
**PROCEEDINGS OF KOFORIDUA POLYTECHNIC 5TH ANNUAL APPLIED RESEARCH
CONFERENCE**

THEME:

BUILDING A SUSTAINABLE SOCIETY THROUGH INNOVATION AND SKILLS DEVELOPMENT

ABBA BENTIL ANDAM THEATER

KOFORIDUA POLYTECHNIC

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Hospitality Staff of Koforidua Polytechnic

In our effort to improve the organization of the Annual Conference, we sincerely are looking forward to the response of our readers, participants and researchers.

RAPPORTEURS REPORT

by

Mrs. Charity Ossom & Mr. Paul Baah

The opening ceremony of the conference started at 9:30am on Tuesday, 26th June, 2012 at the Aba Bentil Andam Theatre, Koforidua Polytechnic. The opening prayer was said by Mr. Mawutorwu Doe. The Chairman of the ceremony was Mr. Osei Tutu, the Vice Rector of the Polytechnic. Representatives of all the other Polytechnics were present.

The Rector of Koforidua Polytechnic gave the welcome address; he welcomed participants to the 5th edition of the annual conference. He told participants that 25 papers from different fields would be presented. He wished participants well and assured them of a conducive atmosphere throughout the conference.

In all, three keynote addresses were delivered. One on the first day and the other two on the second day. The keynote address for the first day was given by Dr. Daniel Baffour Awuah, the Executive Director of the Council for Technical and Vocational Education and Training (COTVET), Ghana. The Theme was: **Building a Sustainable Society through Innovation and Skills Development**

In his address, he reiterated the importance of skill and attitude development especially in this 21st century. According to him, the worker in this century needs vital skills to be competent. The rapid technological changes that characterize the century demand that every worker now must have knowledge, skills and attitudes. These ripple in to basic skills such as reading, writing, computation; in addition, the worker needs technical, organizational and company specific skills. Therefore, the 21st Century worker is worker with complex cognitive skills because as Golden and Ford 2001 said, a strong back and a weak mind will not permit any nation to compete in today's market place. Moreover, globalization has come to make the world a village; every society impacts on another. Economies may become better or worse depending on their competence in the competition brought about by globalization and human capital is a necessary factor in the competition.

For Ghana, the Speaker pointed out that 'a major challenge in innovative skills development for an ongoing basis and how to translate these requirements into changes in learning materials and training approaches; and to ensure that the system is responsive to ongoing change.

The second keynote address was given by Prof. George Afeti on the theme: **Polytechnic Education: Assessing its mandate on the Skills Development and Innovation and their applications with the Enactment of the Polytechnic Act, 2007 (Act 745)**. In his address, he pointed out that Polytechnic education is meant to train students who are practically oriented to meet the diverse developmental needs and the challenges of the country. Polytechnic institutions should therefore concentrate on how best to develop the skills of the students so that they can contribute their quota to the development of the nation. He revealed that Korea and many other developed nations have made giant strides in their economies all because of the abundance of skilled labour force which these nations can boost of. Ghana can only attain such economic successes if the Polytechnics in Ghana train skilled labour force who will fuel the economic development of the nation. He therefore suggested 12 recommendations which will strengthen the Polytechnics to operate within the framework of the 2007 Polytechnic Act.

The third keynote address was delivered by Mr. George Dake on the topic: **An Overview of Local Enterprises Skills and Development Programmes (LESDEP)**. He said that over the years, successive Governments have developed varied interventions to address the seemingly insurmountable problem of unemployment and wealth creation. Even though some level of successes has been chalked, most often these interventions lacked sustained strategy to make the desired impact on the people, particularly at the local economy level. LESDEP programme seeks to build business enterprises using the local entrepreneurs based on local economic aspirations, build businesses out of simple, low technology and environmental friendly equipment and provide comprehensive business and entrepreneurial services to beneficiaries.

Lead Presentation: There was a lead presentation on ‘The Role of Boundary Conditions in Validating Theoretical and Experimental Results’ by Prof. (Ing) Reynolds Okai, Rector of Koforidua Polytechnic. He drew on the fact that theory may diverge from fact; this may happen as a result of contextual factors. Importantly, he advised researchers to be wary of throwing away findings when they do not converge with theory. He drew heavily on a research into a band saw engaging wood and the theories that underline such.

TECHNICAL SESSIONS

There were 49 papers presented in five sessions; there were parallel sessions too. These papers are from diverse disciplines – Sciences, Business, and Environment to Engineering. From how we can heat our water using solar energy, pump water up from wells even in the remotest villages, keep our environment free of waste, be cautious of musculo-skeletal diseases, HIV issues, and the most interesting – Malaria can be detected without giving the painful pinch.

Below is synopsis of all the papers.

- **Can the Expanding Services Sector with Stagnating Industrial Capacity Lead Ghana into Sustainable Growth?**

The current situation of services-lead growth over raw material production base-structure (of the economy) creates import-dependency economic systems with associated balance of payment and foreign exchange instabilities.

