, 25% do not agree with this opinion while the rest (17%) did not respond. This may be an indication that the Act promotes quality services delivery through the bidding process as indicated earlier.

PPDA Act and Contractors Market

This question sought the opinion of the respondents on whether the Act promotes long-term growth of the market by allocating contracts to the most efficient consultants hence saving tax payer money. Majority (89.2%) of the respondents were for the opinion that the Act promotes long term growth of the markets while a few (10.8%) felt otherwise. Interestingly, this finding is in absolutely close range with the earlier findings on the search of potential suppliers. This is a clear indication that the Act is very liberal in its selection for the professional consultancy services.

PPDA Act and Efforts of Procurement Agents

Respondents were asked of their position on whether PPDA Act permits procurement agent to more likely engage in a low level rather than a high level of effort when performing their tasks. Most (63.3%) of the respondents felt that procurement agents are forced to assume a low level effort in the process while the rest (36.6%) felt the effort of procurement agents as high. This may perhaps be due to the complications of evaluating the professional’s credentials and human resource goodwill that may largely lie outside the domain of the procurement agents in an organization.
PPDA Act and Integrity levels

This question sought to establish the opinion of the respondents about whether the Act demands high level of integrity in procuring professional consultants. Majority (72.5%) of the respondents felt that the Act is not very authoritative on issues of personal integrity in depth while the rest (27.5%) felt otherwise. This finding is also in agreement with the earlier inquiries on the accountability and objectivity issues which is an important dimension of integrity issues.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary of the Major Findings

PPDA Act and Flexibility in Pricing of Consultancies

The study found out that most organizations procure the services of professional consultants overwhelmingly and that there procurement activities are guided by procurement legislation. For respondents whose procurement of this service is guided by law majority (86.3%) identified public procurement and disposal (PPDA) Act as their main guiding legislation. This is a clear indication of the preference for PPDA Act as stipulated in the statement defining the problem of the study.

However, the preference of PPDA Act is based on the fact that the pricing depends on the output of the professional and the satisfaction levels of the customers. Majority (73.9%) confided that the Act do not control on the pricing mechanisms. The study also found out that half of the organizations include financial proposals in their overall request for proposal and this is seen to promote negotiation on price. In the theoretical review DeRose pointed out that in many instances negotiations often results in better pricing and the supply of more satisfactory service. In addition Alan Weiss (McGraw-Hill, inc 1992) argues that consultancy fees should be based on the value of the outcome to the client, the consultant’s contribution to the outcome, the relationship with the client, and the consultant’s costs to complete the assignment. Weiss further points out various factors should determine the level of pricing for consultancy services. First the relationship with the client, one should beware of trying to buy client’s loyalty by charging lower fees. Secondly more senior people in a certain field earn higher fees. Professionalism is another valued aspect which determines pricing as those consultants who perceive themselves as experts command higher fees. It is therefore clear from the foregoing that the research findings on pricing quite agree with the theoretical literature reviewed.

PPDA Act and Competitive Bidding of Consultancy Services

The study also found out that the PPDA Act which is the preference for most organizations allows for a thorough search of potential consultants which is seen as a freedom for clients to source the quality of professionals they like. In the bidding process, majority of the organizations accept four to eight bidders while others still make it open although the cost and time for process en mass bidding is the fear for every organization. On the other hand, it is interesting to find out that all organizations believe that the act promotes quality in the procurement process. This is because the Act considers professional credentials and customer delight as the ultimate determinants rather than the price factor which is seen as a quality step by most client organizations. The study also revealed that most organizations still prefer competitive
bidding provided that the customer satisfaction and the quality of the consultants are put into consideration.

Holt (1975) in theoretical review shows that the best possible prices are obtained as a number of bidders increases, and White (1975) shows that quality improves with competition. Still, concerns have been expressed that these effects of competition might not apply in the market for consultancy services. A particular concern is that reduced consultancy services offered by firms as an inducement to clients could be associated with reduced quality of the services. According to Elitzur and Falk (1996) reduced consultancy fees is more likely when consultancy services are exposed to competitive bidding and the quality might decline correspondingly. In past studies it has been established that the winning bidder in a public bid mostly is characterized by both lowest price and lowest estimated hours of competing firms

PPDA Act and Accountability in Procurement of Consultants

On the role of enhancing accountability in procurement of construction consultancy services, the study found out that majority of the respondents do not believe the Act will enhance objectivity and accountability of procurement officials. However, most (58%) believe that the Act value the government business and provide high quality services. The client organizations also believe that PPDA Act promotes long-term growth of the market by allocating contracts to the most efficient consultants hence saving taxpayer money. This was the opinion given by the majority (89.2%) of the response. The study also found out that PPDA Act permits procurement agent to more likely engage in a low level rather than a high level of effort when performing their tasks. Nevertheless majority (72.5%) of the respondents felt that the Act is not very authoritative on issues of personal integrity in depth.

In the theoretical review Arrowsmith, Lineralli and Wallace, (2009) articulated on the importance of accountability in public procurement. The research findings are therefore agreeable to the assembled literature.

Conclusion

Based on the findings it can be concluded that Public Procurement and Disposal Act (PPDA) of 2005 has introduced new paradigm for public procurement in Kenya. It is clearly demonstrated that majority of the organizations in deed prefer the Act due to its flexibility in pricing of the consultancy services. The Act is believed to peg the pricing on the quality of output and consider the customer satisfaction element thus creating freedom. The study also established that the Act is preferred due to its customized bidding process which sets new standards and dimension of competition based on the human factor. This is because professional consultancy services focus on human skill, knowledge, competencies and attitudes which may not be reflected in other procurement legislations. While the Act values the government business and provides high quality services, the same magnitude is not apparent in its effort to promote accountability and objectivity among the procurement Professionals. Either the act does not engage the procurement officials at high levels of efforts.

Recommendations

Based on the findings, the following recommendations can be made:
There is need for the government to streamline the procurement laws into one and clear legislation that will guide the procurement both in the private and public sector entities to avoid the current state of confusion. This is at the right time since Kenya has just promulgated a new set of constitution which replaced the old one in total.

There is a clear need for the procurement professionals, scholars and researchers to come up with a procurement principles and practices that will harmonize both goods and service procurement procedures and in particular, attention should be paid to procurement of service that touch expertise, knowledge and skills. Therefore, the focus at the moment is the human factor in procurement.

Since this is an exploratory investigation, there is need for further analysis to expand the scope and orientation of this study by analyzing the procurement laws which exist with a view to evaluate and come up with merits and gaps.

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RELATIONSHIP BETWEEN FIRM’S CAPITAL STRUCTURE AND DIVIDEND PAYOUT RATIOS: COMPANIES LISTED AT NAIROBI STOCK EXCHANGE (NSE)

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1&2Egerton University, 3Kabarak University

Abstract

Every company requires funds to meet its financial obligations. In Kenya, the most common sources of funds that are available to companies are shareholders’ equity and debt. An optimal combination of debt and equity increases a company’s earnings consequently leading to high dividend payout. Shareholders invest in shares with the hope of receiving income in form of dividends, capital gains or bonus issues. Many companies quoted at the Nairobi Stock Exchange (NSE) however, often pay little or no dividends. The objective of the study is to find out the role of capital structure in dividend payouts, whether high level of debt in the capital structure contributes to payment or non-payment of dividends. The findings from the study will help interested investors and owners in predicting the likely implications of capital structure decisions on companies in regard to payment of dividends. The study will
also close the gap in the existing body of knowledge since not much has been done in this area. The study covers companies listed at the exchange for the period 1998 to 2004. The results will also reflect the current position. Secondary data from 34 companies was used. To obtain the sample, a given number of companies from each category of companies at the NSE were randomly selected. The number of companies for each category was decided proportionately. Correlation coefficient was used to test for relationships and Chi-square test was used to test for differences in capital structures and dividend payout patterns at 5% level of significance on the basis of two-way classification model. It is hypothesized that there is a strong relationship between capital structure and dividend payout.

Keywords: Dividends Payout, Capital Structure

1. Introduction

1.1 General Background

Investors put their money in stocks with the hope of receiving income in form of dividends, capital gains or both. Dividends may be paid once or twice a year. Investors prefer high dividends because it provides certainty about a company’s financial status. On the other hand, investors believe that little dividend payout is more favourable because taxation on a dividend is higher than on capital gain since withholding tax on dividends is at 5% yet that on capital gain is non-existent. A company may chose to pay no dividends in order to reduce borrowings. Profit is a vital source of funds for investment for companies and so if they were to distribute too much to the shareholders, they would interfere with their long-term performance. The size of the dividend to be paid depends on the amount of profit made and the level of profit that the management declares to be distributed to the shareholders. Before deciding on the apportioning of a company’s earnings into dividends and retained earnings, the Board of Directors must understand various conflicting factors apart from capital structure that may influence dividend policy. Such factors include flow of liquidity funds, corporate liquidity, and stock price and investor satisfaction. Dividend policy is normally set by the directors of a company and answers questions of the effects of cash dividend paid, given the firm’s capital budgeting and borrowing decisions. Recommended dividends will then be put to the company’s Annual General Meeting (AGM) for the shareholders to vote on. Every decision made by corporate managers will influence the profitability, dividends and value of the company.

Although companies can change their dividend policies it is advisable that each company establishes its own dividend policy and stick to it because frequent changes can inconvenience existing stockholders, send unintended signals, and convey the impression of dividend instability, all of which can have negative implications for stock prices particularly when lower or no dividends are paid. At the same time companies must meet their debt obligations before declaring dividends because interest on borrowed funds must be paid whether the company makes profits or not. However, shareholders are entitled to a share as the reward for the risk they have taken in investing in the company. The Board of Directors may balance up these two demands on the profit, and will then recommend the size of the dividend they think is appropriate.

1.2 Importance of Debt Financing for Companies
Companies often opt for debt financing due to the many accruing benefits. According to Njeru (2003), on his study about the Effects of capital structure on company valuation, points out that debt capital is a low-cost source of finance in Kenya because interest on debt is an allowable charge for tax purposes. Companies can obtain debt capital and repay according to the expected cash flows, giving the company a greater flexibility to plan and control its capital structure. Equity is more costly due to its permanence nature. Companies engage in loan financing if it cannot be supported by internally generated funds or its mission is to expand or increase business portfolio. The most common types of long term financing in Kenya include long-term debt, common stock, preferred stock and retained earnings. Mainly banks, in form of, loans, Institutional investors in form of Pension funds, Mutual Funds and Life Assurance companies and Commercial Papers provide debt capital. The company’s funding mix is known as its capital structure. Capital structure involves a trade-off between risk and return. As the company begins to substitute cheap debt for expensive equity, the weighted average cost of capital (WAAC) reduces. Using more debt raises the risk borne by stockholders. Higher risk tends to lower a stock’s price. It is the concern of companies to maintain an optimal capital structure (debt-equity ratio). Brigham and Houston (1998) emphasized that every company has its own optimal level of debt/equity ratio. They sought to clarify this aspect by use of diagrammatic representation.

A company that uses very high leverage may face high risk of debt as it is obligated to pay consistent interest to its lenders. This limits payment of dividends to the shareholders. Low or non-payment of dividends discourages investors from investing in shares thus reducing the shareholding capacity. Further, at very high levels of debt, a company may suffer the loss of its tax shield (if interest charges turn profits into losses there is no further tax advantage) and business may experience loss of confidence due to bankruptcy risk. From companies’ annual reports it is evident that many companies quoted at NSE do not pay dividends consistently, and when they pay, the level of payout is very low contrary to shareholders’ expectations. Over the years the number of stocks traded at the exchange stagnated at around 55 quoted companies and some of the quoted companies have been de-listed by CMA, thus listing now stands at current 48 companies. The reason for de-listing being non-compliance with CMA’s requirements. Many of the problems that were faced by the de-listed companies were largely to do with funding. There is need to analyze the role capital structure plays in regard to the inability of companies to pay dividends and even the threats of bankruptcy.

Brigham and Houston (1998) also indicate that changes in the use of debt will cause changes in earnings per share (EPS) and, consequently in stock prices. Cost of debt varies with use of different percentages of debt, the higher the percentage of debt, the riskier the debt, and hence the higher the interest the lenders will charge. The East African Portland Cement procured a liability in 1996 that was yen-denominated. The liability tied fortunes of the cement company closely to currency fluctuations; every time the Kenya shilling depreciates against the hard currencies Portland pays a heavy cost. This situation reduces profitability leading to low or non-payment of dividends. The company’s debt overhang rendered the firm’s leverage ratio at a perilous 36:64, which practically means that at this ratio the firm is mortgaged 64 per cent to foreign entities.

1.3 Process through which Companies Raise Funds
Capital funds in form of equity are raised at the Nairobi Stock Exchange (NSE). NSE was founded in 1954. Over the years the number of stocks traded stagnated at around 55 quoted companies of which some have since been de-listed or suspended for non-compliance with the requirements of the exchange. NSE has experienced slow growth over its entire existence since it was founded. Only 48 quoted companies have been on operation for a long time. The NSE is a forum for trading in stocks, bonds, and shares. Here, companies from across the spectrum of industry gather to raise the public capital that will allow them to expand, in the process creating new jobs, products, services, and opportunities. As their profits improve, so the dividends are passed on to their shareholders, in a cycle of economic empowerment that reflects the stability and well being of a nation. Investors in public companies do not only have to be net worth individuals, the small investor can also stake a claim of a company except where some member firms chose to deal only with institutions or larger investors. Capital Markets Authority (CMA) strives to ensure that companies disclose to investors all they need to know not only during the public issue but also on a continuous basis after listing. From CMA Act Cap 12 (2)(d) (1999), a securities exchange shall within four months after the end of each financial year make available to the Authority, and to the investors, a summary of information on companies listed at the securities exchange. It is suppose to provide information on earnings per share, dividend per share, shareholding structure (institutional, individual and foreign investors), principal or controlling shareholders and total number of shareholders.

The companies under study are operating under the same economic and political environments. Government policies and macro-economic factors like interest rates and inflation impact on all the listed companies at the same time hence their effects on individual companies are offset. In each of the listed companies, capital structure overrides company-specific activities like capital budgeting decisions and dividend policy. Similar accounting procedures apply for all the listed companies and management prudence is observed by all the quoted companies as it is one of the major requirements by CMA before a company is quoted and as long as a company remains quoted. As mentioned earlier capital structure is the funding mix between equity and debt. Different levels of debt dictate the levels at which a company can pay dividends. Besides capital structure, there are other factors that influence dividend payout. These factors are held constant in order to undertake this study. These factors include profits, market price, liquidity, working capital and that the company runs under efficient management.

1.4 Statement of the Problem

A company has many methods of raising required operational funds. In Kenya, companies obtain their capital funds from two main sources –equity and debt. At any one time equity alone or a mix of both may be used in financing a company. A company that uses very high leverage may face high risk of debt as it is obligated to pay consistent interest to its lenders. This limits payment of dividends to the shareholders. Low or non-payment of dividends discourages investors from investing in shares thus reducing the shareholding capacity. Further, at very high levels of debt, a company may suffer the loss of its tax shield (if interest charges turn profits into losses there is no further tax advantage) and business may experience loss of confidence due to bankruptcy risk. From companies’ annual reports it is evident
that many companies quoted at NSE do not pay dividends consistently, and when they pay, the level of payout is very low contrary to shareholders’ expectations. Over the years the number of stocks traded at the exchange stagnated at around 55 quoted companies and some of the quoted companies have been de-listed by CMA, thus listing now stands at current 48 companies. The reason for de-listing being non-compliance with CMA’s requirements. Many of the problems that were faced by the de-listed companies were largely to do with funding. There is need to analyze the role capital structure plays in regard to the inability of companies to pay dividends and even the threats of bankruptcy. The role of capital structure in dividend payouts has not been comprehensively established.

The main objective of the study was to determine whether there is a relationship between capital structure and dividend payout on NSE listed companies.

The specific objectives were:

i To assess the capital structure patterns of the companies quoted at the NSE.

ii To determine the dividend payout patterns exhibited by companies quoted at the NSE.

iii To find out the relationship between capital structure and dividend payment ratios among the companies quoted at the NSE.

The research questions included:

i What capital structure difference is there between companies listed at NSE?

ii What dividend payout difference is there between companies listed at NSE?

iii What is the relationship between capital structure and dividend payouts for companies listed at the NSE.

The hypothesis of research was stated as follows:

There is no significant relationship between capital structure and dividend payouts for companies listed at the NSE.

Research Strategy

This was a quantitative study where secondary data was collected and analyzed to test for relationships. The population of this study consisted of companies on all sectors continuously listed at the NSE over a 7-year period between January 1998 and December 2004. A company is continuously listed if data is available for the 7-year period for which the study is undertaken. This time period was considered because it was sufficiently reasonable time length to accommodate all changes that occurred in the dividend payout patterns. Listed companies were studied because data was more easily available than data for the unlisted companies. A list of companies and samples for which the study was undertaken is shown in the table below:
Table 1  Sampling Frame

<table>
<thead>
<tr>
<th>Company Category</th>
<th>Total No. of Companies</th>
<th>Percentage (%)</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Investment Market Segment (MIMs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural</td>
<td>4</td>
<td>75%</td>
<td>3</td>
</tr>
<tr>
<td>Commercial and Services</td>
<td>8</td>
<td>62.5%</td>
<td>5</td>
</tr>
<tr>
<td>Finance and Investment</td>
<td>11</td>
<td>72.73%</td>
<td>8</td>
</tr>
<tr>
<td>Industrial and Allied</td>
<td>16</td>
<td>75%</td>
<td>12</td>
</tr>
<tr>
<td>Alternative Investment Market Segment</td>
<td>9</td>
<td>66.67%</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>48</strong></td>
<td><strong>70.83%</strong></td>
<td><strong>34</strong></td>
</tr>
</tbody>
</table>

The sample was 70.83% of the population. To select a sample from every sector, proportionate sampling criteria was used to obtain a cross-sector/segment sample totaling 34 companies and a simple random sampling (SRS) method was used to systematically select the sample units. This sample size is taken because it is large enough to reflect the true position of all the listed companies. It is more than two-thirds of the population.

The method of data collection was documentary. The source of data (secondary) was Nairobi Stock Exchange and individual company annual financial reports. The data that was collected/calculated (based on a 7-year period) are: Number of shares in issue, Dividend payout ratio \([\text{Div}/\text{EPS} \times 100]\), Earnings per share (EPS) \([\text{Total Earnings attributable to shareholders} / 100]\), share price at the end of the year, Total liability \([\text{Short term} + \text{Long term}]\), Total Equity \([\text{Common} + \text{Preferred}]\) and Debt/Equity (D/E) ratio \([\text{D/A}/(1-\text{D/A})]\). It is worth noting that D/E and D/A (Debt/Asset) ratios are simply transformations of each other, \(\text{D/A}=[(\text{D/E})/(1+\text{D/E})]\), this is the ratio that was used in this study.

Other important ratios in determination of dividend policy include: Dividend yield, Retention ratio/plowback ratio and P/E ratio. For this research Debt/Equity ratio was used to determine the level of leverage and dividend payout was based on dividend payout ratio

3.0  Data Analysis, Findings and Discussion

For each of the companies studied the debt/equity ratio was calculated. Dividing cash dividends by net assets for the number of years the company shares were actively traded on the stock exchange showed the
Dividend payout ratio. Correlation coefficient was applied to the data to test for relationships between capital structure and dividend payouts for the listed companies.

3.1: Test of Relationships

The comparison of capital structure and dividend payout patterns showed that there was a significant relationship. This means that the leverage trend has a significant direct relationship with the level of dividend payout. This is clear from Pearson Correlation coefficient that showed a 0.656 correlation. This is shown in the table below:

Table 3: Test of relationships on the null hypothesis

<table>
<thead>
<tr>
<th></th>
<th>H₀</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Structure</td>
<td>r =0.656</td>
<td>Accept</td>
</tr>
<tr>
<td>Dividend Payout</td>
<td>r =0.656</td>
<td>Accept</td>
</tr>
</tbody>
</table>

A correlation analysis was run to establish the relationship between capital structure and dividend payout. Pearson’s Correlation coefficient (r), table 3 above was used to determine the relationship between capital structure and dividend payout. This was done to measure the strength of association between the two variables-Capital Structure and Dividend Payout.

The test’s outcome indicated that r>0 which means that there was a positive association between the two variables. The calculated r=0.656 was significantly greater than one. This ratio is significantly large enough to draw meaningful conclusion. The hypothesis of no relationship between capital structure and dividend payouts for companies listed at the NSE is therefore rejected since the r-value is equal to 0.656. There is a positive significant relationship between capital structure and dividend payouts for companies listed at the NSE.

Table 4: Correlation between the capital structure and dividend payout

<table>
<thead>
<tr>
<th></th>
<th>Payout ratio</th>
<th>Debt ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payout ratio</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>.656</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td></td>
<td>.109</td>
</tr>
</tbody>
</table>
This means that debt financing definitely has positive effect on companies’ performance. It is worth noting however that this ratio may reduce to even a smaller value if a company would employ very high level of debt to finance its operations, thus indicating a weak relationship. In fact, a ratio of 0.7 (Table 4) is considered a strong relationship conventionally and the value 0.656 is therefore not a strong but significant. This positive relationship means that companies that source their funds from debt to add to equity funds are able to pay dividends for what they can do with the extra funds.

Table 5: Comparison of dividend payout ratios across counters

<table>
<thead>
<tr>
<th>Year</th>
<th>1998</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.775</td>
<td>1.183</td>
<td>0.354</td>
<td>0.969</td>
<td>-0.617</td>
<td>0.157</td>
<td>0.155</td>
</tr>
<tr>
<td>Commercial</td>
<td>0.263</td>
<td>0.170</td>
<td>0.172</td>
<td>0.174</td>
<td>0.178</td>
<td>0.295</td>
<td>0.893</td>
</tr>
<tr>
<td>Financial Investment</td>
<td>0.351</td>
<td>0.393</td>
<td>0.372</td>
<td>0.477</td>
<td>0.377</td>
<td>5.008</td>
<td>4.315</td>
</tr>
<tr>
<td>Industrial and Allied</td>
<td>0.480</td>
<td>0.674</td>
<td>0.514</td>
<td>0.596</td>
<td>0.450</td>
<td>0.925</td>
<td>0.498</td>
</tr>
<tr>
<td>AIM</td>
<td>0.165</td>
<td>0.511</td>
<td>0.429</td>
<td>0.923</td>
<td>0.382</td>
<td>0.381</td>
<td>0.525</td>
</tr>
</tbody>
</table>

The values of dividend payout ratios in table 5 above were used to draw graphs in figure 1. From the figure the relationship between capital structure and dividend payout is visibly evident especially between 1999 and 2002. The noticeable variation in capital structure (1998 to 1999) (fig 2) and in dividend payout (2002 to 2004) (fig1) emanates from Financial and Investment sector that had very high dividend payout ratios in 2003 and 2004 hitting a high of 5.008 in 2003 from 0.377 the previous year (figure 1).
Fig. 1: Comparison of dividend payout patterns

Table 6: Average capital structure ratios

<table>
<thead>
<tr>
<th>Category</th>
<th>1998</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>0.2109</td>
<td>0.2981</td>
<td>0.3133</td>
<td>0.3247</td>
<td>0.4186</td>
<td>0.4201</td>
<td>0.429</td>
</tr>
<tr>
<td>Commercial</td>
<td>0.9975</td>
<td>0.9972</td>
<td>1.156</td>
<td>1.0404</td>
<td>1.0924</td>
<td>1.5072</td>
<td>1.185</td>
</tr>
<tr>
<td>Industrial and Allied</td>
<td>0.4245</td>
<td>0.5613</td>
<td>0.5044</td>
<td>0.502</td>
<td>0.4612</td>
<td>0.7072</td>
<td>0.7732</td>
</tr>
<tr>
<td>AIM</td>
<td>0.536</td>
<td>0.9214</td>
<td>1.6915</td>
<td>2.2013</td>
<td>0.5402</td>
<td>0.5359</td>
<td>0.4813</td>
</tr>
</tbody>
</table>
The figure below shows the graphs of capital structure pattern for the different company sectors/segment.