- **Design and Construction of a Light Weight Frame for a Rugged Two-Seater Off-Road Recreational Vehicle.**

It is recommended that further research consider designing the frame to accommodate four individuals including the passenger. A foundry application could also be employed to strengthen the Chassis design to ensure it is road worthy.

- **Creation of Artefacts from Plastic Waste Materials as means of Environmental Protection and Management in Ghana.**

The findings of the research revealed that the cast artefacts were lighter and stronger, and could be decorated to serve as decorative pieces. It was recommended among others that this technique could be used to produce teaching aids and artefacts for pre-school levels, and also decorative pieces thereby managing/utilizing the plastic waste materials that have become nuisance to the environment.

- **The Pesticidal Effect of Various Neem Tree Extracts for Use in the Agricultural Industry.**

Oil extracted from the neem seed kernel showed even greater lethal properties on the insects; with a minimal lethal concentration, in all cases, being 0.50% v/V. Again the termites and the weevils responded faster, recording total deaths within 2-5 minutes, compared to the cockroaches and the mosquito larvae where total deaths were experienced only after 30-90 minutes. It was also found out that there was a direct relation between the concentration and degree of lethal effectiveness of the oil. The neem, especially the seed oil, has great potential in biological pests control systems.

- **Performance Evaluation of Institutional E-Learning Implementations Process: Strategy Perspectives for Effective Integration in technical Institutions in Africa.**

A four level excellence Performance Chart (EPC) was developed and used to perform a gap analysis.

- **Response of cockerels to Diets Containing Different Levels of Sheanut Cake.**

It was therefore concluded that though performance of birds was significantly hampered in this experiment, SNC could still serve as a potential replacement for cotton seed cake in cockerels' diet during periods of scarcity.

- **Solid Waste Characterization and Recycling Potential for a Higher Education Institution: A case Study of Koforidua Polytechnic.**

The study revealed that, 1.86 tons of solid waste is generated daily on average basis with per capital generation of 0.37kg. A significant component of the polytechnic waste stream showed a high recycling potential.

- **Development of Automated Dyeing Machine (Boafo) for Small Scale Dyers, Batik, Tie and Dye in Ghana**

Findings revealed that the machine (Boafo) offers minimum handling of chemicals and fabric by operator.

- **Design, Construction and Testing of a Solar Water Heater using available Local Materials.**

The average temperatures of the heated water measure were 26°C in the mornings and 38° in the afternoons which were below the expected range of 40°C to 60°C.

- **Quality Assurance Practices in Polytechnic Institutions in Ghana: The Case of Koforidua Polytechnic**

The findings suggest that, KP has taken steps to assure quality in its operations. These steps are geared towards meeting the standards set by the quality assurance bodies and also to fulfil the polytechnic's mission.

- **Hand Papermaking with Waste Fabrics and Paper Mulberry Bark**

It was found that linen-with-cotton and paper mulberry sheets can be stitched into books to serve as writing and sketch pads. Watercolour worked well on the linen, cotton, nylon, polyester, wool, and acetate fabric papers; colour pencil and pastel worked well on cotton and paper mulberry, and linen-with-cotton and paper mulberry sheets while oil and acrylic worked well on linen-with-cotton and paper mulberry sheets. Linen, cotton, nylon, polyester, wool, acetate with paper mulberry, and linen-with-cotton and paper mulberry sheets are good supports for poster colours.

- **Towards Sustainable Solid Waste Management in the Kumasi Metropolitan area: Beyond the Policies and Legislations**

The results show the legislations are alien to the people for whom they were made and therefore, there is high level of non-compliance. There is very little public education and non enforcement of the bye-laws on the part of officialdom.

- **The Effect of Conflicts among Executives of Identifiable Students Groups on Performance of Executives and Achievement of Goals. A Case Study of Koforidua Polytechnic**

- **Innovative Hand Operated Water Pump for Rural folks**

As a relief in the life of our rural folks, a prototype of a hand operated innovative water pump purposely designed to use in the rural areas to draw water, filter it and pump water from source (without the inhabitants walking to the water source), for domestic and other useful applications has been developed.

- **Adoption of E – Commerce Solutions in Small and Medium –Sized Enterprises in Ghana**

Some of the barriers to e-Commerce adoption identified includes: lack of right technical skills, e-Commerce security, initial cost, resistance by people and culture, lack of interest by management, lack of developed legal and regulatory system.

- **Procurement Practices in Urban Water Supply in Ghana**

The research revealed that the public procurement act in Ghana makes provision for legal and institutional framework, procurement procedures and documentation, procurement oversight and anti-corruption measures. These provisions ensure the integrity and transparency of the public procurement process. The Ghana Water Company Limited (GWCL) has applied the public procurement act in their activities leading to value for money water projects.

- **The Relationship between the Liquidity and the Profitability of Listed Banks in Ghana**

It was reported that the period 2005-2010, both the liquidity and the profitability of the listed banks were declining. Again, it was also found that there was a very weak positive relationship between the liquidity and the profitability of the listed banks in Ghana.

- **Malaria Parasite Detection Using Image Processing**

The process is based on morphological operators using flat, disk-shaped, structuring elements to count the number of cells. A morphological operation top –hat filter is used to detect parasites in human red blood cells. The output is 100% sensitive and 75% specific to malaria parasites; The method is potentially valuable tool for the diagnosis of malaria.

- **An Autoregressive Integrated Moving Average (ARIMA) Model for Ghana's Inflationary Data**

This paper presents a model of Ghana's monthly inflation from January 1985 to December 2010 and use the model to forecast twelve (12) month inflation for the country. Using the Box – Jenkins (1976) framework, the autoregressive integrated moving average (ARIMA) was employed to fit a best model of ARIMA. The seasonal ARIMA model, SARIMA (1, 1, 2) (1, 0, 1) was chosen as the best fitting from the ARIMA family of models with least Akaike Information Criteria (AIC) of 1156.08 and Bayesian Information Criteria (BIC) of 1178.52.

- **Stochastic Forecasting and Modeling of Volatility Oil Prices in Ghana Using ARIMA Models**

It focuses on studying the feasibility forecast using nested conditional mean (ARIMA) and conditional variance (GARCH, GJR, EGARCH) family of models under such volatile market conditions.

- **Relationship Marketing Practices and Customer Loyalty: Evidence from the Banking Industry in Ghana**

The study found that the six Relationship Marketing (RM) constructs cumulatively had significant positive effect on customer loyalty. Individually, Competence, commitment and communication were to be significant drivers of customer loyalty.

- **Exploring Leather as Alternative Material for the Production of Instructional Media for Preschool Education**

Leather was identified to be convenient material for producing instructional medial for preschool education since it has been found to be readily accessible, easily manipulated, remarkably light in weight, and attractive when scorched, painted or dyed in various colours to arouse the interest of children. Leather instructional material produced was attractive and easy to manipulate by the pre-school children.

- **Strategic Repositioning of Koforidua Polytechnic**

The findings indicate significant changes in strategy in Koforidua Polytechnic. The leadership of the Polytechnic has introduced new strategic direction for the Polytechnic, focusing on the provision of infrastructure facilities, improving financial resources mobilization, promoting research, strengthening collaborative partnership at home and abroad, and good governance and planning. External and internal conditions provide pressure for the shift in strategic direction.

- **Measurement of Exhaust Gas emissions from Vehicles at the automotive Engineering workshop of Koforidua Polytechnic**

The results showed that vehicles whose excess air factor lied outside the lambda window showed substantial HC and CO emissions. This has been the case for majority of the vehicles tested. However, vehicles that fell within the Lambda window had the lowest emissions and implications on fuel consumption seemed favorable.

- **An Evaluation of the Quality Measures in the Conduct of examination in Ho Polytechnic**

The findings revealed that the quality systems do exist in the academic affairs but with challenges.

- **Environmental Sanitation and Plastic Waste Management challenges in the in the Dormaa Metropolis, Brong Ahafo, Ghana**

The study established that lack of litter bins, lack of public education on environmental sanitation, lack of sanitary by-laws on littering and poor public attitude are the major factors contributing to the plastic waste management problems in Dormaa –Ahenkro.

- **Performance Appraisal and Lecturers' Productivity: Evidence from Koforidua Polytechnic.**

The results of the study revealed that the performance appraisal process in Koforidua Polytechnic is closely linked to sound policies in conformity with standards.

- **Void Fraction Measurement Using Gamma Rays from Caesium- 137**

The purpose is to highlight the application of gamma rays in determining void fraction experimentally as an alternative to the analytical and empirical correlation methods.

- **Curbing Examination Malpractice in Ghana: A comparative Study of Accra and Koforidua Polytechnics.**

A major challenge in curbing the incidence of examination malpractice in both institutions is students' quest to attain better grades at all cost.

- **Multiple Regression analysis of the Impact of Senior Secondary School Certificate Examination Scores on the Final Cumulative Grade Point Average of Students of Tertiary Institution.**

It was found out that students who attend the morning session on the average obtain higher CGPA than their evening counterparts. It was also found out that there is no relation between a student's sex and his or her cumulative grade points average (FCGPA) at 5% significance level.

- **Cassava as a Feedstock for Bioethanol Production in Ghana**

Ghana has identified bioethanol one of the potential biofuels in her energy mix and subsequently set targets in her Strategic National energy Plan (SNEP). This paper suggests that cassava can be adopted as a potential feedstock for bioethanol production and further argues that net surplus of cassava produce in Ghana is enough to support the biofuel targets.

- **Assessing the Effects of Packaging Materials on the Moisture Content and Surface Finish of Packaged Furniture Products.**

It was concluded the cardboard is the superior packaging material with the lowest MC increase throughout the three time levels.

- **Modeling Predictive Factors of work-related Musculoskeletal Disorders and Associated Disability among Bank workers in Ghana.**

Two multi factor-predictor logistic models fitted to the data showed that female sex; longer job duration and high GHQ12 score were significant predictors of MSDs while high GHQ12 score sedentary lifestyle and alcohol drinking were significant predictors of MSD- associated disability.