Fig 2: Comparison of the capital structures

3.3 Variations in Dividend Payouts

This sharp rise in dividend payout could be due to the trading optimism that came with the policies introduced by the new government after 2002 general elections. During this period the new government had decreed a zero-tolerance to corruption in all spheres of trade and governance, which could be translated to mean favourable terms of doing business. Further to this “Liquidity in the banking sector remained high throughout 2002 as a result of few investment opportunities. Hence the interest rate on the 91 day Treasury bill remained low as this instrument was used to ‘mop up’ excess liquidity in the market. The T-bill averaged at 8.9% in 2002 compared to 12.7% in 2001” (NSE Handbook, 2002). It was a different situation after 2003, because there was a decline in dividend payout for all the counters except commercial and Alternate and Allied segments. Dividend payout was lower in 2004 than it was in 2003. This decline could be due to diversified business opportunities arising due to business enabling environment created by the new government. More business opportunities encourages companies to reinvest their earnings hence reduction of dividend payout. It was around this time that corruption cases including Goldenberg scandal were addressed. All these scenarios provided enabling environment for business hence companies withheld their earnings in order to reinvest.

In addition many banks around this time engaged in product diversification and electronic solutions, which attracted broad base clientele. During the year 2002, the banking sector also experienced depressed results generally due to a combination of adverse factors including lack of economic growth, limited appetite for commercial borrowing, and intense competition for market share, squeezed margins and weakening interest rates for liquid investment (NSE Handbook, 2002). All these led to declining low
levels of dividend payouts. In the years 2003 and 2004 dividend payout declined for reasons which could be attributed to factors applicable to Commercial and Alternate and Allied segments explained above.

4.0: Summary, Conclusion and Recommendations

Summary the Key findings

With respect to the objectives set out, this study has established that companies listed at NSE generally maintain similar capital structure patterns for all the categories. Finance and Investment sector however operates at higher level of debt compared to other counters. In fig 1 the general pattern is interrupted in the years between 1998 and 1999, which could have been due to government’s reduction of interest rates on treasury bills. From this outcome none of the listed companies are heavily indebted. Problems bedeviling some of the companies can be interpreted as being caused by mismanagement of borrowed funds.

The overall trend is that the capital structure has a tendency to increase overtime. This shows that most companies tend to borrow more relative to their equity over the years. This could be attributed to the fact that companies do not often reissue shares after initial public offering (IPO). Furthermore, it is relatively cheaper to manage debt than equity due to its non-permanence nature.

Secondly, the study found out that listed companies generally maintain a similar dividend payout patterns in all the categories. A small difference was however seen in Agriculture and Finance and Investment sectors where swings in dividend payouts were noticeable that affected the general pattern in figure 1 between 2002 and 2004. This change could have arisen due to reasons explained earlier touching on new government promises and the stand it took on business sector.

4.2 Conclusion

The finding from the study has established that there is a significant relationship between capital structure and dividend payout. Companies that optimally engage financial leverage in their operations stand a chance of favourable competitive situations because of the absence of financial inhibitions. Availability of funds enables companies to meet their financial obligations. Debt financing also is cheaper to service since it is offered within specified time frames. Therefore, companies stand a chance of experiencing high earnings from which to pay dividends.

Recommendation

From the findings of this study it is highly recommended that companies maximize their output by engaging in optimal debt financing because there is a positive correlation between dividend payout and capital structure. That is, as companies engage more and more debt towards optimal levels, the more it is likely to experience higher earnings.

4.2 Suggestion for Further Research

The following related area can be researched on to add up to the knowledge of what this study has achieved as far meeting investor expectations of receiving income from their investment. There is need to
assure investors of income from capital gains in addition to dividend payments. In this regard, a study could be conducted to ascertain the average time period that meaningful returns in form of capital gains can be realized.

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THE CHALLENGES OF GOING GREEN TO THE SMALL AND MEDIUM SIZED ENTERPRISES IN KENYA

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ABSTRACT

In the quest for a sustainable society, environmental leadership and green entrepreneurship have taken the forefront. Day by day going green has become the new environmental ethic. The literature on environmental protection and green values was reviewed with an aim of gaining useful insights for the green context. The scope for the investigation encompasses all forms of greening in a business, their internal motivation and external structural influences. The research paper will examine how Kenyan companies are likely to react with the world accelerating concern over climate change; because this is affecting industries more specifically their plans to meet the growing clamour for environmentally friendly products and services. The objectives of this research will be to assess the importance of environment conservation to companies and whether compliance to environmental policies influences competitiveness, to find out the force behind a company’s environment concern and adoption of green values and to find out if green values or going green can be used as a management tool. The ultimate purpose of this study was to collect data to assess the importance of environment conservation to companies and whether compliance to environmental policies influenced competitiveness. The research design used to be used will be descriptive in nature, which will describe the characteristics that relate to the subject population. Questionnaires will be used. The research will provide an analysis of going green practices in Kenya, based on the assumption that most of
the businesses do consider environment protection least in their priorities. Descriptive statistics will be used for the analysis.

**Background of the Study**

The reality of global warming has sunk to many a mind, making it widely accepted. This is attributable to the publication of the report of the Intergovernmental Panel on Climate Change. Likewise, it has been acknowledged that business and corporate activity is contributing significantly to this warming. However, those studying the problem have been skeptical to say that little can be done to prevent the warming trend because we must continue to a certain level of human activity including agricultural and industrial production. But numerous business leaders are now well aware of that reality and trying to do something about it (Robert, 1980).

In the recent past, environmental leadership has become a global corporate aspiration. This may be well understood in terms of industrial sustainability, widely embraced under environmental stability and production. There are a number of ways that concerned people are seeking to limit the risks of ecological disaster and create more sustainable modes of business, giving rise to a term ‘corporate environmentalism’ (Jeremy, Julian, Colin & Stephen, 2006). Businesses and business leaders attempt to play a leadership role in reforming the way business does business, by making it more sustainable, and use tools and approaches of rational management to improve ecological behavior. By seeking to comply with governmental or industrial regulations that maybe in place and outstretching their tentacles to embrace proactive sustainability approaches, referred to as ‘going green’, in an undertaking’s strategic agenda (Woodward, 2008).

Each period of time is dominated by a particular concern, and today ‘going green’ seems to be one of those concerns. The going green trend which has found its way in the current business arena has grown out of the past legal and technical compromises. The current environmental problems are closely intertwined with much broader issues of social, political and economical development. As (Hazel, 1980) predicted the dawn of a new age – ‘solar age’, I place this prediction closely to the going green era. She asserted that in this ‘solar age’ the economies will be based on conservation technologies and renewable energy sources. Ultimately, a new world order would emerge, founded on scientific and ethical principles. She noted that this era was to result from inevitable transformation of our ‘late stage’ industrial society, which she argued is based on maximum rates of production and non-renewable resources (what we are currently experiencing). Further, the transition was to require a design and scientific revolution a concern with scale and significant institutional changes. She said this transition will be resisted but at last people will face up to the un-sustainability of their own value systems.

The ‘going green’ has been expanding rapidly in the United States and the United Kingdom. According to (Green Brands Survey, 2008) consumers in those countries are taking responsibility and doing the right thing. Consumer awareness and motivation continue to drive change in the marketplace—notably through the introduction of more energy-saving and eco-friendly products. Next year, consumers around the world will spend about US$500 billion, double the current level, on green products and services. And approximately three-fourths of the population in the U.S. and U.K. expect to maintain or increase their level of spending on green products in the coming year.
Today in Kenya, data from the United Nations Environmental Programme shows that green energy and climate friendly projects targeting carbon emissions reduction in Kenya has risen from five in 2004 to fourteen in 2009. Nick Nuttall spokesman of the UNEP, was on record saying that green projects allow country’s reduction of emissions and meeting global warming commitments by investing in reduction initiatives (Sunday Nation, 2009). Also, due to the importance to the environment, UNEP’s Finance Initiatives are assessing ways of boosting green projects in the continent (Africa) (Sunday Nation, 2009).

Businesses, large and small, have joined the ranks of the environmentally concerned and are making an effort to protect the earth. Whether it be by implementing a company recycling program, or eliminating toxic materials from their products, more than ever before, companies are getting involved in the environmental movement.

Kenya has in the past made considerable efforts, domestically and internationally, to promote sound environmental policies. This effort is demonstrated by the country’s hosting of the United Nations Environment Programme (UNEP) and the United Nations Human Settlements Programme (UN-Habitat) headquarters, the only UN headquarters in a developing country. Kenya cannot, therefore, afford to lag behind the rest of the world in environmental management policy. The country is a signatory to a number of Multilateral Environment Agreements (MEAs), including Agenda 21, the Montreal Protocol, the Basel Protocol, the Stockholm Convention, the Kyoto Protocol and Convention on International Trade in Endangered Species (CITES) among others.

The need for Kenya to strengthen her capacity to meet international best practices contained in these documents has seen Kenya on the route of going green. It is emerging that the factories have opportunities linked to prudent handling of waste, which easily fits into the global push for going green (Business Daily, 2010).

According to Hackenbroch (2007), the current green projects stem largely from the energy sector. Sugar companies in Kenya, are the most visible towards this greening trend, for instance the 35-MW power station project of the leading sugar producer Mumias Sugar Company (MSC), for electricity generation from sugarcane bagasse is rated as the most advanced.

A paper technologist, Eliud Wamocho, says sugar bagasse (a residue) can be used instead of wood to produce paper — at a cheaper energy cost (Business Daily, 2010). Pan-African Paper Mills (Pan Paper), which is located at the heart of Kenya’s sugar belt, could use the residue to manufacture paper. The use of the raw material for paper manufacturing would mean that the factory uses less or no trees. If Pan Paper uses bagasse, it would cut its energy costs by up to 30 per cent. According to the former CEO of Pan Paper, Mr. Neranjan Saha, the cost of electricity accounted for 33 per cent of the entire factory’s running expenses (Business Daily, 2010). Research shows that bagasse requires less power to make paper compared to wood.

According to Business Daily, (2010) Mumias Sugar Company (MSC), Kenya’s largest sugar miller and a supplier of electricity to the national grid was a company that was recording gains from the ‘green economy’. MSC launched a water bottling plant from condensed steam that runs its electricity turbines; it also was set to start producing ethanol at a capacity of 22 million litres annually as an alternative to petrol.
for running engines this is made from molasses, one of the by-products of sugarcane. MSC projected its earnings would be at least Sh75 million annually from the sale of carbon emission reduction made possible by its co-generation project. These projects fall under what is known as the ‘green economy’ or ‘going green’ the growing new economic development model that appreciates conservation of the environment, unlike the ‘black economy’ that has long been powered by fossil fuels.

In 2007, East African Breweries launched a three-year conservation plan to minimize the impact of its operations on the environment. Key to the plan is the establishment of internal environment management standards as well as the company's involvement in campaigns to create public awareness on the subject. Gerald Mahinda, the managing director, was recorded saying that the company will spend Sh15 million on the campaign dubbed Green Goals 2010. The money will be used to plant more than 100,000 trees in the next financial year and to improve production processes at the factory to reduce carbon emissions, (Business Daily, 2008). "We want to make environment management a way of life," said Mr. Mahinda. He said EABL was following in the footsteps of business leaders across the globe to reduce environmental degradation through innovation and advocacy. EABL has invested more than Sh500 million in effluent treatment plants for its Kenyan and Ugandan factories. The company's Ruaraka Plant is recycling heat energy and carbon dioxide from the brewing process, (Business Daily, 2008). Mr. Mahinda said the measures have helped the beer company save up 20 per cent of its energy costs. EABL will, later in the year, start to recycle aluminum cans used to package some of the products. Mr. Mahinda said strict surveillance could help Kenya achieve the UN's recommended 10 per cent forest cover.

The Magadi Soda Company limited has invested in huge plantations of *Jatropha* in the semi-arid Kajiado district; the company hopes to use these to generate biodiesel, to replace Heavy Furnace Oil (HFO) in its furnaces and power engines. This will not only reduce its huge fuel oil bill, leading to bigger margins and cost leadership, it will then also sell its rights to burn the forfeited carbon.

Kenya’s first six windmills went online on August 2009 at the wind farm in the Ngong Hills, each adding 850 kilowatts of clean, renewable power to Kenya’s national grid. Francis Makabwa, an engineer with KenGen, was quoted in ‘The National’ an e-newspaper saying that in the endeavor of greening Kenya. Wind farms have a very low impact on the environment as they do not use any fuel and emit no pollution. (Brown, 2009)

Most Kenyans understand the benefits of going green. In 2004 Wangari Maathai, a Kenyan activist, became the first environmentalist to win the Nobel Peace Prize. Prof. Maathai started the Green Belt Movement, a grassroots environmental organization that has planted more than 30 million trees (Brown, 2009)

Ecotourism operators have started springing up in Kenya catering to the growing number of tourists interested in reducing their carbon footprint, or the amount of carbon their travels produce. There is a fleet of green-colored Toyota Prius taxis. Eco Cabs, the company that owns the taxis, says the hybrid cars produce 60 per cent less emissions than normal vehicles. Solar power is another green technology that is gaining traction in Kenya. Some residents living off the grid in slums and rural areas have installed solar kits on their houses that power lights, run televisions and charge mobile phones (Brown, 2009).
According to the WBCSD, eco-efficiency is reached by the delivery of competitively priced goods and services that satisfy human needs and enhance quality of life. This is achieved while progressively reducing ecological impacts and resource use through the life cycle of a product to level at least in line with the earth’s carrying capacity (Thorpe, 1999).

From the foregoing, it is evident that enterprises in Kenya are going green. There have been many successful businesses that provide lessons for replication or policy change of strategy towards going green. Increased awareness is needed of the strategies these businesses use and still make profits while embracing green values.

Organizations of all kinds are undergoing the fundamental challenge of value creation and policy execution at a time when global conditions threaten whole sectors and long-established industries. Becoming a more sustainable organization in times good and bad, is the main strategic challenge

**Statement of the Problem**

The deterioration of the natural environment is a major global problem. There is great concern about greenhouse gases (GHG) in the atmosphere due to burning of fossil fuels; about the depletion of the ozone layer due to certain chemicals and global warming (UNFCCC, 1997)

The adverse impact of climate change and global warming is affecting everybody on the earth take an example of the increased cyclical floods, intense storms, heat waves and droughts. Hence, it has become imperative for everybody to work together to tackle this problem. Albeit the creation of a hugely successful business system for creating needs and satisfying them, one of the side effects has been huge growth of environmental degradation, toxic wastes, and species risk (IPCC, 1997)

Climate change and global warming is the result of unrestricted emission of greenhouse gases by countries in two centuries of industrialization. Industries being the major contributor in the climatic degradation and hence the changes, have a responsibility which is beyond mere corporate responsibility to take care of the environment (Clarkson Consulting, 2009).

The environment is one of the key and most important resources of any country. For instance, the drought and famine which is currently affecting Kenya can be largely attributed to the environmental degradation of the resources over the years. Although it might be difficult to directly pinpoint this calamity to industrial processes, since many of the industrial plants find their locality in the capital city, it is indeed proper to give it a remote association to industrial activities. This said, it is important to note that the environment, being the back-bone of any nation’s development strategy faces a great percentage of risk more specifically because of the activities carried on. This thus calls for measures to be taken up to act as checks and balances for any activities and projects which may be carried upon with the end result being the protection of the environment (ILEG, 2003).

The urgency of the environmental problems is recognized as a legitimate concern of business. This is because in a sense, basic environmental and economical goals are broadly shared.
There are laws in place which are supposed to protect the environment, but the environmental protection is on a steep downward slope. Drawing from that, an assumption can be safely made that the perpetrators are leniently punished hence they do not feel obliged to comply with the laws to protect the environment, the laws in place are weak in their effect or the implementers are equally lax in their duties. This lack of responsibility and lack of motivation among stakeholders to protect the environment needs to be addressed (ILEG, 2003 & Clarksonconsulting, 2009).

While many companies and industries in other jurisdictions like the US and UK (Kotler & Keller, 2009) are questing in sustainable development and environmental protection by virtue of green values and clean production, Kenyan industries are still reluctant and they score high in degradation scale. While great opportunities await companies and marketers who create solutions that reconcile prosperity with environmental protection, there is a reason why the companies here are slow to adopt this promising strategy and I seek to dig deeper and know why.

There are many competing human and social needs and one cannot gainsay the fact that there is no general agreement on the extent to which action must be taken and institutional changes necessary to accomplish ultimate transition to conservation and renewable resource technologies. So, there is need to retire conventional wisdom and adapt to changing conditions and information (PWC, 2008).

Most recently, green values have been strongly held, and saving the environment through sustainability is high on the list of value preferences. Summarily, it can thus be concluded that the advent of these environmental ethics - green values mainly referred herein as ‘going green’ has heavily affected the industries Makower (2008), which is the gist of my research.

There is a possibility to mitigate the externalities from the production by expenditures on abatement. However, it is believed that these costs have a negative influence over the company’s competitiveness. Moreover, the relation between the abatement costs and level of pollution is directly proportional: the lower the level of pollution, the higher are the marginal abatement costs (Helfand et al., 2003). Additionally to the compliance costs, environmental regulations have been criticized for high administrative and transaction costs as well as for inflexibility.

Therefore, there has been an increasing interest in market-based environmental policy tools that incorporate ‘the external cost of production or consumption activities through taxes or charges on processes or products, or by creating property rights and facilitating the establishment of a proxy market for the use of environmental services’ (Segerson & Li, 1999).

Despite the fact that a tradeoff between social benefits (increase of welfare by reduction of environmental problems) and private costs (of the company) is observed, there is an increasing number of companies that reduce their environmental impact even more than is required. This phenomenon of “over-compliance” or “corporate environmentalism” helps companies to reduce the sources of possible conflicts between them and society (i.e. pollution of the environment). What is more, there are examples of companies that have increased their (international) competitiveness by over-compliance (Heal, 2007).

Therefore, it is interesting to discuss how the company’s competitiveness is influenced under the mandatory environmental regulation by government and under a voluntary initiative of abatement by the
company. It is on this background that this study will determine if companies are complying only for reasons of marketing and rapid profit, or if the companies and the actors are aware of what is going on, and thus are able to anticipate and manage the change of strategy in order to prepare themselves for short as well as long term growth

**Purpose of the Study**

The general objective of this study is to examine the motivation behind going green in Kenya and whether going green can be included in strategic objectives of companies.

**Specific Objectives**

The specific objectives of this study are:-

To assess the importance of environment conservation to companies and whether compliance to environmental policies influences competitiveness.

To find out the force behind a company’s environment concern and adoption of green values.

To find out if green values or going green can be used as a management tool.

**Literature Review.**

**Theoretical Review**

2.2.1 Theory of Change

According to Kotter (1995), Theory of Change is a specific and measurable description of a social change initiative that forms the basis for strategic planning, on-going decision-making and evaluation. The methodology used to create a Theory of Change is also usually referred to a Theory of Change, or the Theory of Change approach or method (Kotter, 1995). Like any good planning and evaluation method for social change, it requires participants to be clear on long-term goals, identify measurable indicators of success, and formulate actions to achieve goals.

Theory of Change defines all building blocks required to bring about a given long-term goal. This set of connected building blocks interchangeably referred to as outcomes, results, accomplishments, or preconditions (Kotter, 1995).

Built around the pathway of change, a Theory of Change describes the types of interventions (a single program or a comprehensive community initiative) that bring about the outcomes depicted in the pathway of a change map. Each outcome in the pathway of change is tied to an intervention, revealing the often complex web of activity that is required to bring about change.

A Theory of Change would not be complete without an articulation of the assumptions that stakeholders use to explain the change process represented by the change framework. Assumptions explain both the connections between early, intermediate and long term outcomes and the expectations about how and why proposed interventions will bring them about. Often, assumptions are supported by research,
strengthening the case to be made about the plausibility of theory and the likelihood that stated goals will be accomplished. Stakeholders’ value theories of change as part of program planning and evaluation because they create a commonly understood vision of the long-term goals, how they will be reached, and what will be used to measure progress along the way (Kotter, 1995).

The dominant thinking of business firms, till around the mid twentieth century, was only to earn profit for the shareholders (owners). The paradigm of thinking changed as the expectations of society from business altered from 1960s onward. This change was triggered because of the occurrence of certain events like the coming of Rachel Carson’s, book Silent Spring in 1962 and Ralph Nader’s consumer safety and environment movement in the 1960s; Stockholm conference, 1972; Earth Summit (Rio de Janeiro, 1992); World Summit on Sustainable development (Johannesburg, 2002); Bhopal Gas Tragedy, 1984 and corporate bad behavior (Shell, Nike, Exxon-Mobil, Enron and WorldCom) became common place from the 1990s; Formulation of Kyoto Protocol 1997 and institutionalization of the Global-Warming movement. Many such events along with the events mentioned changed the business and society equation. Business firms were expected to take responsibility of the harm the firm activities caused to environment and society act appropriately to minimize the negative impacts caused by firms proactively contribute to address the challenges faced by society and environment, to better the situation. Business responded to these pressures with a set of activities given the generic name of Corporate Social Responsibility (CSR)

2.2.1.1 Corporate Social Responsibility (CSR)

CSR as a concept means being ethical towards stakeholders that is not harming or hurting any stakeholder (Buchholz and Rosenthal 2002; Jones, 2005). CSR represents voluntary company activities (Van Marrewijk, 2003). It means at minimum being legally compliant to the rules of the land (Carroll, 1979). CSR has a dominant goal to better the condition of various stakeholders (broader society, communities and most importantly the natural environment) (Carroll & Buchholtz, 2003; Kotler and Lee, 2005). Further CSR has been seen as a continuous process of engagement of the firm with the stakeholders (Waddock, 2004).

This goal of the CSR is to internalize the externalities produces in order to minimize externalities or avoid the possible sources of conflicts between companies and the society that could occur in the long-run (Heal, 2007). An example of such a source of conflict is pollution an externality which shows the private-social cost differences the costs for society are much higher than the private costs for the company (Heal, 2005).

Heal (2005) defines six mechanisms linked to CSR programmes that lead to higher profits and enhanced competitiveness of the company in the long-run, including: reduction of risk (i.e. minimizing the possible conflicts with the society which in some cases could lead to a significant loss in competitiveness), reduction of waste (due to better management of inputs and processes in the production), improvement of relations with regulators (which is of a significant importance for future negotiations where an environmentally friendly profile of the company is going to be a big advantage), generation of brand equity (the same goods which are present on the market very often do not differ significantly in their features or in the costs of their production, thus the company needs to seek an additional way to attract the
consumer, e.g. by an environmentally friendly profile), improvement of human relations and employee productivity (employees are willing to work for companies associated with a positive social image, which helps companies to a successful recruiting process and maintains motivation of the employees), decrease in cost of capital (with the connection to the Socially Responsible Investment programme) (Heal, 2005).

However, the authors of the European Competitiveness report (2008) state that the strength of the positive impact of each of these mechanisms, and the extent to which it is relevant to all companies, varies. Each case of CSR is unique for different sectors, sizes and conditions related to the current situation of the companies. The strongest evidence of a positive impact of CSR programmes on competitiveness was found to be in the cases of human resources, risk management, brand equity generation and innovation.

### 2.2.2 Stakeholder theory

Stakeholder theory has been articulated in a number of ways, but in each of these ways stakeholders represent a broader constituency for corporate responsibility than stockholders. Discussions of stakeholder theory invariably present contrasting views of whether a corporation's responsibility is primarily (or only) to deliver profits to the stockholders or owners. Milton Friedman's (1970) pronouncement that the only social responsibility of corporations is to provide a profit for its owners stands in direct contrast to those who claim that a corporation's responsibilities extend to non-stockholder interests as well.

One very broad definition of a stakeholder is any group or individual which can affect or is affected by an organization. Such a broad conception would include suppliers, customers, stockholders, employees, the media, political action groups, communities, and governments. A more narrow view of stakeholder would include employees, suppliers, customers, financial institutions, and local communities where the corporation does its business. But in either case, the claims on corporate conscience are considerably greater than the imperatives of maximizing financial return to stockholders (Freeman, 1984).

Stakeholder theories have grown in number and type since the term stakeholder was first coined in 1963. According to Freeman (1984), the stakeholder concept was originally defined as including "those groups without whose support the organization would cease to exist." As a part of management theory and practice, stakeholder theory takes a number of forms. Descriptively, some research on stakeholder theory assumes that managers who wish to maximize their firm's potential will take broader stakeholder interests into account. This gives rise to a number of studies on how managers, firms, and stakeholders do in fact interact. Normatively, other management studies and theories will discuss how corporations ought to interact with various stakeholders.

From an analytical perspective, a stakeholder approach can assist managers by promoting analysis of how the company fits into its larger environment, how its standard operating procedures affect stakeholders within the company (employees, managers, stockholders) and immediately beyond the company (customers, suppliers, financiers). Freeman (1984) suggests, for example, that each firm should fill in a "generic stakeholder map" with specific stakeholders. General categories such as owners, financial community, activist groups, suppliers, government, political groups, customers, unions, employees, trade associations, and competitors would be filled in with more specific stakeholders (Freeman, 1984). In turn, the rational manager would not make major decisions for the organization without considering the impact.
on each of these specific stakeholders (Freeman, 1984). As the organization changes over time, and as the issues for decision change, the specific stakeholder map will vary (Freeman, 1984).

2.2.3 Ethical Theory

Ethics is a branch of philosophy that seeks to define what is right and what is wrong. It helps us understand what actions are wrong and why they are wrong. Across the world, not all cultures share the same ethical commitments, and cultural relativism acknowledges that (Desjardin, 2008).

It is ideal that laws of a particular nation match their ethical commitment; even though some laws are changed to meet the ethical commitments, in most cases one may find that what is ethically right, sometime lacks legal backing. But in such cases, it is only strong personal ethical commitment that can help guide behavior. Even where there is strong personal ethical commitment, there are also cases of conflicting ethical positions (Desjardin, 2008).

There are various philosophical approaches to environmental ethics, but only three will be discussed here; anthropocentrism, biocentrism and ecocentrism. Anthropocentrism or human centered ethics is the view that all environmental responsibility is derived from human interests alone. It assumes that only human beings are morally significant and have direct moral standing. Since the environment is crucial to human well being and survival, there is a duty towards the environment; a duty derived from human interest (Desjardin, 2008). Biocentrism is a life centered moral responsibility. According to the broadest version of biocentric theory, all forms of life have an inherent right to exist (Desjardin, 2008). Ecocentrism maintains that the environment deserves direct moral consideration and not consideration that is merely derived from human or animal interests. It suggests that the environment has a moral worth (Desjardin, 2008).

According to Kaplan (2009) there are three main sources of rules that regulate behavior of individuals and businesses; the law, non – legal rules and regulations and ethics. If a business is breaking the law, by not complying with one of the many environmental laws requirements. The business would want to move from that point of counter compliance. This means taking maximum care of the environment as expected by the society. To get to this point, the business needs to meet its legal and non – legal obligations first. Therefore, law is the minimum level of behavior required. Any standard of behavior below it, is considered illegal and warrants punishment by the society. By meeting non – legal regulations, the business meets a higher level of behavior than just the legal requirement. Ethical behavior is the highest level of behavior that a society expects, hence going green is ethical.

2.2.4 Contingency Theory

Contingency theory as a management approach focuses on adapting management behavior to the particular circumstances of the organization and to each given situation.

The contingency approach is based on the idea that there is no one best way to manage and that to be effective, planning, organizing, leading, and controlling must be tailored to the particular circumstances faced by an organization (Woodward, 1958).
The contingency approach to management (also called the situational approach) assumes that there is no universal answer to some questions which management asks itself because organizations, people, and situations vary and change over time. Thus, the right thing to do depends on a complex variety of critical environmental and internal contingencies (Woodward, 1958).

This viewpoint differs from the "one best way" that the classical management theorists sought because they assumed that management principles are universal, or applicable in all cases, regardless of the organization's unique circumstances. Of course, most of the classical management theorists did not intend their principles to be fixed and all-encompassing; for example Henri Fayol, for one, regarded his principles as general guidelines rather than rigid rules. In the 1950s and 1960s, the research of Paul Lawrence (1967), Jay Lorsch (1967), and others revealed that managers act differently depending on the environment, the technology used by the organization, and other factors. Far from rejecting the management perspectives of the past, the contingency theorists embrace any and all appropriate principles that enable managers to manage more effectively.

2.2.5 Sustainability Theory

Sustainability means meeting the needs of the current generations without compromising the ability of future generations to meet theirs. It seeks to promote appropriate development in order to alleviate poverty while still preserving the ecological health of the landscape. Sustainability works to understand the connections between environment, economy and the society. It emphasizes the importance of fairness and equity and it plans for the long term (UN Commission on Environment and Development Report [Brundtland Commission], 1987).

In 2000, the World Bank published *The Quality of Growth*, advocating a broadening of the growth framework to a complementary agenda that involves key quality aspects in the structural, human, social, and environmental dimensions of sustained growth, emphasizing a more equitable investment in people, the need to sustain natural capital, deal with global financial risks, improve governance and control corruption. The World Business Council for Sustainable Development report (2005), *Creating Business Value and Accountability*, restates the need to increase accountability and change the business approach to sustainable development. Accountability and value creation must be made mutually reinforcing throughout any enterprise, integrating sustainable development amongst all areas of business practice, rather than creating a 'specialist silo.' Although not specific policy responses, the two reports suggest a change in the policy outlook of international institutions (WBCSD, 2005).

According to a research report from the Economist Intelligence Unit by ExxonMobil, illustrates the growing importance of corporate sustainability in enabling companies to compete and to attract customers. Business both impacts and relies on the availability and health of our natural resources. In recognizing this connection and protecting wildlife habitat and biodiversity in and around their operations the survey claims that the adoption of sustainable practices does not cause companies’ share prices to rise. It could be that companies with a strong financial performance simply have more resources to devote to sustainability. What the findings do show, however, is that it is possible to take a proactive position on social and environmental issues while still delivering robust financial growth. Understanding the full life cycle of their operations is important to operating in an environmentally sustainable manner and involves
four key steps: Assessing the surroundings; Designing the facilities and operations; Operating with integrity and Restoring the environment.

Environmental change and uncertainty, work technology, and the size of a company are all identified as environmental factors impacting the effectiveness of different organizational forms. In particular, theorists have applied contingency theory to management problems of leadership, decision making like going green, organizational change, employee motivation, human resource management, and organization structure (Woodward, 1958). As a result, managers have a new set of techniques to try, including situational leadership styles like going green.

2.2.6 Theoretical Framework

The theoretical framework below follows the discussion under 2.2 Theoretical review, from page 14 to page 21.

![Theoretical framework diagram]

Figure 1: Theoretical framework, (Source: Author, 2010)

2.3 Empirical Review

Literature on business development up to the 1980’s showed market forces and environmental interests as irreconcilable, and the views of the business community as placing environmentalism in the realms of being ‘anti-business’, ‘anti-industrialization’, and ‘anti-civilization’(Menon and Menon, 1997).

During the latter stages of the 20th century, however, attitudes from business changed with growing recognition of the need to respond to the demands of customers. Jaworski and Kohli (1993) wrote that business development was now geared to respond to ‘changing market place needs’, which might be expected to include any customer expectation of demonstrable commitment to environmentalism. Studies from the 1990’s (Forte and Lamont, 1998; Gifford Jnr., 1997; Gillespie, 1992) showed that organizations that took proactive measures to implement environmental business practices produced higher levels of profitability and protected their stock value better than those that were reactive or inactive.
Other work (Maxwell et al., 1997; Menon and Menon, 1997; Berry and Rondinelli, 1998) showed a move by major organizations towards placing emphasis on environmental orientation in development of strategy. However, whilst major organizations showed growing evidence of environmental orientation, Aragon-Correa (1998) wrote that, as most strategically proactive firms were inclined to employ both ‘traditional corrective’ and ‘modern preventive’ approaches to the natural environment, there was little evidence of, or support for development of proactive environmentalism in other organizations.

Whilst most management literature has now moved beyond the simplistic and naive concept of strategy as the rendition of the CEO’s personal mission statement (Hax, 1994), Aragon Correa (1998) highlights that the role of the natural environment has until recently received little attention in business literature. Organization theories concerning the need for firms to adapt to their contexts have consistently ignored the importance of the natural environment. This, despite the wider view of strategy (Hax, 1994) as the economic and non-economic contribution the firm intends to make to its stakeholders. Stakeholders are not only those with direct financial and contractual links to the organization but include communities, government, and others. As Andrews (1994) states, strategic decision making is concerned not only with what an organization might do, can do, or may want to do. Here, what a company should do…appears as a fourth element of the strategic decision.

The academic literature in the 1990’s included a number of works on environmentalism from a strategic perspective (Maxwell, 1997, Aragon-Corea, 1998). These works propose a strategic approach to environmental management. At the same time, some of the managerial literature includes mention of environmental regulation and/or impact (Minzberg and Quinn, 1996), or of product safety and environmental standards (Montgomery and Porter, 1991). Recent literature has been explicitly advocating the integration of environmental issues into business strategy and the strategic planning process (Hutchinson, 1992; Rugman and Verbeke, 1998; Judge and Douglas, 1998). Hart (1997) states that companies need to look beyond the greening effort … to a more comprehensive strategy, whilst Berry and Rondinelli (1998) suggest that progressive companies are already moving forward from simple compliance to proactive strategies and management of the environment. In the academic literature (Gladwin, Kennelly, & Krause, 1995; Purser, Park, & Montuori, 1995; Shrivastava, 1994), however, it is highlighted that within the managerial literature on strategy, the term ‘environment’ appears generally to be taken to refer to the organization’s wider external operating environment (De Wit and Meyer, 1994; Johnson and Scholes, 1999) rather than to the ‘natural’ environment.

In much of the literature that discusses environmentalism in relation to economics, we find a dichotomous, conflict-oriented approach to economic interest against sustainability (Wheeler et al., 2000). Organizations are presented as viewing their environmental responsibilities as being a balancing act between taking care of Mother Earth on the one hand and pleasing profit-hungry shareholders on the other (Gifford, 1997). Porter and Van Der Linde (1995), however, propose an interesting and controversial approach to consideration of the environmental/economic paradigm. They propose that the environment against economic interest debate has been so far ‘framed’ incorrectly and that the alternative is a dynamic environment-economic paradigm based on innovation. They propose that environmental legislation, rather than constraining business, acts as a trigger for companies to realize their competitive advantage through
innovation. This innovation not only results in superior products and processes but also reduces costs as operations become more efficient. They support the idea that this will be at no real cost to the companies.

However, Palmer et al (1995) think differently. They do not agree that companies systematically overlook opportunities, or that governmental action in legislating for environmental action will correct this ‘failure’. Xepapadeas and Zeeuw (1999) support this view, stating that if opportunities do exist, companies do not need the incentive of extra costs in order to recognize them. Further, Palmer et al (1995) express concern for the situation in which environmental regulation may cause some companies to fall into bankruptcy, indicating that the resulting innovation is not a free meal after all. In a situation where consumer pressure (Environics, 1999) and legislative frameworks are on the increase and companies have to cope with these, the question is whether they take a proactive attitude or adopt strategies of revenue protection. The financial benefits of environmentally sound activities are propounded by some (Gifford, 1997) but the initial cost of achieving new environmental standards remains an area of debate (Porter and Van Der Linde, 1995), and there is some concern at the resulting financial pressures facing smaller firms (Palmer et al, 1995).

Whilst there is evidence in much of the literature of a general agreement that environment should become core to businesses and that value lies in proactive strategies, there is still little evidence of widespread integration of environmental decisions such as going green and the business strategy process. In some of the literature there seems to be a consensus that environmentalism should be proactively pursued (Rugman and Verbeke, 1998). Yet, some of the discussion (Maxwell, 1997) of the need for corporate environmental strategies provides no explicit explanation as to how this contributes to the achievement of the overall strategic goals of the company. There seems to be a divide between business strategy and environmental strategy, with the two existing within parallel systems rather than within an integrated business model.

**Conceptualization**

Going green, which addresses environmental issues through product design and innovation, is receiving significant attention from consumers, industries, and governments around the world. Going green is not enough on its own but must be anchored to reality. One cannot gainsay the fact that there are factors that influence an industry or entity to go green. The conceptual framework of this study draws that besides the various theories that merge up to going green, there are other independent factors that allow a company to embrace the green values and go green Enger and Smith (2008). The concept is based on the belief theoretical inclination a company chooses to take is influenced by what I choose to call ‘extra-company contextual forces’ which dictate going green.

**2.4.1 Market Demand**

Green products are emerging from the demand-pull of customers with new attitudes towards environmental values (Simon 1992). Both the Roper Organization (1990) and Simmons Market Research Bureau (1992) have proposed to segment customers according to their environmental awareness and attitudes. A survey conducted by the Gallup International Institute (1992) reports that 65% of Americans, 59% of Germans, and 31% of Japanese express their willingness to pay a green premium on an eco-safe
product. Bei and Simpson (1995) suggest that, in addition to the utility obtained directly from a purchased good, green consumers also receive psychological benefits from buying an environmentally friendly product.

2.4.2 Standards

Going Green is also stimulated by various forms of environmental standards imposed by governments around the world, which have become increasingly more stringent in the past thirty years. Traditionally, environmental legislation in the United States and several other countries has been limited to the end-of-pipe control approach that merely focuses on controlling the environmental damages caused by the outputs from industrial activities. Such an approach, however, has often resulted in transferring pollutants from one medium to another and, in many cases, is not cost-effective (Jain, 1993). Going green, which aims to prevent pollution from the beginning through product design and innovation, has thus emerged as an innovative and sustainable tool for solving today's environmental problems.

In response to the increasing public interest in environmental protection, many companies have been actively engaging in designing and marketing environmentally friendly products. For a long time, major paper companies have supplied their customers with both recycled and non-recycled papers. In addition to the automobile manufacturers' efforts to produce and market electric vehicles, many other companies have introduced green products along with their traditional products, such as IBM's "Green" PS/2 Computer, Toro's grass-recycler mower, and Melitta's unbleached coffee filters (Gillespie, 1992). A few companies and industry associations have even adopted some voluntary environmental standards on their products that go beyond the control levels required by the government (Roome, 1992). Spurred by the global trend of adopting the environmental management standards specified in ISO 14000 and attracted by the estimated $56 billion opportunity for environmental products and services (Ottman 1992), green product innovations have received significant attention in today's marketplace.

2.4.3 Management Voluntary Approach

Sullivan (2008) defines voluntary approaches as ‘schemes where organisations agree to improve their environmental performance beyond legal requirements’. However, these ‘voluntary’ actions are often undertaken due to different pressures on the company, as for example pressure from consumers or community, pressure from the other companies in the industry, competitive pressure or the probability that a new environmental regulation will be introduced by the government.

Voluntary approaches can result in many financial benefits for the company, e.g. better compliance (the company can individually set the target abatement level and design their compliance strategy based on their own information, thus uncertainty and the risk of asymmetric information is reduced), improved litigation risk management, better relations with shareholders and society, improved brand or reputation, better morale within the participating parties. Moreover, there are other benefits, such as gaining knowledge on possible abatement technologies that can be used, sharing of information and experience, etc.

On the other hand, one has to realize the disadvantages of voluntary approaches, like: sometimes low environmental effectiveness (when low abatement level has been achieved), lack of reliability (some of
the agreements do not imply any penalties for non-compliance), questionable efficiency benefits (it has been found that companies use a uniform standard instead of differentiating their strategy to obtain the lowest abatement costs), very often it is used to avoid stringent environmental regulation that might be implemented (Sullivan, 2008).

Nevertheless, the voluntary approaches can play two significant roles in environmental policy area. First of all, it can be used as a transitional policy instrument for the company to prepare for the introduction of a new or more stringent regulation, as well as to encourage leadership and innovation.

Secondly, voluntary approach might be used as a mechanism to address some of the limitations of the corporate cost-benefit assessments (for example to turn the focus of investments on long-term business sustainability instead of short-run returns) (Sullivan, 2008).

That the market, the management voluntary approach, the profits, the technology advancement, the laws and the standards and the profits of the company dictate the drive towards going green the establishment needs to be made. These external factors married with the integrated theoretical approach would then influence the strategic inclusion of going green in company long-term management plans.

Research Methodology.

Design of the Study

The research design used in this study was be descriptive in nature, which describes the characteristics that relate with the subject population. Descriptive studies serve several purposes: the discovery of associations among different variables; and discovery and measurement of cause and effect relationships among variables (Cooper and Schindler, 2000). Samples were selected from the target population to represent the area of study. The descriptive research would be facilitated by the general explanation of the problem in order to improve the understanding of the problem under study. Descriptive research would help the researcher know the state of the problem as it exists.

Target Population

Cooper and Schindler (2000) define population to mean that total collection of elements about which we wish to make inferences.

The target population in this study was small and Medium sized Enterprises (SMEs) operating in Kenya and the companies picked formed a representative of the whole number at large. According to Business Daily, special issue of October 2009, Kenya has more than 800,000 SMEs and this was the targeted population for the study. With reference to the cost effectiveness, Nairobi area is a good research sample as compared to a country wide research, which is coupled with other strains like time consumption. The sample though selected from Nairobi, represented a country wide population and not just Nairobi.

Sample Design and Sample Size
The study adopted survey research design which entailed an in-depth empirical collection of data. The design was suitable for the study because it enabled the researcher to collect facts and views from diverse categories of respondents.

Availability sampling was used as method of choosing subjects who are available or easy to find. The primary advantage of this method was that, it is very easy to carry out relative to other methods. The design was easy, particularly the ready known list of respondents.

Purposive or judgmental sampling was also used to select the sample. This called for the expert judgment to select cases that would best enable to answer the research question and meet the research objective. Neuman (2000) says that it works well with a small sample in a case study when you select cases that are particularly informative. Using the judgment of the researcher he picks the extreme cases, heterogeneous, homogenous, critical and typical cases.

In total they are about fifty enterprises specifically selected in Nairobi. They include manufacturing and service providing companies. In these selected companies, the number of respondents will be three; two executives and one other member of staff.

These companies consisted companies named in the top hundred SMEs in 2009 by a survey conducted by KPMG, but the first 50 companies will be taken.

The sampling size for the study was a list of 150 employees (executives and other staff members) obtained from those identified enterprises in Nairobi 3 employee from each named company.

This number was used since it is easier work with already known companies as a representative of the other companies. They have been chosen because it is convenient, cheap and manageable to conduct because of proximity and the choice of the sample rather than a country wide study.

**Sample size**

<table>
<thead>
<tr>
<th>Category</th>
<th>Sample size</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management (Company executives)</td>
<td>100</td>
<td>67</td>
</tr>
<tr>
<td>Other employees</td>
<td>50</td>
<td>33</td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>100</td>
</tr>
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*Table 1 Sample size, (Source: Author, 2010)*

**Data Collection Instruments and Procedures**

Questionnaires were distributed to respondents through hand delivery. This enabled the researcher to clarify any issue that may not have been clear. Before the actual administration of the questionnaire which will be developed on the basis of the research questions, it will be tested by researcher.
One research assistant was trained on how to handle, communicate and interview respondents where possible and at the same time administer the questionnaire and assist in data entry.

After distribution the researcher gave the respondent one week to complete the questionnaire. After the expiry of this period, the researcher collected the instruments for analysis.

**Data Analysis and Reporting**

The quantitative method of data analysis was used. The data was analyzed using the Excel Package and presented using tables and charts to give a clear picture of the research findings. Denscombe (1998) states that descriptive statistics involves the transformation of mass raw data into tables, charts to make sense from the data in frequency distribution and percentage.

**Ethical Issues**

The respondents were informed about the confidentiality of the interview and data collection, and that the study, is for academic purposes only. A copy of an introductory letter from the student was given to the respondent to affirm this. The interviewer would respect the respondent views, those who want to come on record willing to be named but not attributed to their quotes and those who want to maintain complete anonymity with reference to the study, will all be taken into account.

**FINDINGS AND DISCUSSIONS**

**Findings**

5.1.1 Energy efficiency drives going green.

65% of the respondents (from figure 10) believed that potential cost saving from energy efficiency was the most important factor that companies consider when making environmental decisions. This had a direct bearing on the bottom line – the very reason why companies go into business. From figure 11, energy efficiency was cited by the respondents as the top research and development priority now at 40% and in two years, at 31%. This meant that companies are investing more now and will continue to do so especially with the cost of traditional non-renewable energy sources rising by the day. As seen from figure 11, 32.7% of the respondents say that their companies are already designing products and processes that minimise, eliminate or reduce environmentally sensitive materials and 25.9% say they will continue to do so in two years time.

5.1.2 Concern on regulation

A key driver in going green was the worry that there will be legislation, regulation as (see figure 14) 52% of those businesses whose managers are committed to the pursuit of a bottom line that includes environmental stewardship believe in self regulation or even a consumer hostile response against companies seen to be environmental spoilers. Consequently, many actions taken by leading companies are intended to avert regulation and promote a greener image.
For example, companies are developing formal environmental policies, auditing internal green practices, appointing senior executives to oversee green initiatives and creating a clearer linkage between green initiatives and performance. A growing number are also increasing the degree of external reporting relating to environmental sustainability. 55.7% of the respondents from figure 10, think that complying with environmental legislation and regulation is an important factor that is considered by the organizations in deciding whether to go green or not. This is only second to energy saving considerations.

5.1.3 The rise of Green products and service change

The motivation to go green for service companies as seen from table 3 was driven by the quest for market opportunities at 46% and customers demand for those in manufacturing at 36%. Since companies exist to serve these interests, the need for environmentally friendly products would continue to rise. The impact felt on company operations as seen on figure 12 will continue to rise in all sections of any business. In manufacturing for instance, 15.5% of the respondents feel the impact now and think this will rise to 23.6% in two years time from figure 13. In Sales and Marketing, the impact now stands at 6.1% and will rise to 37.2% from figure 13 in two years time. Both consumer and business customers demand will continue to rise in future as seen in figure 7. Demand for green type of products and services will continue to rise as reported in figures 8 and 9. The analysis on figure 6 also shows significant market opportunities available from going green. This means that the change to go green will continue to take place as people become conscious of their impact on the environment.

5.2 CONCLUSION

Even though it cannot be said for certain that environmental debate will have a real effect on industries in Kenya in the near future, I believe that the incentives to go green are strong enough to motivate integrating environmental values into companies’ core strategy. The potential to reduce cost, increase market share and reduce financial and business risks are worth the peril investing in a greener business. However, the challenges the SMEs reported ranged from lack of a proper regulatory framework as discussed in 4.2.5 and on figure 14, the cost of going green as the consumers are not ready to shoulder the costs seen in figure 4 and plain lack of information on the opportunities and impact of environmental stewardship as seen by the number of respondents in figures 5, 6 and 12.

A growing number of market participants now take a dim view of hazardous substances, solid waste and the emission of greenhouse gases.

The reason companies are examining their green practices is because of genuine market opportunities. Consumer demand for green products is on the rise. Business customers are increasingly mandated to purchase green where available, and the spectrum of products covered by such provisos is growing. In business customers, if they demonstrate a return on investment in green products, then demand will materialize. Here, the greatest opportunities are in products that reduce energy consumption. Even so, a growing number of business buyers can be expected to be motivated by nothing more than the desire to be perceived as supporting environmental sustainability.
So change is coming. The green in products is being installed in the R&D phase. Products are being reconfigured and redesigned to use fewer hazardous substances, require less shipping material and flight miles, operate on less energy and promote end-of-life recycling.

So in terms of environmental sustainability, the industries are embracing change. They are changing to avoid negative consequences or to meet green demand or to achieve both. Whatever their motivation, as this survey and these interviews demonstrate, they are incontrovertibly shifting toward green.

Different measures were used in order to assess the influence of the environmental regulations on the companies’ competitiveness. It was found that there is no or little loss in competitiveness after implementation of environmental policies. Furthermore, it was observed that introduction of more stringent environmental standards again did not have a significant influence on the companies’ competitiveness. What is more, the compliance with environmental standards can lead to a gain in companies’ competitiveness.