- **Markov Chain Models of the Incidence of HIV/AIDS Data in Upper East Region**

The steady states distributions for the gender groups were regular and that of the age groups were non-regular. The non-regular sub-classifications meant that some groups were promiscuous while children were not transmitting HIV/AIDS virus. These justified the use of the Markov chain methods as suitable for analyzing the HIV/AIDS data in Ghana.

- **Tenderization of Bambara Beans Using Papain**

Mineral such as calcium, iron and phosphorus were not significantly affected by the various cooking methods employed. Sensory evaluation showed that some sample B (Pressure cooked bambara beans) was the most preferred by untrained panelist. The results showed that the processing improved the nutritional Value of the bean which could serve as important component of food.

- **The Impact of Microfinance on women Empowerment in Ghana: A case of Sinapi Aba Trust, Sunyani**

The study established that improved access to microfinance has been able to empower women economically.

- **Design of electromagnetic Sleep Inducer for Patient Suffering from Insomnia**

The result showed that, in comparison with melatonin stimulants and other sleep-aided devices, magnetic stimulation can influence and modulate the activities of brain potentials and consequently promote the efficiency of sleep process.

- **Evaluation of Turnkey Projects in Urban Water Delivery in Ghana**

The study further revealed that the criteria for evaluating turnkey contract include the financial position an experience of the contractor, technology involved etc. Prompt handing over of site, provision of relevant information, paying for completed works helps contractors to comply with specifications and general award of contracts.

- **Quality of Service in the Hospitality Industry in Ghana: a study of Selected Small Hotels in Ho Township**

Based on the results revealed, of the gap analysis, the conclusion drawn was food quality, waiting time for food and beverage service and other facilities customers were not satisfied with in all the five hotels.

- **Assessment of risk Involved in the Handling of chemicals by Small Scale Textile Producers in the Sekondi Takoradi Metropolis and recommending Steps to Minimise them.**

The study suggests appropriate ways of working with dyes and other chemicals for dyeing.

- **DC Motor Control Using Electromyography signal.**

This project serves as a resource for a man-machine interface and it was tested on different individuals and the same action potential were sensed using the electrodes and the *motor* rotated in the clockwise direction.

- **Effects of Rewards and recognition on Staff Retention in Ghanaian Polytechnics.**

Findings from the study suggest that staff were generally satisfied with salaries and compensations available even though the salaries and compensations appeared the most favoured reward mechanism of staff.

- **Field Drying of Cassava in a solar Tent Dryer Equipped With a Solar Chimney**

The results for both the no-load and loaded trials follow similar trends to those obtained from earlier trials performed on only one half of the triangle of the tent dryer. Thus using both sides of the triangle to make the dryer more stable did not reduce the performance of the dryer.

- **The Use of ICT by Selected Small and Medium –Sized Hotels in Agona Swedru**

This study is one of the first to examine the challenges of ICT use in Agona Swedru hotels and in particular, how this affects its extensive use. It then offers suggestion to the hotels on how they can utilize ICT more effectively.

- **Failure Analysis of Maintenance Free front Hub Used On Metro Mass Vdl-Daf Buses**

It was discovered that failure of the hub was mainly due to the bearings.. The bearing material is not tolerant to the residual stresses mainly as a result of high temperatures and fatigue.

- **Activities of Ghana Space Science and Technology Center**

The plan is to use indigenous knowledge to provide humanitarian benefits with capacity development as key to the growth of the center.

- **Influence of operating Conditions on the Estimate of the Stack Gas Temperature of biomass Fueled Boilers**

The effect of boiler efficiency, moisture content of biomass, and rate of air fed to the boiler furnace on the stack gas temperature of a stoker boiler operating at a capacity of 10,000kg/hr of saturated steam was studied in order to understand how these parameters affect the stack gas temperature and to determine the ideal conditions to operate the boiler to achieve a high stack gas temperature.

Observation:

This year's conference was truly international; we had presenters from the Sub-region. Moreover, there was a lot of collaborative work in the papers presented; less than 10 percent were single authored, majority of the papers had two, three, or four researchers collaborating in presenting a paper.

Moreover, it was observed that there had been a lot of collaboration between researchers from the polytechnics, the universities and industry. We had presenters from all the universities in Ghana participating in this year's conference. This fact is really satisfying and beautiful.

However, it was observed that female presenters were rather few.