It has been presented that companies have incentives to voluntarily improve their environmental performance in order to increase their domestic and international competitiveness. There are a lot of important disadvantages of voluntary approaches, and therefore the government cannot base their strategy using this tool only, however it is a powerful tool and it should be continuously used. Still, the command and control and the market-based instruments should also be used as well, depending on the situation. If there is an urgent need for a regulation, the command and control instruments would be used, which could cause high costs for the companies. Therefore, it is beneficial for the companies to have a good environmental management system and to control their pollution and any waste production because with increasing awareness and boost of research in this field, more stringent regulations will be imposed. As proposed by Porter et al. (1995), it might be more appropriate for a long-run analysis since innovation and changes (especially considering the field of environmental protection) need considerable amount of time to take place and characterize with low rate of return on investments. Thus, it is possible in the long-run that (stringent) environmental regulation will give incentives for the company to invest and innovate, which in the future could give a lower net cost of compliance (‘innovation offsets’), leading eventually to net benefits.

Thus, if the company is aware of its impact on the environment it can be better prepared (investment in pollution prevention technology, waste-reduction equipment, etc.) for the forthcoming policies and thus have a comparative advantage over others.

5.3 RECOMMENDATIONS

5.3.1 Integrate Environmental Concern into Companies Strategic Plans

Today, companies have a strong focus on quality, functionality and style when designing and developing products and services portfolio. This focus is not something that just happened but is as a result of strategic thinking and planning aimed at producing products and services that target specific segment of customers and market trends.
Most companies’ strategic plans have no mention of environmental goals or values and it has therefore not become very important either. I feel that it is important that environmental issues are integrated in strategic plans.

5.3.2 Increase Competence through Education or Awareness.

To be able to become green organization, the employees working at various companies need to understand the impact their actions have on environment from many perspectives. This understanding is lacking in Kenyan companies and in order for a company to become truly green they need to bring new knowledge into the organization.

5.3.3 Forming an Environmental Strategy.

In order for a company to clearly focus in environmental work an environmental strategy is needed.

Renato Orsato (2006) presents a framework inspired by the Boston Consulting Group (BCG) matrix. In the matrix, Orsato presents the relationship between competitive advantage and competitive focus in environmental strategy. Figure 18 below, separates four possible environmental strategies that can be implemented to gain competitive advantage in a company’s business environment.

The first strategy is labeled the Eco-efficiency strategy. Companies that employ this strategy seek to both lower their environmental impact while at the same time lowering the cost of their organizational process and operations.

The second competitive strategy is termed as Beyond Compliance Leadership strategy. Here, a company differentiates itself by excelling in the environmental performance of its internal process. This strategy is often employed by companies who are under public or regulatory pressure to improve their environmental performance. One action that companies striving to move towards strategy two often take, is to comply with the reporting standards required.

The third competitive strategy is called Eco-Branding strategy. This strategy is distinguished by a company offering products and services with green appeal that is difficult for its competitors to follow or imitate.

The final strategy is termed Environmental Cost Leadership strategy. The companies following this strategy not only offer products with good environmental performance but also with a lower price than its competitors.
Organizational process | product & services
---|---
Lower cost | Eco-Efficiency | Cost Leadership
Differentiation | Strategy 2. Beyond Compliance | Strategy 3. Eco-Branding

Figure 18: Generic Competitive Environmental Strategies (source: Orsato, 2006)

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THE EFFECTS OF PERFORMANCE APPRAISAL SYSTEM ON CIVIL SERVANTS JOB PERFORMANCE AND MOTIVATION IN KENYA:
A CASE STUDY OF MINISTRY OF STATE FOR PUBLIC SERVICE

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Abstract.

Performance Appraisal System (PAS) which can be defined as the process of determining and communicating to an employee how he or she is performing on the job. The system (PAS) began to be practiced in the world mainly in the 1940s and through this system, merit rating was used for the first time around the Second World War as a method of justifying an employee’s wages. The process was based on material outcomes where higher output was rewarded with higher pay. Since then, PAS has spread to many parts of the world where is being practiced like in Singapore. In Kenya, PAS within the Civil Service was introduced around 2006 and has over the years become a popular staff management system driven via the popular government performance contracting initiative. The system is being embraced in the Kenyan public service for tracking employees’ performance in service delivery. PAS has signaled possibility for improved performance in civil service productivity and employee motivation. Despite the impressive performance and staff motivation signals elicited by PAS in civil service, no detailed description of the situation has been done. This study then sought to assess the effect of PAS in job performance and employee motivation in the Ministry of State for Public Service. The project sampled staff randomly from also randomly selected departments who were interviewed using pre-tested questionnaires and through focused group discussions. Data was analyzed using appropriate statistical applications in SPSS. The researcher concluded that employees at the MSPS are usually involved in the setting of performance targets. They are also substantially appraised against the targets set at the beginning of the appraisal period. The study revealed that employees were given feedback to enable them improve their performance. This shows that PA has a positive impact on the employee’s performance which leads to motivation. The Ministry was for example number seven in the recent performance rankings released by the President and Prime minister. Based on the findings of this study, the following recommendations among others are made for consideration by the MSPS so as to enhance the employee’s work performance. PA is a good management tool but is should be subjected to continuous reviews in
INTRODUCTION

1.1 Study Background

Performance Appraisal (PA) has been defined as “the process of determining and communicating to an employee how he or she is performing on the job and ideally establishing a plan of improvement”, Byars and Rue (2000). Dessler (2005) defines performance appraisal as “evaluating an employee’s current and past performance relative to his/her performance standards”. Therefore, if PA is successfully carried out in an organization, the employees would be able to know how well they are performing and what is expected of them in future in terms of effort and task direction through an established plan for performance improvement.

The Draft Performance Appraisal System Policy for the Public Service in Kenya (2008) views PA as the process of assessing and recording staff performance for the purpose of making management decisions on the staff.

Performance management is a joint process that involves both the supervisor and the employees to identify common goals which correlate to the higher goals of the institution (Rogers, 1995). In her study on Performance Improvement in the civil Service Marangu (2004), noted that performance management is a formal process through which employees and their supervisors/managers world over jointly define goals, major areas of responsibilities in terms of the expected results and the use of these measures as guides for future performance and subsequent review of performance. PA may therefore be said to be a continuous process which entails setting direction and standards, monitoring and measuring of performance.

Performance Appraisal began to be practiced in the world in 1940s. Merit rating was used for the first time around the Second World War as a method of justifying an employee’s pay/wages (Moorhead and Griffin, 1992). The process was based on material outcomes where higher output was rewarded with higher wages/pay and vice-versa. However, early researchers realized that employees with almost equal ability to work and pay had different levels of motivation towards work and also performance (Dulewicz, 1989).

Today, PA is one of the key elements of any organization’s drive towards competitive advantage through continuous performance improvement (Bratton and Gold, 2003).

In the absence of a well structured PAS, managers will therefore have a tendency of judging employee work performance informally and also arbitrarily (Dulewicz, 1989).

In Singapore, a fast developing country for example, PA in the Public Service is known as PRAISE (Promotion, Ranking and Appraisal System). (Singapore Public Service Division, 2009). In the south Africa, PA has been used to help public servants know what is expected of them, increase motivation, identify poor performance, improve poor performance, recognize and reward outstanding performance
PA in Great Britain according to the scholars is to set objectives and improve performance.

In Kenya, the appraisal system in use in the Civil Service was introduced in 2006. This was as a result of the Ministerial rationalization. The process was a Government initiative whose aim was to enhance efficiency and effectiveness in public service delivery through review of systems, processes and structures in the ministries and departments (Guidelines on Deepening Rationalization, 2002).

One of the guidelines of Rationalization was the inception of a Performance Appraisal System (PAS) which would involve participatory work planning, performance discussions and performance evaluation. This was a deliberate effort aimed at linking staff appraisal to individual work plans.

The Vision 2030 goals include improved performance and quality service delivery, promotion of transformative leadership in the Government of Kenya (GOK) and improved GOK service delivery that meets expectations of the citizens, among other clients (Kenya Vision 2030, 2008).

1.2 Statement of the Problem

The MSPS, has PAS which was established in July, 2006. PAS plays an integral role in the employer’s performance management process as it translates employer’s strategic goals into an individual employee’s goals. PAS is aimed at helping in identifying staff capabilities and aptitudes that match the expectations of their jobs in terms of job knowledge, skills and attitudes, thus enhancing motivation, morale and job satisfaction. This is in line with one of the objectives of PAS in the Public Service which is to increase motivation to perform effectively (Draft Performance Appraisal system Policy for the Public Service, 2008).

Although the PAS was introduced in the MSPS four years ago, there is however no information on whether it has had any effect on employee motivation. In the report on Implementation of Staff Appraisal, (2008), the progress made and the challenges faced upon introduction of PAS were identified and highlighted. However, the report fails to provide findings on staff motivation. Other studies and reports on PAS appeared to provide unclear indication on impact of PAS on staff motivation. For instance, the study on Impact of Remuneration review on Productivity in the Public Service (2008), the Permanent Public Service Remuneration Review Board (PPSRRB), MSPS and the Productivity Centre of Kenya, Ministry of Labour and Human Resource Development also appeared to have largely avoided a detailed description of PAS association with staff motivation. The study only superficially reported that some public servants believed that the reward and recognition systems in the Public Service were adequate and did not generally recognize performance. As a result, a detailed description of PAS on staff motivation and performance particularly in the civil service is necessary.

2.1 General Objectives

This study sought to assess the effect of PAS job performance and employee motivation in the civil service, Kenya.

2.2 Specific Objectives
The specific objectives of the study were to-

1. Examine perception of employees at MSPS
2. Examine levels of employees’ motivation at MSPS.
3. Assess employee challenges in complying with PAS.
4. Identify and recommend areas of PAS improvement it more efficient.

2.3 Significance of the Study

This study was expected to contribute to the knowledge base on Human Resource management in the areas of PA and motivation. The study findings also provide a link between effective performance, appraisal and motivation in the MSPS and the larger Public Service in general. This may lead to attraction and retention of qualified personnel in the Public Service who will be assured of requisite rewards for high levels of performance. The study could benefit other organizations (both public and private) in coming up with an effective PAS. The study would also be useful to HR practitioners since one of the functions of HR management is performance appraisal. The citizens of Kenya who may be interested in the area of PA could also benefit from the study findings. Finally, the study would help other researchers who might want to undertake research in the area of staff appraisal, performance and motivation.

2.4 Scope of the Study

The study focused on employees in Job Groups “H” to “U” in the MSPS headquarters, Nairobi.

2.5 Conceptual Framework

Performance appraisal was expected to result in improved work performance through a motivated workforce. For this to happen, it would be assumed that each employee understands what levels and standards of performance is expected of him. PA involves four (4) basic component which have been summarized by Posthuma and Campion,(2008) as goals, measurements, assessment and feedback. These components characterize the relationship between the supervisor and appraise which may result in motivation or lack of it.

![Conceptual Framework Diagram]

**Independent Variables**

- Objectivity
- Accuracy
- Relevance
- Feedback

**Dependent Variable**

Motivation

Fig 1.0 Schematic Conceptual Framework

2.5.1 Explanation on the Conceptual Framework
Employees’ goals are adopted from an organization’s mission, vision and strategic plan. In the Civil Service, they are cascaded from the Kenya Vision 2030. The goals are then broken down into targets and incorporated in the employee annual work plan. PA involves an employee knowing what is expected of him and staying focused with the help of the supervisor (Casio, 2003). This is only possible if the employee and his supervisor agree during the appraisal process. Assessment involves assessing employee’s performance against the targets or objectives set at the beginning of the appraisal period. Assessment is the review of an individual employee’s performance during the appraisal period. Assessment determines the extent to which the employee has met the set targets. During assessment, the actual performance of the employee is compared to the previous appraisal period and also what was agreed upon at the beginning of the present period. Regular assessment enable the employee to focus his attention on what he is expected to do (Casio, 2003). Feedback involves the appraiser providing the appraise with information on their performance from time to time. Positive feedback refers to emphasis being made on work done well while what needs to be improved is communicated to the employee through constructive criticism. The supervisor and the appraise should exchange views continuously on how performance can be improved.

LITERATURE REVIEW

2.1 Introduction

Organizations aim at achieving high and sustained performance through the HR. PA is one of the important components in the rational and systematic process of HRM (Answers.com). The information obtained in the course of and at the end of PA process provides a foundation for recruitment and selection, training and development of existing staff, and motivating and maintaining a quality human resource through adequate and proper rewarding of their performance. Therefore without a reliable PAS anchored on the elements of objectivity, accuracy, relevance and feedback, the HRM system may fall apart. This may result in the total waste of the valuable human resource.

2.2 Theories of Motivation

Famous scholars such as Maslow A., Vroom V. and Hertzber F have tried to come up with various theories of motivation.

2.2.1 Abraham Maslow’s hierarchy of needs Theory

Abraham Maslow’s hierarchy of needs theory provides an insight into what basically motivates employees. Maslow (1943), came up with five levels of needs. These are; Self Actualization (highest level), Esteem (level 4), Social belonging and Love needs (level 3), Safety (level 2) and Physiological (lowest level). The scholar believed that motivation is driven by the existence of these unsatisfied needs, Silva (2009). According to the theory, if employees are to be motivated, the lower level needs have to be met before the next higher level of needs. After the lower level of needs have been satisfied, the employee will be motivated to satisfy the next higher level of needs. An example is when an employee at the lowest level of the hierarchy will only be motivated by good pay in order to afford his basic needs rather than safety of his work area and stability of the job. The hierarchy of needs theory also shows that employees do differ from each other. If they are therefore to be motivated, the management will have to
look into their needs first and then develop suitable motivation techniques. In an organization, the PA targets set at the beginning of an appraisal period may be viewed as some of the needs employees have to satisfy within the appraisal period.

### 2.7.2 Hertzberg Two Factor Theory

Hertzberg’s two factor theory basically identified two separate groups of factors that impacted strongly on motivation. His first group of factors was the hygiene factors which consisted of factors such as working conditions, quality of supervision, salary, status, safety, company policies and administration. The hygiene factors strongly influence feelings of dissatisfaction among employees which affected their job performance according to Weihrich and Koontz (1993). However, Hertzberg also pointed out that although the presence of these factors will not basically motivate the employees as such, they are necessary to have them right in the first place, if the organization intends to motivate the factors. The second group of factors identified by Hertzberg was the motivating factors which included recognition, achievement, responsibility, interesting job, growth and advancement to higher level tasks. According to him, these factors do bring job satisfaction among employees which will eventually lead to employee motivation.

Hertzberg’s two factor theory may provide managers with an understanding as to how employees could be motivated. The theory also pointed out those factors motivating employees may not just be possible without the presence of intrinsic factors.

### 2.7.3 Vroom’s Expectancy Theory

In his Expectancy Theory of 1964, Victor Vroom believed that employee effort paved the way for job performance and job performance led to rewards (Weihrich and Koontz, 1993). Vroom highlighted the fact that employees tend to believe that putting effort will lead to good performance and likewise the good performance will be rewarded. It is therefore these rewards that motivate the employees. If the rewards are positive and welcoming, then the employees will obviously be motivated, or else if they turn out to be negative or not attractive, then the chances of employees being demotivated are high.

### 2.7.4 Adam’s Equity Theory

Adam’s equity theory of motivation points out the fact that managers should seek a fair balance between the employee’s inputs (effort, loyalty, hard work, sacrifice e.t.c) and their outputs (recognition, salary, status e.t.c), in order to motivate employees (Weihrich and Koontz, 1993). He added that it is extremely important to make an employee feel that he is treated fairly if the managers are to achieve positive outcomes and motivate the employees effectively. If however the employees feel that they have been treated unfairly (their inputs are greater than the outputs), then they will be de-motivated and this will reduce their inputs such as effort.

Motivated employees are needed for an organization’s survival in a highly competitive world. Motivated employees are more productive hence managers need to understand what motivates employees. One of the managerial functions is employee motivation. However this function is rather complex since what motivates an employee today may not necessarily motivate them tomorrow (Kovach, 1987). An example
is when an employee’s income increases; money becomes less of a motivator. In addition, as employees get older, interesting work becomes more of a motivator than pay (Linder, 1998). In a study on *Performance Improvement in Kenya Public Service*, (2004), Marangu noted that motivation is an aspect of management that requires human behavior to be manipulated in order to harmonize an individual employee’s goals to this of the organization.

Therefore well motivated employees are those who work along clearly defined goals and who take action which will result in these goals being met. Employees who manage to motivate themselves seek, find and carry out work that satisfies their needs. However, majority of employees need to be motivated by the management through pay, praise, promotion, transfer, training and development in order to improve their performance.

**METHODOLOGY**

3.1 Introduction

This chapter discusses the methodology that was used during data collection and analysis.

It also covers the area of study, target population, sample size, sampling procedures data, collection instruments, methods of data analysis and presentation.

3.2 Location of the Study

The research was carried out at the Ministry of State for Public Service (MSPS) which is part of the central Government. The ministry has a total of about 600 officers ranging from the lowest rank (Job Group “A”) to the highest (Job Group “U”) at the time of the study. These officers are distributed in the departments located in Nairobi (HRM, HRD, MCS, PPSRRB and Finance and Administration) and GTIs (Mombasa, Matuga, Embu and Baringo) which are located outside Nairobi. Employees working outside Nairobi were not take part in the study due to time and financial constraints. In addition, Kenya Institute of Administration (KIA) and Kenya Distance Learning Centre (KDLC) staff were not form part of the study since both do not fall under the central Government. The Departments which were included are those whose employees are paid directly from the Ministry’s payroll.

3.4 Target Population

The study population was drawn from the MSPS management cadre which comprises officers in Job “H” and above. These are the officers who were subjected to PA. There are 354 officers in these Job Groups at the Ministry.

3.5 Sampling Technique and Sample Size

The study adopted stratified random sampling. The target population will be divided into twelve (12) sub-groups. Elements will then be selected randomly from each sub-group. The elements selected to represent each sub-group was be based on its size and the nature of its characteristics. A Job Group may for example comprise officers from different cadres (HRM, HRD officers and Management Consultants or Supporting staff).
The study was based at the Ministry headquarters due to tome factor and financial constraints. The final group of selected employees was drawn from the 207 employees based at the Headquarters. These included top management (Job Groups “R”, “S”, “T”, and “U”), middle management (Job Groups “L”, “M”, “N”, “P” and “Q”) and junior management (Job Groups “H”, “J”, and “K”). A total of 74 respondents were selected from the twelve sub-groups. This was one third (1/3) of each sub-group rounded up to the higher whole number as indicated in Table 3.1:

**Table 3.1: Sample Design, Sample Size and Categories**

<table>
<thead>
<tr>
<th>Category(Job Group)</th>
<th>Total Population Size</th>
<th>Target Population (Ministry Hqs)</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>T</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>S</td>
<td>6</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>R</td>
<td>14</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>Q</td>
<td>18</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>P</td>
<td>41</td>
<td>35</td>
<td>13</td>
</tr>
<tr>
<td>N</td>
<td>44</td>
<td>24</td>
<td>8</td>
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<tr>
<td>M</td>
<td>27</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>L</td>
<td>25</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>K</td>
<td>38</td>
<td>26</td>
<td>9</td>
</tr>
<tr>
<td>J</td>
<td>77</td>
<td>44</td>
<td>15</td>
</tr>
<tr>
<td>H</td>
<td>61</td>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>354</strong></td>
<td><strong>207</strong></td>
<td><strong>74</strong></td>
</tr>
</tbody>
</table>

**Source:** Research Data

### 3.6 Data Collection Instruments

The researcher used both primary and secondary data during the research. Primary data collection instruments were a combination of questionnaires and interview guides. In addition, the researcher made use of secondary data sources and literature. The questionnaires were self-made. To ensure that they were reliable, a pilot study involving seven (7) randomly selected respondents were carried out. The respondents came from various departments, but not the actual sample. The pilot study assisted the researcher in making the necessary corrections on the instruments, before carrying out the actual research.
The questionnaire consisted of structured (close ended) and unstructured (open ended) questions. Unstructured questions were given to the respondents the freedom of response (Mugenda and Mugenda, 2003). The questionnaires were also to be in two (2) parts. Part A sought personal data of the respondent and general data on the MSPS. Part B sought information related to PA and motivation. The questionnaires were administered to the junior and middle management staff (Job Groups “L”, to “Q”). Interview guides were administered to the top management (Job Group “R” and above).

3.7 Data Analysis and Presentation

The researcher edited all the data that was received using SPSS before actual data analysis is undertaken, to identify inconsistencies and establish uniformity. Through editing of the raw data, errors and omissions were detected and corrected (Kothari, 2008). Quantitative analysis was subjected to the data that is quantifiable and was presented in a way that was simple and easy to understand. This was by use of graphs, tables, percentages and textual form or explanation.

Data from the open questions were analyzed qualitatively. The data was organized into persistent areas of study based on the research questions. The presentation was in narrative form describing the researcher’s objectives.

RESEARCH FINDINGS AND ANALYSIS

4.0 Introduction

This chapter presents the result of the field research. Quantitative and qualitative techniques were used in analyzing the data. The data was collected from 56 out of the target population of 74. This presented 76% response rate. This percentage is high enough to guarantee acceptability of the research. Two (2) managers were not available for interview while 16 employees did not return the questionnaires given to them.

4.1.1 Department

The respondents who took part in the study were from four Departments namely; Finance and Administration, HRD, HRM and MCS. According to the findings, majority of the respondents (56% ) were from HRD department.

4.1.2 Gender

Data from questionnaires were collected from 50 respondents out of the target 66 in the sample. This population comprised 54% male and 46% females. This implies that more men than women took part in this study as illustrated in figure 4.1.
When asked to explain the responses on the extent to which PA gave job satisfaction, ten (20%) of the respondents reported that targets were set through PA, Seven (14%) reported that the supervisor was always in touch with what was being done. Fifteen (30%) indicated that it helped one to identify their training needs and the areas that needed improvement while five (10%) reported that PA helped one to
focus on the core activities. Other responses that were listed were that it helped eliminate the lazy employees, motivated one to work hard and, rewarded those hard working employees.

It was however noted that some of the respondents did indicate that PA alone should not be used for assessment because it did not address some issue like motivation and the work environment. The findings also indicated that sometimes there was little relation between the set targets and the achievement. Some respondents reported that sometimes the process was subjective depending on the appraisee’s relationship with their supervisor.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction:

Objectivity of the Performance Appraisal is a critical HR process. However it is hard to eliminate subjectivity as the process is based on human judgment. Human performance is also largely qualitative; it is not always possible to measure it quantitatively (Singh, 2002) this research was no exception to this limitation. The majority of the managers at the MSPS reported that the process was objective. The reason given were that the process involves joint setting of targets, gives room for discussion between the employee and the supervisor, the assessment is based on set targets and that supervisors are able to monitor the performance of the employees. This helps the employees to work hard to meet the set targets.

However, a minority of the managers felt that PA was subjective because it is hard to measure some value like honesty and integrity. In addition PA may be used by some supervisors to settle scores with their juniors.

5.2 Conclusion

From the findings of this research, the researcher concluded that employees at the MSPS are usually involved in the setting of performance targets. They are also substantially appraised against the targets set at the beginning of the appraisal period. Performance targets are clearly defined and employees understand them. PA is also carried out in the right way at the MSPS and makes employees effective. The study revealed that employees were given feedback to enable them improve their performance. This shows that PA has a positive impact on the employee’s performance which leads to motivation. The Ministry was for example number seven in the recent performance rankings released by the President and Prime minister.

However there is need for discussions between appraisee and supervisors throughout the appraisal period. The discussions will enhance performance at the individual, Departmental and Ministry levels since there will be continuous flow of idea. The top management also needs to wholly support PA if the system is to be effective.
In addition PA should not be the only for assessment because if does not address some issue like motivation, honesty, integrity and the work environment. It is also subjective. To enhance motivation amongst the Ministry’s employees therefore, both the manager and the supervisor should provide continuous feedback.