WELCOME COMMENTS BY PROFESSOR (ING.) REYNOLDS OKAI, RECTOR, KOFORIDUA POLYTECHNIC

Salutation

Mr. Chairman, (Vice Rector of Koforidua Polytechnic)
Dr. George Afeti, Chief Inspector of Schools
Dr. Daniel Baffour Awuah, Executive Director-COTVET
Executive Secretaries of National Council for Tertiary Education, (NCTE),
National Board for Professional and Technicians Examinations (NABPTEX) and National Accreditation Board
(NAB)
Rectors of Sister Polytechnics
Registrar
Finance Officer
Participants
Distinguished Guests,
Members of the Press
Ladies and Gentlemen,

Welcome

It is an honour to welcome you all, distinguished Ladies and Gentlemen, to the fifth (5th) in the series of the Annual International Applied Research Conference of the Koforidua Polytechnic. On behalf of the Governing Council, Management, Staff and Students of Koforidua Polytechnic, it is my pleasure and honor to welcome all distinguished speakers as well as all participants from the business community, academia and civil society attending this conference. Thank you all for accepting our invitation and for spending your valuable time with us.

Distinguished Ladies and Gentlemen, we are privileged to have Dr. George Afeti and Dr. Daniel Baffour Awuah, our Keynote Speakers, in our midst. Dr. Afeti had been the Rector for Ho Polytechnic and now the Chief Inspector of Schools. Dr. Daniel Baffour is also the Executive Director of COTVET. I warmly welcome them for graciously accepting our invitation.

We look forward to receiving all your contributions to form part of the reliable research data which is paramount to the achievement of national development strategies and sustainable development.

The theme of today's conference as you may be aware, is **"Building a Sustainable Society through Innovation and Skills Development."** Undoubtedly this theme is both timely and relevant since there is a greater consciousness today of the world increasingly becoming interdependent, the links and inter-dependence of the two topics; innovation and skills development could lead to a better understanding and knowledge of socio-economic issues vital for posterity.

Ladies and Gentlemen, the interest shown in the scientific community is understandable. The Conference has attracted 226 participants from academia and industry. We will hear 45 oral presentations, and have the opportunity to witness several exhibits of researched items.

Ladies and Gentlemen, there is an exciting programme of two keynote presentations and 45 reviewed oral presentations (as mentioned earlier) focused on the nineteen sub-themes of the conference. The subjects range from descriptions of Environment, Waste and Sanitation, Building and Construction Industry, Oil, Gas and Energy Sector, Engineering Education and Training among others. I am sure that the selected topics will provide you with a wealth of information and many opportunities for discussions.

In the two days that we are gathered here, we will be engaged in a process of sharing the wisdom, experience and knowledge of distinguished experts and practitioners from academia and industry as well as the policy outlook of our Government. This encouragement from the highest echelon of the Government, plus the valuable support of several ministers and many senior officials, testifies to the importance that the Government places on the advancement of Polytechnic education in Ghana. As we progress in our discussions the strategic importance of building a sustainable society through innovation and skills development should be crystal clear to all of us.

Distinguished Ladies and Gentlemen, we have received 95 abstracts for oral and poster presentations. The organizers are grateful to the authors for their enthusiasm and to all the reviewers for their work and time given to evaluate the volunteered submissions in detail.

The associated exhibition will provide you with up to date information on commercially available support in your field. These will be available during the sessions, lunches, and breaks.

I am convinced that all parties will gain something valuable from this Conference. The corporate world hopefully will come to realize that in the longer terms their profitability as well as their socio-political acceptability shall depend on the betterment of the quality of life of all people and that the continuing achievement of good quality of life requires concerted and sustainable effort not only through government initiatives but through academic activities as well.

Ladies and Gentlemen, a well-organized meeting is but one prerequisite for a successful event. I would like to recognize especially the serious commitment of the members of the Organizing Committee in preparing for this Conference. Their active leadership - through so many months of meetings, research studies, stakeholder consultations, conference planning, fundraising, and all manner of other activities - has been critical to our achievements to date. I would like to congratulate the committee for their excellent preparations.

The most important element is of course, you, the contributors and participants. I would like to thank all the attendees for coming to Koforidua and, further, for your work and preparation for this meeting. It is not only the presentations and papers that you have prepared and submitted for this meeting, but the dedication and many hours of work and effort during the past year to a wide variety of our activities.

We look forward to a highly successful meeting, with approximately 300 participants from around 30 institutions. As usual, the programme promises to be quite interesting, with diverse presentations encompassing policy, technical, and programmatic matters.

Ladies and gentlemen, finally allow me on behalf of the Governing Council of the Koforidua Polytechnic and Management to wish you fruitful and pleasant deliberations.

THANK YOU

REMARKS BY THE CONFERENCE CO-ORDINATOR, NII ANNANG MENSAH-LIVINGSTONE

I would like to take this opportunity to welcome you all to Koforidua Polytechnic. We are particularly pleased at the response from institutions/organisations in sending full teams of participants. We hope that you will have a worthwhile experience.

This is our fifth conference and in our previous conferences, we placed special emphasis on the sharing of experiences and best practices in this area among participants while taking into account, their relative strengths and weaknesses.

Your participation is critical and we hope that you are all prepared to actively engage in an intense and productive two days of work. Over the next two days, we have six sessions, each comprising two streams. These are an Introductory Presentation and Discussion, a series of Break-out Sessions, and a brief Plenary Session where Breakout Groups can report back on their discussions. At the end of each day, we will have an overall Wrap-Up Session to synthesize key findings and lessons learned during the day. Active participation by each delegate will enable everybody to benefit from a sharing of our collective experiences. Your input into this workshop will determine its success and the extent to which each person can convey back the benefits to their own places of work.

Given limitations on numbers of participants at each workshop, we also hope that over the series, benefits can be shared among as many people as possible, particularly among those directly involved in the topics of each workshop.

If anyone needs any assistance, our Administrative Staff will be available between the hours of 8:00am and 5:00pm. Additional information is also available in the folders you received earlier.

Please do not hesitate to contact us if there is anything we can do to help. We trust you will find this workshop in Koforidua Polytechnic to be a productive opportunity to discuss issues and share experiences with counterparts from other institutions.

Welcome and enjoy your stay.

Thank you.

OBJECTIVES OF THE CONFERENCE

The main objectives of the 5th Annual International Applied Research Conference are:

- To provide a forum for presentation of research output by members of the Polytechnic Community and beyond
- To stimulate interest in research and publication in the Polytechnics

EXPECTED OUTPUT OF THE CONFERENCE

It is expected that at the end of the Conference:

- Research findings of members of the Polytechnic Community would be presented
- Interest in research and publications would be stimulated

THEMATIC AREAS

- A) Authors and Presenters are to demonstrate the Development of Skills and the application of Innovation in the following areas:
- Environment, Waste Management and Sanitation
 - Building and Construction Industry
 - Oil, Gas and Energy Sector
 - Occupational Health, Safety, Security and Risk Management
 - Telecommunications Engineering
 - Engineering Education and Training
 - Information and Communication Technology
 - Mathematical and Statistical Modeling
 - Hospitality and Tourism Industry
 - Decision Analysis and Methods
 - Project Management
 - Quality Control and Management
 - Supply Chain Management
 - Service Innovation and Management
 - E-Business and E-Commerce
 - Laws and Social Policies
 - Creative Art Industry
 - Policy Formulation Analysis and Implementation
 - Agriculture
- B) Sustaining Efforts of Skills Development and Innovation in (a) above
- C) Implementation Barriers to Skills Development and Transfer in (a) above
- D) The Concept of NYEP AND Local Enterprises and Skills Development Programme (LESDEP) as tools for Skills Development for youth and Job Creation

**KEYNOTE ADDRESS DELIVERED BY DR. DANIEL BARFOUR-AWUAH, EXECUTIVE
DIRECTOR OF THE COUNCIL FOR TECHNICAL AND VOCATIONAL EDUCATION AND
TRAINING (COTVET)**

MR CHAIRMAN
HON REGIONAL MINISTER
DIRECTORS OF EDUCATION
CHIEFS AND ELDERS
GOVERNING COUNCIL OF KOFORIDUA POLYTECHNIC
THE MEDIA
RECTOR OF THE POLYTECHNIC
FACULTY MEMBERS
DISTINGUISHED CONFERENCE PARTICIPANTS
LADIES AND GENTLEMEN

I feel greatly honoured to be invited by the Planning Committee of this important International Conference to give the keynote address under a theme of crucial importance to the socio-economic development of any country – **BUILDING A SUSTAINABLE SOCIETY THROUGH INNOVATION SKILLS DEVELOPMENT.**

First, let me congratulate the Management of Koforidua Polytechnic for their commitment towards the organization of this Annual International Applied Research Conference. Any institution that takes research seriously gets the opportunity to address latent issues which normally would not come out if the institution had not taken time to undertake in-depth research on issues. Mr. Chairman, five consecutive years of organization of such a conference is no mean achievement. It demands and continues to demand a great deal of sacrifices from management, faculty members and all other logistical support needed to ensure a successful Conference. I am very much grateful for the invitation as I am personally motivated to see skills development move to a high level in any country's bid to achieve socio-economic improvement in the lives of the citizenry.

Mr. Chairman, may I take this opportunity to register Government's appreciation to the Council members, management and staff of the Polytechnic for their support to Koforidua Polytechnic, especially where the effort of Government has not been prompt or adequate.

Mr. Chairman as we get into the substantive of our Conference this morning let me refer to some statements made by two eminent persons whose contribution to skills training cannot be overlooked. Firstly, Armstrong (2003) defines training as the formal and systematic modification of behaviour through learning, which occurs because of education, instruction, development, and planned experience. Training and capacity building for both men and women is therefore a key priority for sustainable development of any nation in order to address the lack of appropriate skills and capacity within the private and public sectors. Basically, if people lack in technical skills, knowledge and entrepreneurial skills, the natural resources of the country tend to remain unutilized, underutilized or even misutilized. The consequence is that there would be no sustainable development in the country.

Secondly, Jhingan (1985) argues that undeveloped human resources are an important obstacle to economic development of any country. According to him, the economic quality of production remains low when there is little knowledge of available natural resources, possible alternative production techniques, necessary skills, existing market conditions and opportunities, and institutions that might be created to favour economizing effort and economic rationality. Today more than ever the role of training and especially post-primary training is critical because of the changes taking place in the world. Rapid technological changes and globalization have made training of the workplace prerequisite in any nation that wishes to survive.