5.3 Recommendation

Based on the findings of this study, the following recommendations are made for consideration by the MSPS so as to enhance the employee’s work performance.

PA is a good management tool but is should be subjected to continuous reviews in line with the changing trends. This is because HRM is dynamic and for PA to be Relevant, it has to keep up the pace. All stakeholders should be consulted during the PA process. This should include use of 360- degree feedback. Supervisors need to be continuously trained on the appraisal process. This is to ensure that PA is carried out as objectively as possible. Employees need to be sensitized on the importance of PA especially in the setting of targets. This would lead to SMART which would be possible to meet. There is need to reward the high achievers so that high performance standards are maintained. This may be achieved through introduction of the high-fliers scheme. The top management should ensure that PA is used as a corrective but not a punishing instrument. It is only when PA is used as a corrective tool that it can bring a motivation workforce

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INNOVATIVE BUSINESS STRATEGIES FOR INDUSTRIALIZATION: THE FINANCIAL DOWNTURN AND THE EMERGING DIMENSIONS IN RISK UNDERWRITING IN THE INSURANCE INDUSTRY

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Abstract
The global depression being witnessed has brought about a paradigm shift in the way the insurance industry has traditionally operated. Many fields that were hitherto uninsurable are now covered. With the emergence of stalls, and other micro-businesses, competitive insurance firms have been enticed to grab this opportunity. The purpose of this paper is to explore the ways in which insurance underwriting continues to play in promoting small businesses and the challenges that lie ahead as organizations transit into the boom and there after.

Keywords: Financial Downturn, Risk Underwriting

1.0 Background
This paper acknowledges that exposure of insurance companies to the global financial downturn has been basically through their investment portfolios. Nevertheless, insurance has erroneously been thought to be a preserve of the rich and mighty. It is for this reason that traditional insurance companies used to focus only on the well-to-do individuals and businesses on the basis that they had the capacity to buy covers for risks. While this was the trend then, little attention was given to the rest of the public. The majority who despite their desire to get insurance cover notwithstanding scanty information on the objectives and benefits of insurance continued to be exposed to risks. It is estimated that over 3 billion low income individuals around the world (Thomas, 2010) are likely to benefit from micro-insurance i.e. the provision of basic, low cost insurance cover to people on low incomes, small businesses or specific portions of a thing.

The global financial downturn appears to have been a blessing in disguise for insurance companies. Studies have shown that global poverty of an estimated 135 million people will be the propellers of micro-insurance. While the strategic firms have opportunities in this development, others continue to crumble courtesy of poor leadership and lack of visionary risk underwriting decisions. Along the way, many of them have become either insolvent or have been placed under receivership. In Kenya for instance, the situation has never been any different. Competitive underwriters have taken the cue and resorted to the development of many insurance products, many of which could not be insured by the traditional underwriter. In addition, many have discovered that the future of their competitiveness lies in the emerging markets such as micro-business – which has given forth the concept of micro-insurance.

1.1 The Insurance Industry in Kenya
Since 1985, the insurance industry in Kenya has undergone a metamorphosis that has seen a number of changes being introduced and adopted. It is worrying to note that eight insurance firms have either
collapsed or have been placed under statutory management; representing an average of one insurance company after every four years. These include:- Kenya National Assurance Company, United Insurance Company, Lake Star Assurance Company, Standard Assurance, Access Insurance Company, Stallion Insurance, Invesco Assurance and Blue Shield Insurance Company. In response to this trend, the government of Kenya responded by establishing the Insurance Regulatory Authority (IRA) which is the prudential regulator of the insurance industry in Kenya (formerly the Department of Insurance). IRA became autonomous on 1st May, 2007 through an Act of Parliament. IRA is also responsible for supervising and developing the insurance industry in collaboration with other stakeholders such as agents and brokers. Other changes include the establishment of certificate of proficiency (CoP) examination as a minimum requirement for licensing insurance agents and insurance brokers as from 1998.

Though the government introduced an agency to safeguard the interest of the insureds in the event of underwriters being declared insolvent, many of those that have been mismanaged have failed to attain the rigorous threshold that has been set by the Policy Holders’ Compensation Fund (PHCF) in order for their policy holders to be compensated, at least partially. However, this scheme has promoted confidence in the industry. Nevertheless, it is anticipated that the ongoing review of the insurance Act will promote the uptake of insurance, provide security to stakeholders and develop the insurance industry as a whole.

2.0 The Financial Downturn

Financial downturn is an economic occurrence where the economies of countries are diminishing. This is when the Gross Domestic Product (GDP) continues to register negative results. The world has experienced several downturns which have eventually been followed by upturns, though in varying magnitudes and speed over these various periods. The effects of 2007/8 the financial downturn, global recession, coupled with prudent fiscal management measures helped to accelerate the flourishing of micro-insurance.

3.0 Risk Underwriting Decisions

Risk underwriting is the process of selecting and evaluating insurable risk. The primary objective of underwriting is to guard against adverse selection. Each company has its guidelines on risks underwriting decisions. These include conducting or ordering for a medical examination of the prospective insured and examining the property status. However, almost no decision that is arrived at in an organization (insurance firms included) is made by one person despite the fact that the ultimate responsibility for taking such action shall be shouldered by some specific individual. This means that a decision is a phenomenon formed by several components which can be tracked down through several peoples’ communication channels that are both formal and informal (Simon, 1997). However, the influence of such individuals involved in formulating such decisions will greatly be dependent on the degrees of influence and amount of discretion that is allowed these people. At the tail end of the decision making process, it is not surprising to realize that the contribution of the individual who made the final formal decision was so insignificant.

Hill (2001), states that a firm’s vertical differentiation determines where in its hierarchy the decision-making power is concentrated. For example, are production and marketing decisions centralized in the
upper-level managers, or are they decentralized to lower level managers. There are arguments for centralization and others for decentralization. Hill further says that centralization can facilitate coordination. Centralization can help ensure that decisions are consistent with organizational objectives. When decisions are decentralized to lower level managers, some decisions that are at variance with top strategic goals may be made. Centralization of important decisions minimizes the chance of this occurring. Centralization can avoid duplication of activities by sub-units within the organization. Centralization provides a means for management to bring about desired changes easily. Hill (2001) further says that decentralization lessens the burden of decision-making on top management. Decentralization gives top management the time to focus on critical issues. It also motivates the employees in that they can make decisions. It also increases accountability in lower level managers. It brings about better decisions since decisions are made closer to the spot by individuals who may be having clearer information than managers several levels up in the hierarchy. Decisions that are made in a relatively short time enhance the overall organizational performance.

4.0 Emerging Dimensions in Risk Underwriting and Innovative Business Strategies for Industrialization

Leading underwriters of micro-insurance business argue that administering micro-insurance is often an expensive business. In their opinion, they have attributed the low volumes of micro-insurance business to the use of manual processes such that extension of these services to low income potential clients becomes untenable. In other words, manual processes have been costly, hence increasing the operating costs that erode the profits. To arrest this challenge, competitive firms have opted to collaborate with mobile phone companies using technology in money transfer platforms such as M-Pesa, Yu Cash, and Airtel Money among others to be cost effective in insurance distribution and payment mechanisms. The same technology is what the firms are applying in penetrating deeply into the untapped market of small businesses and low income earners.

Furthermore, studies and experience on the default in premium payment, irregular/periodic incomes and levels of income have led to innovative ways of buying insurance covers by installment payments until the whole premium is settled. The impact of this approach has been deepened by firms charging as little as Kshs. 10 premium payment through their cell phones. Apart from this charge helping to tap into the low income earning groups thereby widening their clientele base, this strategy has also addressed affordability of insurance cover. It is interesting to note that beauty conscious individuals, sportsmen and women or people who value certain parts of their bodies can now exclusively insure those parts without having to worry about the premium of the rest of the body.

These innovative channels have equally enhanced awareness, knowledge, marketing, and distribution of insurance products. However, one of the greatest achievements in micro-insurance is instilling confidence for venturing into new field of investments which were deemed to be risky for instance diary cow insurance, crop insurance et cetera. In actualizing the promises made, insurance firms have promoted confidence in the insuring public, and hence the increase in the uptake of insurance products.

5.0 Insurance Challenges as Firms Transit from Recession to Boom
There is an escalating demand for indemnities prompting underwriters in regions like Africa and South East Asia to venture into micro-insurance. These insurers must also grapple with the headache of spreading awareness of the concept of insurance to some individuals who may be ignorant about commercial or personal protection. Underwriters will also need to strike a balance between low-level insurance premiums and the volume of potential indemnity seekers. It is worth noting that environmental factors such as climate change, flooding and drought effects will spread out the micro-insurance market. Estimates indicate that African micro-insurance could be worth US$ 25 driven by a potential 700 million client base. Further, approximately 147 million Africans are covered by micro-insurance policies, thereby generating premiums worth US$ 257 million (Thomas, 2010). This scenario reinforces the Bottom of the Pyramid (BOP) approach where the apex of the pyramid is a small wealthy clients, the middle where majority have average consumption capacity whereas at the bottom lies the real drivers of the much needed penetration and broadening insurance coverage.

In Kenya, a very small population of 6.8 per cent has purchased insurance products. The micro-insurance is slowly picking up and just like many other African countries, there have been little indicators of growth and underwriters have in turn been slow in seeking market penetration. The recent requirements that insurers must separate life from general business and new capital rules will frustrate and undermine the growth of micro-insurance and even prevent new entrants into the market. Though micro-insurance is a new concept there is no legal framework to govern, instead, the regulator IRA applies its discretionary authority as and when a situation arises. At times, this kills innovation and blurs the planning horizon of insurers.

However, with an estimated 50-90 million low-income earning individuals from developing economies plunging into poverty, there will be reason to believe that more micro policy formulators will be on demand.

**Conclusion**

The introduction of micro-insurance has contributed to premium growth of insurance firms.

With the introduction of micro-insurance, more people can now afford insurance covers as a result of payment of premiums in installments.

Flexibility in mode of premium payment has led to higher penetration to the insuring public.

The financial downturn has triggered firms to be more innovative in their insurance product.

**Recommendations**

Insurance companies are encouraged to recruit and develop their staff to acquire skills required in the implementation of use of new channels of distribution of insurance products.

Enhance company structures to serve the anticipated surge in number of policy holders.

Government should establish legislation that caters for the partnerships between insurance firms and mobile phone firms so as to safeguard the insured population.
Government should provide incentives to insurance firms to invest in micro-insurance in order to alleviate the low income earners from hunger, extreme poverty and poor medical care.

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THE ROLE OF HUMAN RESOURCE DEVELOPMENT IN THE REALIZATION OF KENYA’S VISION 2030

Kimutai G. and A. Patrick

Abstract

Human Resource Development (hereafter referred to as ‘HRD’) is a fad that many people do not understand yet it is a strategic process of imparting competencies (knowledge, skills, attitudes and values) to people in a society in order to improve organizational performance and in turn improve an individual’s quality of life. Linking HRD with Kenya’s vision 2030 will make concerned authorities to fully recognize the role that the country’s human resource will play in the realization of the same and in turn fully exploit its capabilities. The recognition of the vast importance of HRD in this dream is provision of a "womb that births" accelerated economic growth and industrialization. HRD entails expansion of people’s capabilities for living decent lives and enhancing their opportunities for economic, social and political empowerment. The paradigm puts people at the centre of development with all persons being involved in the process. Industrial activities offer unique scope for learning, improvement and transformation. The industrialization process thus entails empowering people to access productive resources by addressing inequalities in the distribution of assets. It also requires expanding human capabilities through education, nutrition, healthcare, water and sanitation, all of which are important indicators. The main objective of this study is to identify the role of HRD in the realization of Kenya’s vision 2030. Other objectives include; to identify the challenges facing HRD in the process of hastening realization of Vision 2030, and to make recommendations on how HRD can be used to realize Vision 2030 efficiently and effectively.
Data from sources of different quality has been utilized. Some information is from published sources but most is from unpublished. Special reference will be made to Kenya’s vision 2030 document, the human development reports and World Bank reports.


INTRODUCTION

Background

Human Resource Development (hereafter referred to as “HRD”) is the process of increasing the knowledge, skills, and the capacities of all people in a society. In economic terms, it could be described as the accumulation of human capital and its effective investment in the development of an economy. In political terms, HRD prepares people for adult participation in political processes, particularly as citizens in a democracy. From the socio-cultural point of view, HRD helps people to lead fuller and richer lives, less bound by tradition. In short, the process of HRD unlocks the doors to modernization. (Source; www.google.co.ke). HRD is therefore a multifaceted concept entailing processes of competency development in people and creation of conditions (through public policy programs and other interventions) to help people apply these competencies for their own benefit and that of others and hence co-existence.

The deterioration in the standards of living in Kenya has in the last two decades prior to 2002 been worsening in key social indicators. Illiteracy rates increased as enrolment rates in primary schools declined while life expectancy and child mortality worsened. This disappointing development was further complicated by the upsurge of the HIV/AIDS pandemic. It is against this background that the government of the National Rainbow Coalition (NARC) was elected in 2002. In 2004, the same government appointed a team of imminent persons, led by Dr. Gakuru Wahome, to the National Economic and Social Council of Kenya (NESC) to offer valuable advice on critical issues on the country’s overall development aimed at developing a long term vision for the country. The team was drawn from the public and private sectors, the academia and civil society. The team offered advice on numerous areas including new ways for accelerating the pace of reconstruction and expansion of infrastructure, new ways of delivering health and education services to the people of Kenya and in devising effective ways of promoting local and foreign investment. In so doing, they were conceptualizing the blueprint for a prosperous Kenya that will last generations to come. This is the essence of Kenya’s long-term vision and was dubbed “Vision 2030”.

Vision parse means a desired picture of the future. The vision 2030 aims to make Kenya “a globally competitive and prosperous nation with a high quality of life” (source; Vision 2030 blueprint pg; 1). This is the future picture Kenyans would like to have in the next 25 years.

The vision is hinged on three key pillars: -

Economic pillar: This aims at maintaining a sustained economic growth of over 10 per cent per annum over the next 25 years.
Social pillar: This aims at building ‘a just and cohesive society with social equity in a clean and secure environment.

Political pillar: This aims at realizing a democratic political system founded on issue-based politics that respects the rule of law, and protects the rights and freedoms of every individual in the Kenyan society. (Source; Vision 2030 blueprint, pg; 1).

**Linking HRD to Kenya’s Vision 2030**

The purpose of HRD and aims of vision 2030 are married because as Bacchus (1992) states that, “the ultimate goal of HRD in any country is or should be to improve the quality of life of its entire people”. This is what Vision 2030 blueprint suggests from its overall aim- “to make Kenya a prosperous nation with a high quality of life”. Ghee (1986) also asserts that “HRD should refer to not only aspects of physical well being of people such as life expectancy, infant mortality, rates of morbidity and levels of nutrition but also to socio-cultural aspects including education and employment, social cohesion and stability, political expression, cultural diversity and even ecological harmony”. This implies that HRD is a multifaceted concept encompassing provision of all those conditions necessary for man to develop himself and others. Ghee asserts further that, “the only dimension of intrinsic value in development is the human dimension in its totality”. This assertion ‘holds more water’ when one considers that in any resource mobilization process, it is the human element that commands, directs, organizes, coordinates and plans how the resources are to be utilized efficiently and effectively. The quality of people appropriate to the particular level and complexities of the activities involved in the process of resource mobilization, determines how well or poorly these tasks are accomplished.

Through its three pillars, it is evident that the realization of vision 2030 will be pegged on HRD as a multifaceted concept entailing the same pillars.

**Relationship Between Elements of HRD And Economic Development**

**Overview**

There are a number of micro-economic studies which have attempted to establish the relationship between HRD and economic development. This includes studies which have been carried out in Brazil, Kenya, Malaysia, and South Korea.

**Relationship between Health and Economic Development**

Economic advantages of investment in health have been studied from a variety of perspectives. Better health and nutrition raise workers’ productivity, decrease the number of days they are ill, and prolong their potential working lives. “By reducing morbidity and debility, the malaria eradication program in Sri Lanka in the 1940’s and 1950’s led to a 10% rise in incomes. In Sierra Leone, a 10% increase in calorie intake of farm workers consuming 1500 calories a day raised output by 5%. Similar results have been found among Kenyan road construction workers with a daily intake of 2000 calories,” (World Bank, 1991a, pg; 54). Dietary and nutritional improvements have also been found to have long–term and indirect effects on economic development.
It could affect subsequent learning, IQ, school performance and physical activity. Thus after reviewing several studies, Behrman and Deolalikar (1988) came to the conclusion that ‘nutrient intake and health status both appear to positively affect agricultural productivity and labor market wages and possibly schooling productivity for some poor populations’. Health and nutrition are not only important ends in themselves, but also may be important means through which productivity and human development goals are affected. Levinger (1986) found that ‘improvements in children’s diet alone can lead to cognitive changes, and conversely, evidence strongly supports the hypothesis that early nutritional deficiencies may significantly retard intellectual development’.

The United Nations Administrative Committee on Coordination formally stated that ‘nutritional deficiencies and health conditions impact negatively on school enrolment, aptitudes, time spent in school (i.e. attendance and drop out rates) and achievement. Severe nutritional conditions are known to be important factors contributing to the educational crisis facing the developing countries’ (UNACC, 1990, pg; 2).

An overall assessment of the positive relationship between health and economic development is provided by the World Bank’s household survey data on nine countries. The results of household surveys stated that ‘the potential income loss from illness in eight developing countries averages 2.1%-6.5% of yearly earnings. Reducing illness could raise GDP accordingly. Health and nutrition also have long-run effects on productivity and output because they influence a child’s ability and motivation to learn. Disease and malnutrition in infancy may retard mental development, and illness and temporary hunger may reduce children’s ability to concentrate and keep them away from school’ (World Bank, 1991a, pg; 54).

**Relationship between Education and Economic Development**

The effects of education on economic development are indirect because education has to be internalized first then put in practice. ‘Two-thirds of economic development is attributed to education itself’ (UNICEF, 1990b). Further, ‘research has shown that primary education for girls is positively related to economic production, longevity, lower fertility, and reduction in infant and maternal mortality’ (UNDP, BPPE, 1999, pg; 5).

In essence, education increases the efficiency of parents determining their children’s health. Evidence that education promotes economic growth and thus puts development within reach is firm. ‘A one-year increase in schooling can augment wages by more than 10% after allowing for other factors. An additional year of schooling has raised farm output by nearly 2% in the republic of Korea and 5% in Malaysia. And in family owned enterprises in Peru, education appears to be more critical to earnings than physical capital’ (World Bank, 1991a, pg; 56). Studies in rural areas in Bolivia, the Dominican Republic, Guatemala and Paraguay have led to the conclusion that ‘education has a positive and significant correlation with rural productivity in two of the four countries, and a strong link between education and modernization of an environment’ (Jameson, 1985).

There is historical evidence to support that none of the presently rich industrialized countries was able to achieve significant economic growth before attaining universal primary education. ‘The most successful of the newly industrializing countries- Korea, Singapore, Hong Kong- and those with the fastest growing
GNPs in the 1960’s and 1970’s- Thailand, Portugal, Greece and others- had usually achieved universal primary education and near universal literacy just before their economy began its ascent’ (Hollak, 1990, quoting World Bank, 1980, 1987; and Peasle, 1965). However cross country analyses suggest that high performance in literacy and schooling are not automatically followed by sound and sustained economic development, ‘the outstanding performances of Japan and Korea were apparently not founded solely on mass literacy but on socio-economic regulation, land reform, and modern economic management. Education should be looked upon as a necessary but not sufficient condition for economic development’ (Hallak, 1990).

**Relationship between Technology and Economic Development**

Another development which has an effect on economic development and implications for inter-sectoral linkages is technology. ‘Technology is reshaping the industry/occupational structure as well as the skill requirements of the jobs themselves. These changes are just beginning to be understood and are already having profound effects on the way that we all prepare for and conduct work in all sectors of our economies’ (Lawrence, 1990). Such changes are not confined to industrial economies or modern wage sector. Examples in the formal sector include; use of computer technology in public offices of Kenya.

A developing country’s capability of participating in the benefits of technological progress, and contributing actively to technological innovation depends on a number of educational pre-requisites. High-level researchers, engineers, and technicians must be trained and used effectively. A country’s engagement in the development and use of technologies has serious implications in terms of employment and skill requirements.

**Relationship between Politics and Economic Development**

The experience of Malaysia and Ghana indicates that political will can protect the investments on HRD even in the context of a down turn in the economy and in government expenditure. These two examples of governments which were able to divert increased shares of resources to key areas of HRD demonstrate the viability of political will if present. Political will ensures human dignity through freedom of expression, democratic participation and an opportunity to influence things that in turn influence the individual’s living and that of others are respected.

In sum, the link between economic development and HRD is not obvious. Resource distribution factors or allocation policies mediate the effects of wealth in a country regarding social welfare and human development goals such as the millennium development goals. Thus two countries even in close geographical proximity, like Kenya and Uganda, may have similar economic growth patterns or levels of wealth per capita, but may decide to allocate resources to social priorities quite differently. Resource allocation strategies are mainly pegged on political will, especially in developing countries like Kenya.

**HRD Strategic Sectoral Interventions that Hasten Realization of Vision 2030**

**Overview**
Kenya’s Vision 2030 which aims to make Kenya ‘a globally competitive and prosperous nation with a high quality of life is basically a HRD policy because if implemented as planned, the programs and flagship projects contained in it are bound to improve the quality of life of the Kenyan people. There are a number of sectors to be covered by HRD for the Vision 2030 to be realized. They include education, agriculture, health, population, industry, infrastructure, communications and media, science and technology, environment, sanitation and water among others. While policy interventions may deal with all these sectors, some of these sectors like education may be chosen for intensive action during a particular period for their relationships with other sectors are vital because of multiplier effect they have. The choice of sectors for action becomes a strategic choice and hence investment in such a sector should be increased because the role they play will help in achieving more than one goal of HRD at a go. For instance, education will reduce mortality rate, increase knowledge required to do jobs in different sectors, and even increase food production in the agriculture sector.

Effective implementation of HRD policies and programs for instance Kenya’s Vision 2030 requires a choice of instruments or methodologies for implementation. These methodologies may be as narrow as involving a particular group (e.g. youth) or institutions (e.g. NGOs) or broad continuous schemes of mobilizing resources (e.g. Constituency Development Funds), or improving effectiveness of government institutions or developing leadership qualities in the program managers.

All sectors mentioned in the Vision 2030 blueprint are important in its realization. Agriculture, industry, infrastructure (roads, telecommunications, power), health, education, environment, technology, politics, all play a critical role. However, focus on some of the sectors has a facilitating effect on others. Health, education, science and technology, environment and even governance seem to have catalytic effects on other sectors

**Critical Role of Health Sector**

Health is critical in the process of realization of Kenya’s vision 2030 because health determines productivity of a people. An under nourished or sick person cannot properly work for long in the process of any goal attainment procedure. Absence of medical facilities further reduces productivity.

Better diets, housing and control of communicable diseases have raised the quality of life in the industrialized nations. By reducing illness, these improvements have increased people’s alertness, capacity for learning, and the ability to cope with and enjoy life. By prolonging life, they have made investments in knowledge and skills. “The benefits of good health also flow well into the future; a mother’s health influences her children’s health” (World Bank 1991a). Better health is desirable as an end in itself. As the 1991 World Development Report observed, “Good health also brings substantial economic benefits, releasing resources that can be used to achieve other development goals. Better health and nutrition raise workers’ productivity by prolonging their working life” (World Development Report, 1991).

From Kenya’s Human Development Report (2006, pg; 17), health facilities in Kenya have increased by 3.0% from 4,767 in 2004 to 4,912 in 2005. From Kenya’s Vision 2030 blueprint (2006, pg; 12), the government intends to improve the overall livelihoods of Kenyans, the country aims to provide an
efficient and high quality health care system with the best standards. This will reduce health inequalities and improve key areas where Kenya is lagging, especially in lowering infant and maternal mortality.