Mr. Chairman, from these two eminent persons submission above, they clearly indicate that any nation that places skills development high on its national agenda is likely to make progress and move the nation towards building a sustainable society. Countries that lead in sustainable development such as those in Europe, America and Asia are those that placed emphasis on skills development more than fifty years ago. They are indeed reaping the fruits of their labour. Moreover, we live in a knowledge-based age where a country is measured by her ability to add value to its human and material resources for self and national development. Developing the human resource base for the socio-economic development of any country should therefore be the main pre-occupation of the Government in power.

The increases in technology require a highly trained workforce to design and operate the system. Rapid changes in technology development require a continuous learning philosophy. A commitment to training and continuous learning is therefore crucial for the labour force to remain competitive (ibid). The rapid changes in technology are compounded by movement from an industrial to a knowledge society; in an industrial society, the workers do not own their tools. But in a knowledge society, workers carry their own knowledge both in their heads and in their computer and they transport it from job to job, thus, rapid changes in society fueled by technological developments calls for training systems that promote and deliver high quality just-in-time training (Rothwell and Kolb, 1999).

Mr. Chairman, it must be mentioned that for any country to build a sustainable future, youth employment and participation in various events particularly skills development is paramount.

Globally, the major issues affecting youth in specific ways are lack of adequate education and employment, lack of assets and property rights, exposure to risky behaviour, violence and crime and, most importantly, lack of participation in decision-making. In the context of youth demographic explosion globally, the combination of the factors above poses severe threats not only to the medium-long term development of a generation, but for various countries as a whole. For example, in Africa, over 200 million people are now officially designated as youth (i.e. aged between 15 to 24 years). Youth make up 40 per cent of Africa's working age population, but 60 per cent of total unemployed. In all, 72 per cent of African youth live on less than \$2 a day. Some 133 million young people (more than half of Africa's youth) are illiterate. Many of these young people have few or no skills, which really poses a major challenge towards building a sustainable society.

Policy makers and Politicians have responded to this demand for youth employment by proposing dramatically increased support to Post Basic Levels education, particularly technical and vocational skills development. The major drivers for any Government's interest in Technical and Vocational Skills development include: increased social demand for post-basic education and training opportunities and, concerns about unemployment among the youth. The issue of unemployed youth who are unable to take further studies and training should be a serious concern to Government at the highest level – as the majority of these youth end up working in low productive informal jobs.

It should be noted that most of the skills training provided in most developing countries is delivered through private providers. However, private providers are mainly active in fields where it is relatively cheap to establish training (such as secretarial training, business skills, computer skills and others), while the more technically complex and costly programmes are usually left to government institutions. Also, the quality of private training can vary considerably, and there is a great need for quality assurance.

The maximum employability of the labour force, however, depends not only on supply of training or the skills themselves, but also on the dynamism of the economic environment in which they can be applied. Mr. Chairman, let me emphasize here that training alone does not by itself create jobs which would lead to a sustainable society. Other interventions from both the public and private sectors are needed to create the necessary jobs leading to a sustainable society.

Mr. Chairman, a major challenge in innovative skills development for any sustainable society is how to set up a system to determine industrial skill requirements on an ongoing basis and how to translate these requirements

into changes in learning materials and training approaches; and to ensure that the system is responsive to ongoing change. Mr. Chairman, in most developing countries, where the informal sector dominates skills acquisition, the challenge of determining industrial skill requirements links to the related challenge of building the capacity of trade associations. Meanwhile, informal skills development, which largely takes the form of on-the-job apprenticeship, finds it hard to connect to technological advances, delivers training of varying quality and provides trainees with little, if any, theoretical understanding of the on-the-job processes that they learn.

Strengthening the link between skill acquisition and skills utilization in most countries also remains a challenge. At the individual level, graduates complete pre-employment training courses or apprenticeships and find themselves with virtually no formal post-training support. Most of them rely on informal networks to find wage employment (formal and informal), or to make business contacts and acquire resources for self employment (including land, start-up capital). Mr. Chairman, let me indicate here that technical and vocational skills development has emerged as one of the most effective human resource development strategies that any country needs to embrace in order to train and modernize their technical workforce for rapid industrialization and national development. One of the most important features of vocational training is its orientation towards the world of work and emphasis of the curriculum on the acquisition of employee skills. Vocational training delivery systems are therefore well placed to train the skilled and entrepreneurial workforce that a country needs to create wealth and emerge out of poverty. Another important characteristic of vocational training is that it can be delivered at different levels of sophistication. This means that vocational training can respond, not only to the needs of different types of industries, but also to the training needs of learners from different socio-economic and academic backgrounds, and prepare them for gainful employment and sustainable livelihoods. A skilled workforce is a basic requirement for driving the engine of industrial and economic growth, and Mr. Chairman, vocational education holds the key to building this type of technical and entrepreneurial workforce. It is important to note that vocational training and education is not only about knowing how to do things but also understanding why things are done in a particular way.