From the Daily Nation newspaper (June 11th, 2008 pg; 12), the government intends to implement the National Health Insurance scheme and the National Health Care Council is to be created to improve services in the health sector. Free universal delivery of medical services will increase safe deliveries from the current 42% to 90% through free delivery of medical services, training more traditional birth attendants and equipping the referral hospitals. There are also plans to prevent new cases of HIV infection among vulnerable groups and improve the quality of life through expansion of free treatment and provision of drugs for tuberculosis patients and anti-retroviral drugs for people living with Aids.

Further importance of health in the process of realization of vision 2030 is evident in the 2008/09 budgetary allocation to the health sector. From standard newspaper (June 13th 2008 pg; 3), kshs. 5.77 Billion was allocated for developing the health sector of which is 2.94% of the total budget. It is evident that with such plans and interventions, Kenyan authorities fully recognize the role that the health sector as a HRD tool will play in the realization of vision 2030.

**Critical Role of Education**

Education has the capability to influence many other variables of development. Educated people have higher productivity, education provides necessary skills for self employment, and educated people earn higher incomes. Orchestrating the investments in education in such a way that they can yield the maximum possible returns is an issue that deserves considerable attention for the Kenyan government to realize vision 2030. Education is the key to poverty eradication as it is ascribed an equalizing power. “Education also helps improve health and nutrition of children and parents, hence it can help reduce mortality and increase life expectancy. The more educated the parents are, the better the nutritional conditions of the children” (Hallak, 1990, pg; 46).

Section 7 of the children’s Act (2002), provides that, ‘every child shall be entitled to education the provision of which shall be the responsibility of the government and parents.. Kenya launched the free primary education program in 2003 as a strategy for achieving universal primary/basic education by 2005. This is part of the process seeking to attain education for all by 2015.

In 2008, the government provided tuition fees for secondary schools who met preset conditions and this has seen increase in secondary school enrolment country wide. The government has engaged high gears to improve the education sector in its vision 2030 action plan. As observed in the Daily Nation newspaper (June 13th 2008, pg; 3), “the school enrolment rate will be increased to 95% and an additional 28000 teachers employed while adult literacy rate will be raised to 80%. The transition rate to technical institutions and Universities will be increased from 3% to 8% by 2012. International ranking will be introduced for students in mathematics, science and technology. The plan also includes making early childhood centres part of primary schools, modernizing teacher training, and revising the curricular of universities and technical institutions to make them compatible to market demands”. President Kibaki in his speech during the launch of vision 2030 noted that:
“...primary education, however, is merely a foundation and does not empower our youth with sufficient knowledge and skills for them to participate fully as productive members of society. The strategy we are developing should therefore come up with a comprehensive set of measures that enable us to ensure that all the youth graduating from primary schools advance to secondary schools at affordable cost to the parents and the country within the next five years. We need to have this critical mass of educated youth to enhance the productivity of our economy and social mobility and cohesion in our society...” (Mwai, 2006). The theme of this extract is education for knowledge. Peter F. Drucker observes that, ‘we now know that the source of wealth is something specifically human: knowledge. If we apply knowledge to tasks we already know how to do, we call it productivity. If we apply knowledge to tasks that are new and different, we call it innovation. Only knowledge allows us to achieve these two goals’ (Drucker, 1993, pg; 206). In Kenya’s 2008/09 budget, the education sector received Kshs. 137 billion, the highest amount ever allocated to the education sector in Kenya’s history. “To ensure that transition rate to secondary school does not lead to congestion and poor quality of education, I have allocated Kshs. 280 million for the construction and equipping of new secondary schools,” said finance minister during the annual budget speech.

Critical Role of Training

On the part of training, the government will invest in training, research and development to create a firm foundation for the manufacturing and Information Communication Technology (ICT). As noted in sessional paper No. 2 (1996, pg; 30), ‘the availability of well educated and trained workforce is critical to the success of Kenya’s industrialization process.’ Further, the paper notes that, ‘since independence, education and training have received high priority and very considerable resources have been devoted to expanding education at all levels. The paper further highlights that the foundation of a productive workforce is laid in the formal primary and secondary education and the government will continue in its efforts to broaden participation and improve the quality of school education. Government, jointly with the private sector, should engage a process to develop a national skills training strategy in order to ensure that skills training is relevant to the national economy, industrial training should be offered through the directorate of industrial training. Formal pre-employment, vocational and technical training offered at technical institutes and national polytechnics will be expanded and nature of training improved to better reflect actual skills demand as identified through private sector consultation and input.

As observed by Dr. Wahome Gakuru, Director of vision 2030 policy, that:

“At the moment, we do not know exactly how many skilled people we have in each sector of our economy and the level of their technical skills, yet this information is crucial for us to be able to gauge the needs of each sector” (source; Daily Nation, 28th October 2007).

For instance, under Vision 2030 blueprint, the government of Kenya intends to, ‘invest in training, research and development and a host of other incentives as part of efforts to create a firm foundation for the manufacturing and ICT sectors to attract new investments and create new jobs,’ (source; Standard Newspaper, 13th June, 2008, pg; 26).

The Critical Role of Science and Technology
There is importance of investing in science and technology to build technological capability and lay the foundations for economic growth and improved standards of living.

Technological development can be considered in terms of advances that lead directly to improvements in the quality of living, those that are needed to improve effectiveness of the investments in basic HRD programs and those that aim to put the country at par with the developed industrial world. All three contribute to development as all of them lead to increases in productive activity and employment. As observed by Rao (2000), ‘the techno-scientific revolution is changing the demand for education and training, as the number of those required to engage in this activity increase.’ To meet such needs, the government could play two roles:-

It can expand and improve the quality of primary and secondary education,

It can create incentives to increase the supply of and demand for more specialized training. (World Bank, 1991a).

There is a major concern surrounding the widening technological gap between the developed and the developing countries. The concentration of knowledge in the industrialized countries means that further advances tend to occur in such countries. It is essential therefore for developing countries like Kenya to go beyond basic concerns of human survival and invest heavily in all levels of human capital formation—particularly in technical and managerial skills. ‘Unless they acquire greater control over the expanding knowledge industry, they will languish in the backwaters of low value added production,’ (UNDP, 1992b).

In the light of the above concepts, Kenyan government should strive to exploit knowledge in science, technology and innovation in order to function more efficiently and improve social welfare. As observed by Kenya’s Higher Education, Science and Technology minister, ‘there is urgent need to apply technology to meet the country’s development objectives’ she further observed that, ‘science, technology and innovation can better serve humanity if research findings get widely disseminated for use in the development activities, including influencing of policy making and review and for the application in explaining or resolving economy and social issues,’ (source; Kenya Times, 29th April, 2008, pg; 3).

Further importance with which science and technology is attached to realization of Kenya’s vision 2030 is evident in the increasing budgetary allocations over the recent years to the ministry of Higher education Science and Technology.

**Critical Role of Industry and Agriculture**

Industry, including manufacturing, constitutes an important component of a country’s wealth which is essential for facilitating investments in HRD. To be able to compete in international markets, quality becomes essential. Quality improvements can take place through localized and industry-based HRD programs and interventions. The critical contribution of industry-based HRD policies and programs in improving the efficiency and productivity of the industrial sector is evident from the past. For instance, the Japanese management style is a good illustration of the role that HRD can play in improving the efficiency and productivity of the industrial sector whereby quality-oriented systems and practices are
needed. Policies that facilitate investment by the industrial sector on development of employees, e.g. on exchange programs, are useful as they add to the country’s resource base.

Agriculture as a sector should not be neglected. HRD can play an important role in improving the adoption of practices that increase agriculture productivity and thus increase food production needed to feed the country’s population and for export. This increases physical productivity of people and earns the country foreign exchange needed for economic development. In Kenya for instance, agriculture sector has been one of the sectors central to its economy and was for a long time termed as “Kenya’s economic backbone.” Kenya’s struggling agriculture sector is expected to add about Kshs. 80 billion to the economy under the Vision 2030 development program. The blue print identifies seven flagship projects to be implemented in the next five years in agriculture, livestock and fisheries.

Top on the agenda of Vision 2030 will be to transform the agriculture sector to achieve an average growth rate of 7% by 2012 which will add Kshs. 80 billion to the GDP. The sector currently accounts for 24% of the GDP. To increase the export of manufactured goods, the government plans to establish special zones and parks to promote export-oriented firms. The government of Kenya in order to tackle the present food crisis, it has allowed importers to import maize duty-free and also zero-rated value added tax on rice, wheat and barley and lower import duty from 4% to 10%. The minister of finance also set aside Kshs. 7 billion for food emergency. The government also promises to take measures to lower the cost of fertilizers and seeds, while providing farm inputs to those in need.

**Developing Strategic Target Groups That Hasten Realization of Vision 2030**

**Overview**

The Vision 2030 for gender, youth and vulnerable groups is gender equity, improved livelihoods for vulnerable groups e.g. the poor, and a responsible globally competitive and prosperous youth.

**Educating Girls and Empowering Women**

Women play a strategic role in developing human resources. They are the primary agents of HRD as mothers. Children learn from their mothers and the foundation for their later development is laid by the mother. Children of better educated women tend to be better-nourished and healthier suggesting a strong relation between the mother and the general health and well being of the family. Higher levels of female education also results in increased adoption of family planning methods. In Kenya, women contribute a great deal to the economic activities of their families either through household activities or through other direct income generating activities. Investing in women and their development by giving them access to education, training and credit for employment-generation activities is therefore likely to raise productivity in all sectors. Women seem to be central to the effectiveness of a broad range of investments in development.

Research has shown that primary education for girls is positively related to economic production, longevity, lower fertility, and reduction in infant and maternal mortality (source; UNDP, BPPE, 1991). In most developing countries like Kenya, women have much less access to education, jobs, income and power than men. The level of health and nutrition of women are often inferior to that of men. Women
generally account for the largest proportion of the deprived people. The improvement of human capabilities requires, in particular, that the capabilities of women are improved. In Kenya for instance, attitudes and customs will have to change in order for women’s role in realization of vision 2030 to be appreciated, hence paving way to investment in women. Educating girls has more social than individual returns. Due to less observable returns, opportunity costs, cultural factors and lack of easy availability of schooling facilities, parents are reluctant to educate their female children. The World Bank’s paper (1991) on this theme suggests that:

Opportunity costs of female schooling should be reduced by ensuring that water and fuel wood are nearby and better household technology is available so that girls spend less time on household chores; and

Public transportation is available to girls so that parents do not fear for their children’s safety, and the time of children is saved.

Such measures are theoretically ideal but are quite tough to put into practice as most economies that have lower rates of girls’ schooling are caught in the vicious cycle of economic constraints to improve such facilities which affects social development, which in turn constraints economic development.

Women enterprise fund that was set up to give Kenyan women loans to set up businesses is a clear indication that the government recognizes the role that women play in economic development.

**The Poor, Unemployed and Youth**

Any HRD strategy is incomplete if it does not take into consideration the need for improving the income generating capabilities of people through employment and other productive activities. HRD goals cannot be achieved if a large segment of the population cannot afford to have access to education, health and other basic services because of poverty or low income levels. There is a vicious cycle between HRD and poverty. Poverty is also linked to environmental degradation that threatens the current and future generations. In developing countries, a large part of the poor are the youth and the unemployed. The rate of unemployment among the youth is rising. This target group is disadvantaged in Kenya because of inequality in Kenya.

Striking Features on Inequality in Kenya include:

- **Income**: The 10% richest households in Kenya control more than 42% of incomes, while the poorest 10% control 0.76% of income.

- **Life Expectancy**: A person being born in Nyanza province can expect to live 16 less years than his fellow citizen in Central province. Life Expectancy in Meru is double that in Mombasa, 68.6 and 33.1 years respectively.

- **Gender**: About 93% of women in North Eastern Province have no education at all, compared to 3% in Central Province.

- **Health**: In Central Province, there are about 20,000 people for every doctor while in North Eastern Province there is one doctor for every 120,000 people.
• Education: Every child in Central province attends primary school compared to about one out of three children in North Eastern Province.


Developing self-employment and entrepreneurial capabilities through appropriate entrepreneurship skill development programs and strategies, self-help programs, providing credit opportunities for the poor, and encouraging NGOs to come up with new models and methods of improving the economic welfare of the poor are most important. Government should also implement strategies aimed at ensuring equitable distribution of national resources.

The national youth policy will be revised and the youth enterprise fund strengthened. The national youth commission will be established to manage youth affairs. First, he increased the budgetary allocation for the youth enterprise fund from Kshs. 1.2 billion to Kshs 1.7 billion and gave Kshs. 250 million towards youth empowerment (source; Standard Newspaper, 13th June, 2008, pg; 6). If the massive investment is effected, the process of realization of Vision 2030 will be hastened because a large percentage of Kenya’s population is predominantly the youth and therefore empowering this group is in actual sense empowering the majority who are needed to realize Vision 2030.

**CHALLENGES FACING HRD IN THE PROCESS OF HASTENING REALIZATION OF VISION 2030**

**Overview**

HRD as a multifaceted concept is bound to experience a lot of challenges while being used as a strategic tool to realize Vision 2030. Impediments facing key sectors that directly or indirectly affect other sectors need to be identified and addressed urgently in order to provide a framework for the realization of Vision 2030.

**Impediments to Education**

**Lack of infrastructure:** - Physical and human (particularly schools and teachers) and lack of resources to create such infrastructure characterize the Kenyan educational context. This impediment came out clearly when the government introduced free and compulsory primary education whereby the enrolment rate overwhelmed available school infrastructures and hence compromising acquisition of skills necessary for enhancing achievement of Vision 2030.

**Inadequate allocation of resources:** - This impediment is linked with lack of appreciation of the critical importance of basic education. Resources allocated to ministries such as ministry of defense could be partly diverted to development of education.

**Inability to balance resource allocation within the basic education sector:** - For instance, between infrastructure building, curriculum development, management and quality improvements. Often, this impediment is beyond the control of the ministry of education or even the government because minimal resources available do not allow adequate allocation of resources to the different sectors of education.
Lack of links between education and productive work: - This results in lack of appreciation of the education system by the parents and adults who matter in educating children. Education system in Kenya mainly dwells on theoretical aspects and practicality is not sufficiently emphasized. This de-links education system from productivity.

Poor quality of education: - In Kenyan context, this is mainly characterized by lack of innovations in teaching methods, organization and management of primary education including school hours and curricular. This is partly caused by upsurge in enrolment rates and subsequent lack of infrastructure to handle this upsurge.

Impediments to Health

Most health-oriented development challenges facing developing countries like Kenya can be attributed to the growing population which makes increasing demands on the meager resources available. It is estimated that between 1990 and 2030, the world population will grow to 3.7 billion, food production will need to double and industrial output and energy need to increase three times worldwide and increase fourfold in developing countries. This growth brings with it the risk of appalling environmental damage and hence exposure to health hazards such as floods, drought, HIV and Aids and respiratory diseases as a result of emissions form industry, transport and from domestic energy consumption’ (source; World Bank Report, 1991).

Impediments to the Development of Science and Technology

Lack of meaningful commitment towards science-either basic or applied: - There is little realization that science can be applied to development. The consequences are to have weak Universities having few research centers for applied sciences, weakness in scientific and technological education processes and little expenditure on science as an entity.

No commitment of self-reliance in technology: - The government is not willing to commit itself through self-reliance in production of technology, for instance, the “Nyayo Car” project collapsed because of lack of government’s commitment to see its completion and improvement.

Inadequate institutional and legal framework to support science and technology:- Laws that support this sector are deficient and when deliberated upon, there is lack of required support for it to succeed. For instance, legalizing the use of Genetically Modified food crops has been contentious in Kenya for a long time and yet its importance on providing food for the poor at a cheap cost is evident from countries that have legalized its use.

Impediments Facing Efficiency and Effectiveness of Governance

The major problem facing governance and arguably the “mother” of all problems is the poor value system possessed by government officials. Most government projects and programs are characterized by corruption, nepotism, tribalism, ethnicity and all sorts of evils stemming from possession of a poor value system! This creates deficient allocation of national resources to some people/regions in favor of others.
Policies implemented are always designed to favor a certain group of persons and hence the ‘mighty’ will always be favored day-in day-out wherever and whenever he/she is in need.

One of the most salient challenges to face HRD in the near future is the projected growth in the economically active population and resulting employment problems. In Kenya, by 2030, the population is estimated to be 60 Million; this is bound to cause employment problems if economic growth rate will be less than population growth rate.

**RECOMMENDATIONS**

Experience from developed and developing countries that have a high human development index indicates that the establishment of a long-term policy framework is essential to guide development. Such long-term policies may range from a minimum of 15 to 20 years to a 50 year framework. Such a framework should be evolved after taking into consideration the national and physical resource base of the country, its current economic situation, human capabilities available, opportunities offered by the resource base, experiences of other countries, time required for initiating change, historical, cultural and other factors affecting change process, existing institutional and other infrastructures, and the structural changes and other reforms required to achieve developmental goals.

The long-term policy should focus on intended level of growth, in terms of economic development, science and technology, infrastructure and industry, employment, agriculture, environment and human skill formation. “Malaysia’s plan –vision 2020 entails a complete re-orientation of policies and strategies as well as planning mechanisms for the building of an industrialized society and technically competent skilled labor force. It also entails the inculcation of strong positive values which will form the foundation for a united and progressive nation,” (source; [www.google.co.uk](http://www.google.co.uk)). Kenya could learn a great deal from Malaysia if it is to let HRD occupy centre stage in the process of realization of vision 2030.

In formulating HRD policies and plans such as vision 2030 policy, it is useful to take the following four steps:

A HRD profile of the country and its regions and constituent parts/groups should be prepared.

HRD goals should be established.

Budget allocations to various goals, sectors, activities and programs on the basis of the priorities should be decided.

Strategies of implementation including government interventions that assist in mobilization of resources wherever deficiencies exist should be developed.

Above all, long-term HRD policies and programs should be free of undue political interference and bias as much as possible. It is useful to develop a development ideology for which the country gets committed. Such an ideology should be developed through debate and information sharing.
CONCLUSION

In the light of the above, the availability of a well developed human resource base is critical to the realization of Kenya’s vision 2030. HRD should occupy centre stage because earlier development strategies such as 2020 industrialization strategy which largely neglected the social aspects of development can be catered for in this master plan. The much needed higher productivity in the process of realization of vision 2030 depends on the quality of human capital and how they are utilized – a lesson to be learnt from developed countries.

Education, management and training shorten the time span with which a country with low wage costs like Kenya can achieve higher productivity. HRD contributes to a more equitable distribution of income. It thereby negates the necessity for compulsory redistributive measures such as the tax system. Also, there has been a steady decline in the importance of other resources in economic development, such as natural resources e.g. forests, because with their over-exploitation comes with it global climatic conditions that are not favorable for life hence HRD should be considered as the best alternative to strategically realize Vision 2030.

Due to information and advances in other technologies that have increased the demand for intelligent workers, HRD will ensure that these workers can extract the most out of technology and with proper utilization of these technologies; realization of Vision 2030 can as well be termed as a foregone conclusion.

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Aluvi A. Patrick and G. Kimutai

ABSTRACT

The ever quickening pace of technological evolution is now more than ever affecting the way standards are proposed, developed and implemented in Kenya’s sugar industry. The international organization for standardization (ISO) is among the organizations that ensure that there is standardization of goods and services worldwide so that the goods and services are acceptable worldwide by different consumers. High demand and changes in consumer tastes have made industries globally and locally to devise ways of coping with the ever increasing demands of their customers by ensuring that they standardize their products and services using ISO 9001:2000 certification as a means of standardization. The purpose of this paper is therefore to address the role of ISO 9001:2000 certification in Kenya’s sugar industry. This paper arises out of a research conducted in Mumias Sugar Company limited between October 2008 and January 2009. It is based on the following objectives, to examine the principle of ISO 9001:2000 and how they were implemented, the effect of ISO 9001:2000 certification on production and suggesting appropriate ways of enhancing production. The kaizen philosophy of continuous improvement was used as a theoretical framework to guide the study. A sample of 186 out of 1646 was used; questionnaires, interviews and documentary reviews were used as data collection instruments. The data collected was later analyzed using Statistical package for social sciences (SPSS). The acquisition of the ISO 9001:2000 certificate appeared to have played an important role in increasing the production capacity of the company. This is mainly due to the fact that the implementing of the ISO 9001:2000 standard principles has got benefits that lead to an increase in production. The paper will help other non ISO 9001:2000 certified companies to consider investing in the development and deployment of a suitable Quality management Systems (QMS) preferably the ISO 9001:2000 which is now ISO 9001:2008 based on the advantages an organization gains when it becomes ISO 9001:2000 certified.

Key words: ISO 9001:2000, quality management system

Background of the Study

The ISO 9001:2000 is an international standard for quality management systems that specify the quality management systems requirement and provides a framework to establish, document and maintain an effective quality management systems in order to meet client requirements. The standards emphasize on continual improvements, customer satisfaction, and effective management among other principles.

Quality is no doubt a crucial element in any management system today. The acquisition of ISO 9001:2000 is a great milestone for any organization. By acquiring ISO 9001:2000 an organization demonstrates that customer satisfaction is improved, competitive power raised and productivity is increased. Formal management systems offer real strategic value especially is such systems are aligned with corporate goals and business objectives. ISO 9001:2000 now ISO 9001:2008 standards controls and documents the various processes within the organization. This results in efficiency enhancement, detection, reduction and elimination of wastes. The ultimate benefits are enhanced customer satisfaction, reduced operational costs, increased competitiveness, performance and profitability, improved transfer of
knowledge within the organization and increased morale and motivation among employees. Globally the implementation of ISO 9001:2000 is a valuable aid to improving the quality of an organization's products and services (The standard 4th September 2009).

Objectives

This paper seeks to address the following objectives:

To examine the principle of ISO 9001:2000 and how they were implemented in the context of Mumias Sugar Company limited.

The effect of ISO 9001:2000 certification on production of Mumias Sugar Company

Suggesting appropriate ways of enhancing production.

The ISO 9001:2000 Principles

The ISO 9001:2000 mainly focuses on eight main principles that guide its implementation:

Customer focus: Because organizations depend on their customers, they should understand current and future customer needs and try to exceed customer expectations in the best way possible. This can be done by ensuring that the objectives of the organization are linked to customer needs and expectations and communicating customer’s needs and expectations throughout the organization.

Leadership: The organization willing to implement ISO 9001:2000 standards needs strong organizational leadership in order to establish unity of purpose and direction for the organization. The leadership should create and maintain internal environment in which people can be fully involve in achieving the organizations objectives. Leadership is providing role model behaviours consistent with the values of the organization. If this is done then people will understand and become motivated towards the organizations goals and objectives.

Involvement of people: The involvement of people provides an opportunity for continuous process involvement within the organization. When people are involved, there is sharing of knowledge, utilization of experiences, cooperation and a feeling of belonging and commitment to the organization. Furthermore people are the essence of an organization and their involvement enables their abilities to be used for the organizations benefit.

Systems approach: Systems are constructed by connecting interrelated processes together to deliver the system objective which in the case of quality management systems is the satisfaction of the interested parties.

Process approach: The process within an organization should be structured in order to achieve organizational objectives because a desired result is achieved more efficiently when activities and their and their related resources are managed as a process.

Continual improvement: The organization should commit itself to continual improvement by having appraisal of their staff to evaluate their performance on the basis of meeting continual improvement
objectives. An organization should also have education and training mechanisms for measuring, monitoring processes performance and finally have a reward and recognition scheme for employees that achieve desired results.

**Factual approach to decision making:** Decisions are made based on the analysis of data and information this is because facts are obtained from observations performed by qualified people using qualified means of measurement thus the integrity of the information is known.

**Mutual beneficial relationships:** According to this principle an organization and its suppliers are interdependent. A mutually beneficial relationship enhances the ability for both to create value. When a mutually beneficial relationship exists, there is enhanced knowledge, vision values and understanding, further other organizations are treated as peers and not adversaries.

It is on the basis of these principles that an organization can be well placed to attain certification which guarantees the consumers of the highest standard of the goods and services being offered. In today’s world, globalization and technological advancement has made organizations change the way they operate and produce their goods and services. In order to achieve competitive advantage through maintenance of high quality, an organizations change the way they operate and produce their goods and services. In order to achieve competitive advantage through maintenance of high quality, an organization must ensure that they achieve the highest standards possible in order for them to attract and maintain their customers in the market. The means through which these organizations can achieve these high quality standards is through the attainment of ISO 9001:2000 certification.

**Theoretical Framework**

The study was guided by the Kaizen Philosophy of continuous improvement. Kaizen is a Japanese philosophy of continuous improvement of all employees in an organization so that they perform their tasks a little better each day. It is a never ending journey centered on the concept of starting a new each day with the principle that methods can always be improved (Oakland, 2000).

Kaizen means improvement Japanese. It was propounded by a Japanese scholar Masaaki Imai who defined it as on going improvement involving everyone from top management, managers and workers. The Kaizen strategy recognizes that management must seek to satisfy the customer and his needs if it is to survive and grow in business. It assumes that all activities should ultimately lead to enhanced customer satisfaction.

Kaizen is a compound word involving two concepts (*kai*) change and to (*zen*) become good. To engage in Kaizen therefore is to go beyond ones contracted role to continually identify and develop new or improved process to achieve outcomes that contribute to organizational goals. One of the primary goals of Kaizen is eliminating waste and considering both process and end results.

Kaizen embraces the following principles:

It is process oriented: processes need to be improved before results can be achieved.
Improving and maintaining standards: combining innovations with ongoing effort to maintain and improve standard performance levels.

People orientation: kaizen should involve everyone in the organization, kaizen focus primarily on improving work methods, routines and procedures usually defined by management.

Continuous improvement is required in all activities of an organization, be it in productivity improvement, new product development, labor management relations or total productivity maintenance; Customer orientation among others all are directly or indirectly productivity generating activities of the organization which come under the umbrella of kaizen.

Basically kaizen has to do with small step by step continuous improvements. It believes that all people at all levels in the organizational hierarchy can contribute to improvement. This is possible because kaizen asks for only small improvements. It is important to note that kaizen is to be performed at all levels from top management to lower level employees (Chary, 2004).

Kaizen has to do with the philosophy of or strong commitment to continuous improvement. Without a philosophical basis, improvement can diminish and disappear over time. Continuous improvement can therefore be achieved by organizations through training that will equip the employees with the skills knowledge that can enable them do their work better hence improve on the quality of work that they undertake hence remain competitive.

This theory/philosophy is therefore relevant to this research since it provides an insight of the need to continuously improve the way organizations carry out their functions. In order to maintain the necessary quality standards so that they can attain the internationally recognized ISO and remain competitive in the diverse market.

How the MSC implemented ISO 9001:2000

Management responsibility: According to this requirement top management shall provide evidence of its commitment to the development implementation and continual improvement of the quality management system by communicating the need to meet customer, legal and regulatory expectations, establishing a quality policy, ensuring quality objectives are established, conduct management review and avail resources for the whole process. The research findings indicate that Mumias Sugar Company management took responsibility by availing resources for implementing ISO 9001:2000 and putting up a strategic plan to guide company operations. In addition their value statement underscores its adherence to the requirements of management responsibility as stated in the ISO process approach.

Resource management: This requirement states that the organization shall determine and provide the resources needed to implement and maintain the quality systems and continually improve its effectiveness and to enhance customer requirements. Some of the requirements include human resource, infrastructure and work environment. The findings indicate that MSC implemented these requirements. Some of the requirements include human resource, infrastructure and work environment. The findings indicate that MSC implemented these requirements by ensuring there were adequate resources to make ISO 9001:2000 secretariat and staffing it with personnel.
**Product and service realization**: This requires the organization to plan and develop the processes needed for product realization. The planning of product realization should however be consistent with the requirements for the product, the need to establish processes, documents and provide resources specific to the product, verification, validation, monitoring, inspection and test activities specified to the product and the criteria for product acceptance and records needed to provide evidence that the realization processes and resulting product and service meet requirements. The research findings indicate that indeed MSC documented all the value addition processes and this was in line with MSC business strategy and quality management systems. In MSC they were at four levels, farm level, factory level, marketing and supply, manpower needs and appraisal in addition they documented a quality manual, quality policy and created records and date center for the management and control of quality documents and records. This shows consistency with QMS related to product realization.

**Measurement analysis and improvement**: This requires the organization to plan and implement the monitoring measurement analysis and improvement process needed to demonstrate conformity of the QMS and continually improve the effectiveness of the QMS. Under this requirement the following issues are addressed: Customer satisfaction: as one of the measures of the performance of the QMS, the organization shall monitor information relating to customer perception as to whether the organization has met customer requirements.

**Internal audit**: The organization shall conduct audits at planned intervals to determine whether the organization conforms to the requirements of the standards and the standards determined by the organization are effectively planned and maintained. Audits shall be planned considering the status, importance of the processes and areas to be audited as well as the results of the previous audits. The findings of this research indicated that MSC conducted internal and external audits in a planned and periodic manner it was noted that the audit were done in the course of the research in October-November 2008 for the purpose of recertification and one was scheduled at the end of October 2009 for purposes of auditing.

**Monitoring and measurement of processes**: The organization shall apply suitable methods for monitoring and where applicable, measurement of QMS processes.

**Monitoring and measurement of product and service**: The organization shall monitor and measure the characteristics of the product to verify that product requirements have been met.

**Methodology**

Methodology: a case study method was employed in the study. Data collection instruments used included questionnaires, interview schedules and documentary review. The target population was 1646 from seven departments. However 186 respondents were used for the purpose of the study. Taro Yamane’s formula was used to determine the sample size. The data obtained was analyzed using Statistical package for Social Sciences (SPSS).

**Taro Yamane’s (1967) Formulae for determining sample**

The formula for determining sample size is shown below:
n = ___N

1+N(e)^2 Where: n=sample size, N=population size, e= level of precision/sampling error at 0.069

n= 1646

n=1646

n =1646

n=1646

n =186

Therefore 186 respondents would therefore be the lowest acceptable number of responses to maintain a 93.1% confidence level and a 6.9% sampling error. According to Hussey and Hussey (1997) a sampling error of less than 10% and confidence levels of more than 90% is acceptable, the study therefore adopted a sampling error of 6.9% to determine the minimum sample size that could be used for the purposes of this study.

**SAMPLING ACCORDING TO DEPARTMENTS**

<table>
<thead>
<tr>
<th>DEPT</th>
<th>AGRIC</th>
<th>FACT</th>
<th>FIN</th>
<th>HR</th>
<th>S/MKT</th>
<th>GEN/MGT</th>
<th>ICT</th>
<th>TTL</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL</td>
<td>731</td>
<td>484</td>
<td>153</td>
<td>164</td>
<td>53</td>
<td>40</td>
<td>21</td>
<td>1646</td>
</tr>
<tr>
<td>SAMPLE</td>
<td>82</td>
<td>55</td>
<td>17</td>
<td>19</td>
<td>6</td>
<td>5</td>
<td>2</td>
<td>186</td>
</tr>
</tbody>
</table>

**FINDINGS**

The study findings indicated that Mumias Sugar Company availed the necessary resources needed for the implementation of the ISO 9001:2000. These requirements were captured in the planning phase where there was management commitment, the appointment of a quality management representative who was responsible for establishing, implementing and maintaining a quality management system conforming to ISO 9001:2000 standards.

**The effect of ISO certification on production**
This study aimed at determining the effect of ISO certification on production. As seen in the table below, the percentage of employees who were of the view that production was high before ISO certification was 33 at 17.7%.

<table>
<thead>
<tr>
<th>Production</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>33</td>
<td>17.7</td>
</tr>
<tr>
<td>Average</td>
<td>93</td>
<td>50.0</td>
</tr>
<tr>
<td>Low</td>
<td>60</td>
<td>32.3</td>
</tr>
<tr>
<td>Total</td>
<td>186</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Production after ISO Certification

After ISO certification, there was an increase in percentage and the number of respondents who hold the opinion that production increased as shown in the table below. This indicates that indeed ISO certification had led to an increase in production of the company.

<table>
<thead>
<tr>
<th>Production</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>176</td>
<td>94.6</td>
</tr>
<tr>
<td>Average</td>
<td>8</td>
<td>4.3</td>
</tr>
<tr>
<td>Low</td>
<td>2</td>
<td>1.1</td>
</tr>
<tr>
<td>Total</td>
<td>186</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Recommendations on ways of enhancing production

Regular Audits Because ISO9001:2000 is based on continual improvement philosophy, it is prudent that the company should carry out regular audits to check areas of non-conformities hence reduce occurrence of errors. Further the regular audits will enable the company to identify areas of continual improvement in the company.

Conducting of Refresher Courses for Auditors The Company should ensure that they conduct refresher courses for the internal auditors to enhance their skills and knowledge on ISO9001:2000 QMS as they keep on changing. In November 2008, the ISO 9001:2008 was been introduced it would therefore be advisable for the company to update the implementers with its requirements in advance before its application.

Identification of Customer Needs since ISO9001:2000 is customer focused, the company should develop strong customer service machinery by ensuring that they capture all the customer complaints and be able to identify what they need and act according to the needs of the customers.
**Auditing for All Suppliers Input** The Company should regularly carry out an audit on all their suppliers to ensure that they too conform to ISO 9001:2000 requirements. This will enhance quality on all their inputs and ultimately the processes and output.

**CONCLUSION**

The findings indicated that the company experienced an increase in production since the attainment of ISO 9001:2000 status. Both the company and employees have experienced benefits that have accrued as a result of attaining ISO 9001:2000 status.

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Nzoia Sugar Company limited ‘Nzoia Sugar Company ISO 9001: 2008 Certification’ The
VOLATILITY MODELLING OF THE NAIROBI STOCK EXCHANGE WEEKLY RETURNS USING THE ARCH-TYPE MODELS

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¹Chuka University College, ²Kabarak University, ³Egerton University

ABSTRACT

Modeling of stock market data has witnessed a significant increase over the past two decades. Focus has been mainly on the use of the ARCH model with its various extensions due to its ability to capture heteroscedasticity prevalent in the financial and monetary variables. However, the model efficiency of the competing ARCH-type models has not so far been exhaustively studied. The underlying problem is that of identifying the most efficient model that can be applied to a particular stock exchange data for forecasting and prediction of volatility which in turn is important in pricing financial derivatives, selecting portfolios, measuring and managing risks more accurately. The efficient model will not only be useful in long term forecasting and short term prediction but also in helping the investors on decisions regarding which shares to sell, hold or buy. The establishment of an efficient stock market is indispensable for an economy that is keen on utilizing scarce capital resources to achieve its economic growth. The purpose of this study was to determine the most efficient model from the symmetric ARCH models (namely, the original ARCH, GARCH and the IGARCH) and the asymmetric models: TGARCH and EGARCH. The results show that the AR-Integrated GARCH (IGARCH) models with student’s t-distribution are the best models for modelling volatility in the Nairobi Stock Market data.

Key words: ARCH, Model Efficiency, MSE, Volatility
1.0 INTRODUCTION

Stock market volatility is one of the most important aspects of financial market developments, providing an important input for portfolio management, option pricing and market regulation (Poon and Granger, 2003). An investor’s choice of a portfolio is intended to maximize the expected return subject to a risk constraint, or to minimize his risk subject to a return constraint. An efficient model for forecasting of an asset’s price volatility provides a starting point for the assessment of investment risk. To price an option, one needs to know the volatility of the underlying asset. This can only be achieved through modelling the volatility. Volatility also has a great effect on the macro-economy. High volatility beyond a certain threshold will increase the risk of investor loses and raise concerns about the stability of the market and the wider economy (Hongyu and Zhichao, 2006).

Financial time series modelling has been a subject of considerable research both in theoretical and empirical statistics and econometrics. Numerous parametric specifications of ARCH models have been considered for the description of the characteristics of financial markets. Engle (1982) introduced the Autoregressive Conditional Heteroscedasticity (ARCH) for modelling financial time series while Bollerslev (1986) came up with the Generalized ARCH (GARCH) to parsimoniously represent the higher order ARCH model while Nelson (1991) introduced the Exponential GARCH to capture the asymmetric effect. Other specifications of the GARCH model includes: the TGARCH introduced by Zakoian (1994), IGARCH by Engle and Bollerslev (1986), the Quadratic GARCH (QGARCH) model introduced by Sentana (1995), the GJR model by Glosten et al., (1993) just to mention but a few.

There is a significant amount of research on volatility of stock markets of developed countries. For instance, Gary and Mingyuon (2004) applied the GARCH model to the Shanghai Stock Exchange while Bertram (2004) modelled Australian Stock Exchange using ARCH models. Other studies on these stock markets include Baudouhat (2004) who utilized the GARCH model in analyzing the Nordic financial market integration, Walter (2005) applied the structural GARCH model to portfolio risk management for the South African equity market as well Hongyu and Zhichao (2006) who forecasted the volatility of the Chinese stock market using the GARCH-type models.

The Sub-Saharan Africa has been under-researched as far as volatility modelling is concerned. Studies carried out in the African stock markets include, Frimpong and Oteng-Abayie (2006) who applied GARCH models to the Ghana Stock Exchange, Brooks et al., (1997) examined the effect of political change in the South African Stock market, Appiah-Kusi and Pascetto (1998) investigated the volatility and volatility spillovers in the emerging markets in Africa. More recently, Ogum et al., (2006) applied the EGARCH model to the Kenyan and Nigerian Stock Market returns. From the available literature, the NSE just like other Sub Saharan Africa Equity Markets has been under-researched as far as market volatility is concerned and therefore this study contributes to the small literature available on the Nairobi stock market.

Mandelbrot (1963) utilized the infinite variance distributions when considering the models for stock market price changes. Fama (1965) when modelling stock market prices attributed their discrepancies to the possibility of the process having stable innovations and thus fitted an adequate model on this basis.
These developments in financial econometrics suggest the use of nonlinear time series structures to model the stock market prices and the expected returns.

The focus of financial time series modelling has been on the ARCH model and its various extensions thereby ignoring the aspect of efficiency within the ARCH-type of models. As a matter of fact, the subject of the efficiency of the models for financial modelling has received little attention as far as econometric modelling is concerned. This study therefore aims at finding the most efficient model from amongst the autoregressive conditional heteroscedasticity class of models. The remainder of this paper is arranged as follows;

The Nairobi Stock Exchange (N.S.E) was formed in 1954 as a voluntary organization of Stock brokers. It is now one of the most active capital markets and a model for the emerging markets in Africa in view of its high returns on investments and a well developed market structure (Ogum et al., 2005). It is a market place where shares and bonds are traded.

Financial time series data often exhibit some common characteristics. Fan and Yao (2003) summarizes the most important features of financial time series as: The series tend to have leptokurtic distribution, i.e they have heavy tailed distribution with high probability of extreme values. In addition, changes in stock prices tend to be negatively correlated with changes in volatility, that is; volatility is higher after negative shocks than after positive shocks of the same magnitude. This is referred to as the leverage effect.

The sample autocorrelations of the data are small whereas the sample autocorrelations of the absolute and squared values are significantly different from zero even for large lags. This behaviour suggests some kind of long range dependence in the data. The distribution of log returns over large periods of time (such as a month, a half a year, a year) is closer to a normal distribution than for hourly or daily log-returns. Finally, the variances change over time and large (small) changes of either sign tend to be followed by large (small) changes of either sign (Mandelbrot, 1963). This characteristic is known as volatility clustering. These are facts characterizing many economic and financial variables.

Researchers have applied different models to the stocks data from time to time. Mandelbrot (1963) utilized the infinite variance distributions when considering the models for stock market price changes. Fama (1965) similarly pointed out initially, their application in cases of economics particularly in modelling stock market prices. Fama et al., (1969) used a random walk to model the price changes. Andrew and Whitney (1986) tested the random walk hypothesis for weekly stock market returns by comparing the variance estimators. Here the random walk model was strongly rejected. Omosa (1989) applied the ARIMA model to the NSE data. Muhanji (2000) studied the efficiency of the Nairobi Stock Exchange and concluded that the NSE had a weak form of efficiency implying that the market is efficient at a particular period and becomes inefficient at another time.

In recent studies, various specifications of ARCH models have been considered for the description of the characteristics of financial markets. Some studies in which ARCH-type models were utilized include; Gary and Mingyuon (2004) who applied the GARCH model to Shanghai Stock Exchange, Bertram (2004) modelled Australian Stock Exchange using ARCH models and Baudouhat (2004) used the GARCH model in analyzing the Nordic financial market integration. In addition, Curto (2002) employed
the GARCH model to explain the volatility of the Portuguese equity market, Walter (2005) applied the structural GARCH model to portfolio risk management while Frimpong and Oteng-Abayie (2006) modelled the Ghana Stock Exchange volatility using the GARCH models. Moreover, Ogum et al., (2006) applied EGARCH model to the Kenyan and Nigeria daily stock market data.

Simple regression models have also been utilized in modelling stock market data. Bodicha (2003) applied regression models to the NSE data and found out that the regression models are only appropriate for short term prediction and not for long term forecasting. The analysis of the general linear regression model forms the basis of every standard econometric model. Mills (1999) applied the simple linear relationship in modelling the expected risk and return in holding a portfolio.

2.0 Autoregressive Conditional Heteroscedasticity (ARCH) models

An ARCH process is a mechanism that includes past variances in the explanation of future variances (Engle, 2004). Autoregressive describes a feedback mechanism that incorporates past observations into the present. ARCH models specifically take the dependence of the conditional second moments in modelling consideration. This accommodates the increasingly important demand to explain and to model risk and uncertainty in financial time series (Degiannakis and Xekalaki, 2004; Engle, 2004; Fan and Yao, 2003).

An ARCH process can be defined in terms of the distribution of the errors of a dynamic linear regression model. The dependent variable $y_t$ is assumed to be generated by

$$y_t = x_t' \xi + \varepsilon_t \quad t = 1, \ldots, T$$

where $x_t'$ is a $k \times 1$ vector of exogenous variables, which may include lagged values of the dependent variable and $\xi$ is a $k \times 1$ vector of regression parameters. The ARCH model characterizes the distribution of the stochastic error $\varepsilon_t$ conditional on the realized values of the set of variables $\psi_{t-1} = \{y_{t-1}, x_{t-1}, y_{t-2}, x_{t-2}, \ldots\}$. In practice, it is assumed that

$$\varepsilon_t / \psi_{t-1} \sim N(0, h_t) \quad h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \ldots + \alpha_q \varepsilon_{t-q}^2$$

with $\alpha_0 > 0$ and $\alpha_i \geq 0, i = 1, \ldots, q$ to ensure that the conditional variance is positive (Engle’s (1982). An explicit generating equation for an ARCH process is

$$\varepsilon_t = \eta_t \sqrt{h_t}, \quad \eta_t \sim i.i.d \ N(0,1).$$

Since $h_t$ is a function of $\psi_{t-1}$ and is therefore fixed when conditioning on $\psi_{t-1}$, it is clear that $\varepsilon_t$ as will be conditionally normal with

$$E(\varepsilon_t / \psi_{t-1}) = \sqrt{h_t}, E(\eta_t / \psi_{t-1}) = 0 \quad \text{and} \quad \text{Var}(\varepsilon_t / \psi_{t-1}) = h_t, \text{Var}(\eta_t / \psi_{t-1}) = h_t.$$

The Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model developed by Bollerslev (1986) is a generalized ARCH (GARCH) where the conditional variance is

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \ldots + \alpha_q \varepsilon_{t-q}^2 + \beta_1 h_{t-1} + \ldots + \beta_p h_{t-p}$$

with the inequality conditions $\alpha_0 > 0, \alpha_i \geq 0$ for $i=1, \ldots, q$, $\beta_i \geq 0$ for $i=1, \ldots, p$ to ensure that the conditional variance is strictly positive.
When the parameter estimates in GARCH (p,q) models are close to the unit root but not less than unit, i.e.
\[ \sum_{i=1}^{p} \alpha_i + \sum_{j=1}^{q} \beta_j = 1, \]
for the GARCH process, the multi-step forecasts of the conditional variance do not approach the unconditional variance. These processes exhibit the persistence in variance/volatility whereby the current information remains important in forecasting the conditional variance. Engle and Bollerslev (1986) refer to these processes as the Integrated GARCH or IGARCH and they do not possess a finite variance but are stationary in the strong sense (Nelson, 1990).

The simplest GARCH(1,1) is often found to be the benchmark of financial time series modelling because such simplicity does not significantly affect the preciseness of the outcome.

Another extension is the GARCH-M model developed by Engle et al., (1987) whose key postulate was that time varying premia on different term instruments can be modelled as risk premia where the risk is due to unanticipated interest rates and is measured by the conditional variance of the one period holding yield. The GARCH (1,1)-M model is presented as
\[ x_t = y_{t-1} \beta + h_t \gamma + \epsilon_t \]
where \( x_t \) and \( h_t \) are defined as before while \( y_{t-1} \) is a vector of additional explanatory variables. Just like the GARCH model, the GARCH-M is unable to capture asymmetric characteristics of financial data.

The Exponential GARCH (EGARCH) models were introduced by Nelson (1991) in an attempt to address the two major limitations of the GARCH models. Here the volatility depends not only on the magnitude of the shock but also on their corresponding signs. The non-negativity restrictions are not imposed as in the case of GARCH since the EGARCH model describes the logarithm of the conditional variance which will always be positive. The specification for the conditional variance (Nelson, 1991) is given as,

\[
\log \sigma_t^2 = \sigma_0 + \sum_{i=1}^{q} \beta_i \log \sigma_{t-i}^2 + \sum_{i=1}^{p} \alpha_i \frac{|\epsilon_{t-i}|}{\sigma_{t-i}} + \sum_{i=1}^{p} \gamma_i \frac{\epsilon_{t-i}}{\sigma_{t-i}}
\]

Note that \( \epsilon_t = \sqrt{\eta_t \sigma_t} \) where \( \eta_t \sim \text{i.i.d} (0,1) \).

The parameter (\( \alpha_i \)) in equation (10) measures the impact of innovation on volatility at time \( t \) while parameter (\( \beta_i \)) is the auto-regressive term on lagged conditional volatility, reflecting the weight given to previous period’s conditional volatility \( t \). It measures the persistence of shocks to the conditional variance. The stationarity requirement is that the roots of the auto-regressive polynomial lie outside the unit circle. For EGARCH (1,1) this translates into \( \beta_1 < 1 \) (Ogum et al., 2006). Unlike the linear GARCH, in the EGARCH model a negative shock can have a different impact compared to a positive shock if the asymmetry parameter \( \gamma_i \) is non-zero.

Threshold GARCH models (TGARCH) were introduced by Zakoian (1994). The generalized specification of the conditional variance equation is given by,

\[
h_t = \alpha_0 + \sum_{j=1}^{q} \beta_j h_{t-j} + \sum_{i=1}^{p} \alpha_i \epsilon_{t-i}^2 + \sum_{k=1}^{r} \gamma_k \epsilon_{t-k}^2 I_{t-k}
\]
Where \( \epsilon_i = \sqrt{h_i} \) and \( I_i = 1 \), if \( \epsilon_i < 0 \) and zero otherwise. In this model, good news, \( \epsilon_{t-i} > 0 \), and bad news \( \epsilon_{t-i} < 0 \), have differential effects on the conditional variance; good news has an impact of \( \alpha_i \), while bad news has an impact of \( \alpha_i + \gamma_i \). If \( \gamma_i > 0 \), bad news increases volatility while if \( \gamma_i \neq 0 \), the news impact is asymmetric. When the threshold term is set to zero, then equation (12) becomes a GARCH \((p,q)\) model.

This study was focused on modelling the weekly NSE 20-share index and share prices for the three chosen companies namely, National Bank of Kenya Limited (NBK), Bamburi Cement and Kenya Airways from Nairobi Stock Exchange using ARCH-type models. The companies selected have been consistent in the NSE and are representative of the three sectors namely, Finance & Investment, Industrial & Allied and Commercial & Services categorized in the NSE. The ARCH-type models are more appropriate for the stock market data since they are able to capture the stylized facts exhibited by the NSE.

### 3.0 GARCH MODELS FOR VOLATILITY

In this study, four sets of data consisting of the weekly average share prices for Bamburi Cement Ltd, National Bank of Kenya Limited (NBK), Kenya Airways (KQ) Ltd as well as the weekly average NSE 20 share index were used. The data was obtained from the Nairobi Stock Exchange (NSE) for the period between 3rd June 1996 to 30th October 2010 for the company share prices while for the NSE 20-share index data was for period between 2nd March 1998 to 30th October 2010.

The NSE 20-share index is a weighted mean with 1966 as the base year at 100. It is based on 20 companies calculated on a daily basis. The index is useful in determining the performance of the NSE by measuring the general price movement in the listed shares of the stock exchange.

Bamburi Cement, Ltd. was founded in 1951 and manufactures cement in sub-Saharan Africa. The company reported earnings results for the six months ended June 30, 2006. For the period, the company reported that the profit increased by 32.7% from KES 1.03 billion that was posted in a similar period the previous year. The firm improved in profitability with the turnover rising by 12% to KSH. 7.9 billion from KSH. 7 billion.

The Kenya Airways’ principal activities include passengers and cargo carriage. It was incorporated in 1977 as the East African Airways Corporation (EAA). The company was listed in the NSE in 1996 and has been a major player in the Nairobi stock market.

The National Bank of Kenya Limited (NBK) was incorporated on 19th, June 1968 and officially opened on Thursday 14th, November 1968. Its main objective was to help Kenyans to get access to credit and control their economy after independence. NBK’s current shareholding is distributed as: National Social Security Fund (NSSF) 48.06%, General Public 29.44%, and Kenya Government 22.5%. During the 34th, AGM held on 25th, April 2003, the bank increased its Share Capital by Kshs. 6 Billion. NBK is a major player in Kenya's banking industry and is one of the largest bank in the country giving financial services to all sectors of the economy. NBK is also involved in the stock market playing multiple roles as an
arranger, underwriter and placing agent. The preliminary analysis was done by use of time plots for the various series presented in Figures 1 and 2.

![Time plots for various series](image)

**Figure 1:** Time plots for the weekly average prices

A visual inspection of the time plots clearly shows that the mean and variance are not constant, implying non-stationarity of the data. The non-constant mean and variance suggests the utilization of a nonlinear model and preferably a non-normal distribution for modelling the data.

The series were transformed by taking the first differences of the natural logarithms of the values in each the series. The transformation was aimed at attaining stationarity in the first moment. The equation representing the transformation is given by $X_t = \ln(P_t) - \ln(P_{t-1})$, where $P_t$ represents the weekly average value for each series. The sequence plots for the returns are presente
The basic statistical properties of the data show that mean returns are all positive and close to zero—a characteristic common in the financial return series. All the four series have very heavy tails showing a strong departure from the Gaussian assumption. The Jarque-Bera test also clearly rejects the null hypothesis of normality. Notable is the fact that all the four series exhibit positive Skewness estimate. This means that there are more observations on the right hand side.

The series having exhibited heteroscedasticity as shown by the time plots were tested for the ARCH disturbances using Engle’s (1982) Lagrange Multiplier (LM) while the Portmanteau Q test (McLeod and Li, 1983) based on the squared residuals was used to test for the independence of the series. Since both the Q statistic and the LM are calculated from the squared residuals, they were used to identify the order of the ARCH process.

For all the return series, the Q statistics and the Lagrange Multiplier (LM) tests indicated strong heteroscedasticity for all the lags from 1 to 12. This suggested an ARCH model of order $q=8$.

3.1 ARCH models

The first set of models implemented in this study was the original Engle’s (1982) ARCH models. The student’s t-distribution and the General Error Distribution (GED) were tested for all the series. The student’s t-distribution assumption provided a better model for NBK and KQ while the GED performed well for NSE Index and Bamburi. This could be due to the fact the financial data is highly heavy tailed and is better captured by the student’s t-distribution since the GED distribution has a higher peak than the student’s t-distribution. Although the GED distribution may be better able to capture peaks, it is far worse for capturing fat tails. The Jarque-Bera (1980) statistic also strongly rejected the normality assumption in
the standardized residuals for all the series. The fitted models were adequate since their standardized residuals were not significantly correlated in all the four series basing on the Ljung-Box Q statistics. The squared residuals were also not significantly correlated for lags up to 12 for all the four series.

b) GARCH models

The next class of models implemented was the GARCH models. The autoregressive models were applied to capture the autocorrelation present in the series. The GARCH models for different values of p and q were fitted to the data, diagnosed and from the diagnosis and goodness of fit statistics, the GARCH (1,1) was found to be the best choice. This is consistent with most empirical studies involving the application of GARCH models in financial time series data. The Maximum Likelihood Estimation (MLE) method was employed in the parameter estimation.

The GARCH parameter estimates for the variance equation was significant for all the series except for the NSE Index in which \( \alpha_1 \) was not statistically significant. In the GARCH model, the parameters \( \alpha \) and \( \beta \) must satisfy \( \alpha + \beta < 1 \) for stationarity. However, the GARCH (1,1) estimates violated the restriction imposed i.e. in all cases, \( \alpha + \beta > 1 \). This implies that the fitted GARCH model is not weakly stationary and the conditional variance \( \sigma_t^2 \) does not approach the unconditional variance \( \sigma^2 \) and thus the series might not have finite unconditional variance. This calls for the implementation of Integrated GARCH (1,1) model since it is capable of being stationary in the strong sense even though \( \alpha_1 + \beta_1 = 1 \) (Nelson,1990).

Two distributions were tested (i.e student’s t and GED) for the specific GARCH (p,q) model and the best distribution choice was determined based on the SBC, AIC and the Log likelihood Ratio test in all the cases (see Table 4.8). For the NSE index, the distribution of choice was the student’s t-distribution while for NBK, Bamburi, and KQ the Generalized Error Distribution was chosen. This shows that the NSE index data had fatter tails as compared to NBK, Bamburi and KQ. The model adequacy was checked using the Ljung-Box Q statistics for residuals and squared residuals in which the null hypothesis of no significant correlations was not rejected for all the series implying that the fitted models were adequate. The JB statistics rejected the null hypothesis of normality in the standardized residuals. This implies that the models with the respective distributions failed to normalize the residuals. The Goodness of fit statistics and Diagnostic tests are presented Appendix 2.

c) Integrated GARCH (IGARCH) Model

Since the parameter estimates in GARCH (1,1) models were close to the unit root but not less than unit, i.e \( \sum_{i=1}^{p} \alpha_i + \sum_{j=1}^{q} \beta_j = 1 \), the IGARCH model was fitted. The MLE method was utilized for parameter estimation for the mean and variance equations.

The parameter estimates for the variance equation were statistically significant at 0.05 significance level in all the series. In addition, \( \alpha_1 + \beta_1 = 1 \) for all the cases; implying that multi-step forecasts of the conditional variance do not approach the unconditional variance (i.e the unconditional variance is infinite). Despite the infinite unconditional variance, one attractive feature of the IGARCH model is that it is strongly
stationary even though it is not weakly stationary. The results indicate that the data sets used exhibit the persistence in variance/volatility whereby the current information remains important in forecasting the conditional variance, i.e. the current information in the NSE remains important in forecasting the conditional variance.

Two distribution assumptions namely, Generalized error Distribution and t-distributions were tested. Generalized error Distribution provided the best fit for the data adequately when modelling with the IGARCH model in all the four series. The models were fitted and diagnosed using the AIC, SBC and the Log likelihood ratio test. However, the final model was considered adequate if its standardized residuals and squared residuals were not significantly correlated at 5% significance level. The residual correlation was tested using the Ljung-Box Q statistics. All the fitted IGARCH models were adequate since their residuals were not significantly correlated. Further, the standardized residuals were still non-normal as shown by the JB statistics for normality. The goodness of fit statistics for the IGARCH(1,1) model and the diagnostic tests are presented in Appendix 1 and 2 respectively.

In order to capture the leverage effects, two asymmetric ARCH-type models; the Exponential GARCH (EGARCH) and Threshold GARCH (TGARCH) were fitted.

d) EGARCH models

Despite the popularity and apparent success of GARCH models in practical applications, they cannot capture asymmetric response of volatility to news since the sign of the returns play no role in the model specification. Statistically, the asymmetric effect occurs when an unexpected decrease in price resulting from bad news increases volatility more than an unexpected increase in price of similar magnitude following good news.

Accordingly, Nelson’s (1991) EGARCH model was fitted. Unlike the GARCH (p,q) model, a negative shock can have a different impact on future volatility when compared to the positive shock if asymmetry parameter \( \gamma_1 \) is not zero for the EGARCH model. It also does not need restrictions to be imposed on the parameters to ensure the non-negativity.

In the EGARCH model estimation, the MLE criterion was employed. Different orders for p and q in the variance equation were tested with the best results being achieved for p=q=1. The Generalized Error Distribution emerged as the best distribution for all the series (NSE, Bamburi, KQ and NBK). This implies that all the series under investigation have long tails and are asymmetric.

The EGARCH model parameter estimates also reveal the persistence in volatility of the Nairobi equity market. This is because the sum of \( \alpha_1 \) and \( \beta_1 \) is approximately 1 in all the data sets. The asymmetric parameter \( \gamma_1 \) is positive and significant for all the four series namely NSE Index, NBK, Bamburi and KQ. The positivity of \( \gamma_1 \) indicates that positive shocks increase volatility more than the negative shocks of an equal magnitude. This shows that the concept of “leverage effect” (i.e. the negative shocks increasing volatility more than a positive shock of the same magnitude) is not applicable to the individual company stocks. This is consistent with the earlier studies on the Nairobi Stock Exchange for instance Ogum et al.,
(2005, 2006) who found the asymmetry parameter $\gamma_1$ to be positive when modelling the daily NSE 20 Share Index using the EGARCH models.

This could arise from the fact that the weekly return series were used in this study while Ogum et al., (2005, 2006) modelled the daily returns. Some information could have been lost when using the weekly average for the NSE index and the share prices for the companies. In addition, the flow of information in NSE might not be as efficient as in the developed equity markets.

The model diagnostics and goodness of fit statistics are presented in Appendix 1 and 2 respectively. The diagnostics included the autocorrelation of the standardized residuals and squared residuals respectively. The Ljung-Box Q statistics represented by $Q(12)$ and $Q^2(12)$ for residuals and squared residuals respectively were used which were not significant in all cases confirming the adequacy of the fitted models. The models could thus explain the non-linear dependence in the residuals i.e the models captured the dependence in the variance shown by the original series of returns.

The EGARCH model, in all cases showed a smaller Kurtosis compared to the ARCH and GARCH models. In addition, the student’s t-distribution and Generalized Error Distributions also captured the tail properties of the data better than the Gaussian distribution in all the four cases. The JB statistics also strongly rejected the null hypothesis of normality in the standardized residuals in all the series under consideration.

e) Threshold GARCH (1,1)

The TGARCH (1,1) model which falls in the asymmetric class of ARCH-type models was also used. The model was fitted, estimated and diagnosed just like the previous models. From the two distributions tested, the student’s t distribution emerged the best for the NSE index while GED was considered the best for the NBK, Bamburi and KQ. This is because the GED and the students’s t-distributions were able to capture the tail properties of the data. It is worth noting that under the student’s t distribution, the convergence during estimation was a major problem. The algorithm converged very slowly and sometimes weakly. This casts doubts on the stability of the parameter estimates.

In the variance equation, the asymmetry parameter $\gamma_1$ was less than zero for all the four series. This implies that good news increases volatility more than bad news. This is consistent with the findings of Ogum et al., (2005, 2006) who applied EGARCH models to the daily NSE 20 Share Index. Hence the leverage effect experienced in developed markets might not be a universal phenomenon.

The diagnostic tests and goodness of fit statistics for the TGARCH models are presented in Appendix 1 and 2 respectively. Just like the previous models, the best distributions were GED and the student’s t-distribution. Also, based on the Ljung-Box Q statistics, both the residuals and the squared residuals were not significantly (5% level) correlated implying that the models were adequate. The JB statistic for normality also rejected the normality assumption in the standardized residuals.

3.3 Efficiency Comparison between the ARCH-type Models
Model efficiencies for each of the ARCH-type models implemented were evaluated using the various MSE. The MSE for the chosen models are presented in Table 1.

Table 1: MSE for the fitted ARCH-type models

<table>
<thead>
<tr>
<th>Series</th>
<th>ARCH(q)</th>
<th>GARCH(1,1)</th>
<th>IGARCH(1,1)</th>
<th>EGARCH(1,1)</th>
<th>TGARCH(1,1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSE INDEX</td>
<td>0.0006946</td>
<td>0.0006958</td>
<td>0.000696</td>
<td>0.0006967</td>
<td>0.000699</td>
</tr>
<tr>
<td>NBK</td>
<td>0.006757</td>
<td>0.006765</td>
<td>0.006744</td>
<td>0.006766</td>
<td>0.006765</td>
</tr>
<tr>
<td>BAMBURI</td>
<td>0.003119</td>
<td>0.003073</td>
<td>0.003098</td>
<td>0.003019</td>
<td>0.003073</td>
</tr>
<tr>
<td>KQ</td>
<td>0.002997</td>
<td>0.002993</td>
<td>0.002989</td>
<td>0.002996</td>
<td>0.002993</td>
</tr>
</tbody>
</table>

Considering the MSE values in Table 1, it is clear that ARCH, GARCH, EGARCH and IGARCH are all equally efficient in modelling volatility based on the MSEs only, since the different ARCH-type models are almost equal for the respective data sets. The disadvantage with the ARCH model is that so many parameters are to be estimated. The GARCH, IGARCH, EGARCH and TGARCH models are able to parsimoniously model the series and hence are preferred to the original ARCH model. Considering the asymmetric properties of the data and the respective MSEs, the EGARCH (1,1) emerged as the best model for the NSE Index and Bamburi. For the NBK, both the EGARCH and the TGARCH are equally good but EGARCH is considered the best since the parameter estimates for the TGARCH are unstable due to weak convergence. The best model for Kenya Airways was the GARCH model.

The respective models chosen are justified by their relatively lower values of residual Kurtosis and MSE in addition to the other diagnostics considered as well as the asymmetric parameter that captures the leverage effect. However, in terms of stationarity, the IGARCH model with the Generalized Error Distribution (GED) emerged as the best ARCH-type model since it was strongly stationary thus being more stable. This makes the IGARCH model to be the preferred model from the ARCH-type models for modelling the Nairobi Stock Exchange data for the periods between 2nd March 1998 to 30th October 2010 for NSE 20-Share index while and 3rd June 1996 to 30th October 2010 for company share prices, i.e NBK, Bamburi and Kenya Airways.

4.0 SUMMARY AND CONCLUSIONS

In this study, the original Engle’s (1982) ARCH (p) model and its three extensions namely, standard GARCH (p,q), IGARCH(p,q), EGARCH (p,q) and TGARCH (p,q) were applied to the data. Different orders for ARCH(p) were tested in all cases where p=8 was found to be the most adequate for NSE index, Bamburi and KQ while for the NBK series, p=9 provided the best order for ARCH model. Four different p and q values were tested for GARCH(p,q), EGARCH (p,q) and TGARCH (p,q): (1,1), (1,2), (2,1) and (2,2). The order p, q equal to (1,1) is by far the most used values in GARCH research today and results obtained is also consistent with this.

In all the four series, the order (1,1) is the best choice. Comparing the diagnostics and the goodness of fit statistics, the IGARCH (1,1) outperformed the ARCH, EGARCH and TGARCH models majorly due to
its stationarity in the strong sense. However, the IGARCH model is unable to capture the asymmetry exhibited by the stock data. The EGARCH (1,1) and the TGARCH (1,1) are the preferred models to describe the dependence in variance for all the four series studied since they were able to model asymmetry and parsimoniously represent a higher order ARCH(p). However, the standardized residuals still displayed non-normality in all cases.

Judging from the asymmetric parameter ($\gamma_1 < 0$) in the EGARCH model, the volatility increases more with the bad news (negative shocks) than the good news (positive shocks) of the same magnitude for the NSE Index. This is not consistent with the findings of Ogum et al., (2005, 2006). However, for the individual stocks the asymmetric parameter ($\gamma_1 > 0$) meaning that volatility increases more for good news more than bad news of the same magnitude. This implies that the leverage effect may not be a universal phenomenon after all. From the different distributions tested and estimated, the student’s t distribution was the best choice for NSE index while GED was the best for NBK, Bamburi and Kenya Airways. The Gaussian assumption provided the poorest results and in some cases had convergence failures.

REFERENCES


APPENDICES

APPENDIX 1: The goodness of fit statistics

<table>
<thead>
<tr>
<th></th>
<th>ARCH (q)</th>
<th>GARCH(1,1)</th>
<th>EGARCH(1,1)</th>
<th>TGARCH(1,1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gaussian</td>
<td>t</td>
<td>GED</td>
<td>Gaussian t</td>
</tr>
<tr>
<td>NSE</td>
<td>L</td>
<td>1105.97</td>
<td>1234.183</td>
<td>1186.69</td>
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<tr>
<td>NBK</td>
<td>L</td>
<td>751.7188</td>
<td>888.5304</td>
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<td>BAMBU</td>
<td>L</td>
<td>931.8938</td>
<td>1173.448</td>
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<tr>
<td>KQ</td>
<td>L</td>
<td>622.678</td>
<td>1056.460</td>
<td>877.2675</td>
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L-represents the Log likelihood test.
<table>
<thead>
<tr>
<th>Series</th>
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<th>ARCH</th>
<th>GARCH(1,1)</th>
<th>EGARCH(1,1)</th>
<th>TGARCH(1,1)</th>
<th>IGARCH(1,1)</th>
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<tbody>
<tr>
<td></td>
<td>Kurtosis</td>
<td>247.6270</td>
<td>336.4305</td>
<td>281.5813</td>
<td>334.0355</td>
<td>164.221066</td>
</tr>
<tr>
<td></td>
<td>JB</td>
<td>1273648(0.0)</td>
<td>2362405(0.00)</td>
<td>1650644 (0.000)</td>
<td>2328646 (0.00)</td>
<td>2372988.14 (0.0001)</td>
</tr>
<tr>
<td></td>
<td>Q(12)</td>
<td>9.1250 (0.244)</td>
<td>1.7414 (0.973)</td>
<td>1.9366 (0.963)</td>
<td>2.050 (0.957)</td>
<td>181.363 (0.500)</td>
</tr>
<tr>
<td></td>
<td>Q^2(12)</td>
<td>0.2561(1.00)</td>
<td>0.0362 (1.00)</td>
<td>0.0488 (1.00)</td>
<td>0.357 (1.00)</td>
<td>127.096 (0.444)</td>
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<td>NBK</td>
<td>Skewness</td>
<td>0.440471</td>
<td>0.826570</td>
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<td>0.788546</td>
<td>1.25458426</td>
</tr>
<tr>
<td></td>
<td>JB</td>
<td>2464.525 (0.00)</td>
<td>2368.132 (0.00)</td>
<td>2175.813 (0.00)</td>
<td>2460.232 (0.0)</td>
<td>2209.2269 (0.0001)</td>
</tr>
<tr>
<td></td>
<td>Q(12)</td>
<td>12.153 (0.275)</td>
<td>13.956 (0.175)</td>
<td>12.569 (0.249)</td>
<td>13.468 (0.143)</td>
<td>16.48 (0.170)</td>
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<tr>
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<td>7.7550 (0.653)</td>
<td>3.3475 (0.972)</td>
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<td>3.3146 (0.951)</td>
<td>40.21 (1.0000)</td>
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<tr>
<td>BAMBURI</td>
<td>Skewness</td>
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<td>46.14442</td>
<td>36.27621</td>
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<td></td>
<td>JB</td>
<td>46944.72(0.00)</td>
<td>27841.11 (0.00)</td>
<td>12638.47 (0.00)</td>
<td>18523.7 (0.0)</td>
<td>52802.3806 (0.0001)</td>
</tr>
<tr>
<td></td>
<td>Q(12)</td>
<td>13.073 (0.159)</td>
<td>16.192 (0.063)</td>
<td>18.489 (0.300)</td>
<td>14.448 (0.107)</td>
<td>26.49 (0.670)</td>
</tr>
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<td></td>
<td>Q^2(12)</td>
<td>0.5454 (1.00)</td>
<td>1.0873 (0.999)</td>
<td>2.1275 (0.989)</td>
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<td>136.98 (0.988)</td>
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<td>465.1099</td>
<td>357.2894</td>
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<tr>
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<td>JB</td>
<td>4928567(0.00)</td>
<td>537054(0.00)</td>
<td>3160227 (0.00)</td>
<td>5127155</td>
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<td>Q(12)</td>
<td>3.8591 (0.920)</td>
<td>1.8585 (0.994)</td>
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<td>1.8733 (0.993)</td>
<td>197.66(0.664)</td>
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<td>0.0250(1.00)</td>
<td>0.0264 (1.00)</td>
<td>0.391 (1.00)</td>
<td>0.0273 (1.00)</td>
<td>87.453 (0.442)</td>
</tr>
</tbody>
</table>

L- Represents Log likelihood Ratio test

JB- Represents Jarque-Bera statistics for normality

Q(12) - Represents Ljung-Box Q statistics for residuals

Q^2(12) - Represents Ljung-Box Q statistics for squared residuals
APPENDICES

Appendix 1: The goodness of fit statistics for ARCH models

<table>
<thead>
<tr>
<th></th>
<th>ARCH (q)</th>
<th>GARCH(1,1)</th>
<th>IGARCH(1,1)</th>
<th>EGARCH(1,1)</th>
<th>TGARCH</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>t</td>
<td>GED</td>
<td>t</td>
<td>GED</td>
<td>t</td>
</tr>
<tr>
<td>LR BAMBURI</td>
<td>1350.889</td>
<td>1464.813</td>
<td>1529.121</td>
<td>1554.337</td>
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<tr>
<td>LR BURU</td>
<td>1349.801</td>
<td>1269.075</td>
<td>1353.618</td>
<td>1360.433</td>
<td>1306.834</td>
</tr>
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</table>

LR- Represents Log likelihood Ratio test

JB- Represents Jarque-Bera statistics for normality

Q(12) - Represents Ljung-Box Q statistics for the standardized residuals

Q^2(12) - Represents Ljung-Box Q statistics for squared standardized residuals

P-Values are given in the brackets
### Appendix 2: Diagnostic Tests for Standardized Residuals for ARCH-type models

<table>
<thead>
<tr>
<th>Series</th>
<th>Statistics</th>
<th>ARCH(q)</th>
<th>GARCH(1,1)</th>
<th>IGARCH(1,1)</th>
<th>EGARCH(1,1)</th>
<th>TGARCH(1,1)</th>
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<tbody>
<tr>
<td>NSE INDEX</td>
<td>Skewness</td>
<td>0.371885</td>
<td>0.453360</td>
<td>0.274917</td>
<td>0.604607</td>
<td>0.510931</td>
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<tr>
<td></td>
<td>JB</td>
<td>1634.604 (0.00)</td>
<td>1718.698 (0.00)</td>
<td>1061.89(0.000)</td>
<td>1208.424 (0.00)</td>
<td>1584.85 (0.000)</td>
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<tr>
<td></td>
<td>Q(12)</td>
<td>6.7497 (0.345)</td>
<td>7.5418 (0.274)</td>
<td>5.2777 (0.509)</td>
<td>7.4763 (0.279)</td>
<td>7.0248 (0.319)</td>
</tr>
<tr>
<td></td>
<td>Q^2(12)</td>
<td>6.7934 (0.340)</td>
<td>5.7669 (0.450)</td>
<td>13.047 (0.560)</td>
<td>5.2634 (0.511)</td>
<td>6.3818 (0.382)</td>
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<tr>
<td>NBK</td>
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<td>0.280164</td>
<td>-0.228243</td>
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<td>2573 (0.000)</td>
<td>3181.45(0.000)</td>
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<td>30228.6(0.000)</td>
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<td>Q(12)</td>
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<td>13.569 (0.06)</td>
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<td>13.200(0.105)</td>
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<td>6.1931 (0.626)</td>
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