Being a 21st Century Worker – Knowledge, Skill and Attitudes

Mr. Chairman, to build a sustainable society in the 21st Century through innovative skills development, apart from the skills sets that trainees will acquire, it is important to ensure that all graduates do possess what we call 21st Century Skills, and also adopt a Life Long Learning approach. As 21st Century worker – which all are required to be – a number of core skills need to be developed alongside the technical skills. These include:

Basic Skills: reading, writing, and computation are needed in jobs of all kinds.

- Reading skills are essential as most employees will have to work with information – e.g. on computer terminals, forms, charts, instructions, manuals, and other information displays.
- Computation skills are needed to organize data for analysis and problem solving.
- Writing is an essential part of communications

Technical Skills: Computer and IT skills are baseline requirements for many jobs.

- Employees will use a growing array of advanced information, telecommunications, and manufacturing technologies, as employers turn to technology to boost productivity and efficiency, and to deliver services to customers in new ways.
- Most jobs will use some form of IT/computers/technology

Organizational Skills: New systems of management and organization, as well as employee customer interactions require a portfolio of skills in addition to academic and technical skills.

These include:

- Interpersonal skills
- Communication skills
- Analytical skills

- Problem-solving skills
- Creative thinking

Company Specific Skills: New technology, market changes, and competition drive companies to innovate, constantly upgrade products and services, and focus on continuous improvement of work processes. As a result, employees must frequently acquire new knowledge and skills specifically relevant to the company's products and services, and their production processes or service delivery modes.

Unlike in the industrial age where one was guaranteed a job for life, and one could almost predict the skills one would need; in the Information Age the opposite is true. It requires hard work from the students and the teachers.

Mr. Chairman, rapidly changing technologies involve a whole set of individual, organizational and societal factors. Changes in technology emphasis the need for more complex cognitive skills. Let me quote from Goldstein and Ford in 2001 when they said that 'a strong back and a weak mind will not permit any nation to compete in today's market place'. Goldstein and Ford argue that it is not simply a matter of literacy skills but the need for complex thinking skills. These include abilities to assess information, understand work systems, deal with new technologies as the workplace changes and develop interpersonal skills. These are in addition to the 3Rs of reading, writing and arithmetic. Increasing 'smart' machines increases the cognitive complexity for the human being. Jobs increasingly become complex due to technological and sophisticated systems.

Mr. Chairman, the promotion of innovative skills development for industrialization, economic development, wealth creation and poverty reduction leading to sustainable development in the society demands policies and strategies that address the cross-cutting issues of quality and relevance of training, employability, collaboration between training institutions and employers.

Mr. Chairman, we are all living in a global village. Globalization refers to the growing economic interdependence of countries worldwide, through increasing volume and variety of cross-border transactions in goods and in services and of international capital flows and the rapid and widespread diffusion of technology (Richardson, 2001). Due to globalization, the world has become a large village and this is reflected in nations, enterprises and in the life of workers. Globalization has both positive and negative impact on economies. For weaker economies, globalization may cause them to go worse from effects of intense competition. Richardson argues that in a global economy, the hitherto accepted 'infant industry economy' will no longer be sustainable. Globalization will lead to mega-competition and may 'hollow out' industries and have major impacts on labour markets.

To counter the impacts of globalization, for sustainable development, every country must invest in human capital. Investing in training leads to acquisition of skills that raise labour productivity and allow widespread use of existing technology, in addition training allows promotion of new technological development. Globalization places a lot of pressure on not only the economies but also the enterprises and individuals to become competitive. Higher level of skills is therefore a core factor in enhancing and enabling the necessary response. Training is therefore required continuously throughout working life to enhance employability of the individual and collectively the flexibility of the workforce. This means that training should equip people with skills and competences they require to be employable or create their own jobs for sustainable development.

Mr. Chairman, I hope I have given all of you some food for thought during these few days you would spend here at the conference. On that note let me place on record again my appreciation for this invitation and wish you successful deliberation and God's blessings. Thank you.

KEYNOTE ADDRESS II:

**DELIVERED BY TVET CONSULTANT AND CHIEF INSPECTOR OF SCHOOLS, DR GEORGE
AFETI**

**ASSESSING THE MANDATE OF POLYTECHNIC EDUCATION IN THE AREA OF SKILLS
DEVELOPMENT AND INNOVATION WITHIN THE POLYTECHNIC ACT OF 2007**

As tertiary institutions, the polytechnics in Ghana are very young, having been upgraded to tertiary status only about twenty years ago by government decree, PNDC Law 321 of 1992. Within this relatively short period, the polytechnics have made impressive progress in several areas, including the exercise of greater autonomy in the management of the institutions, the recruitment, retraining and empowerment of staff, the strengthening of academic programs and the upgrading of teaching and learning facilities. Beautiful and imposing buildings have been constructed on every polytechnic campus. In a word, the face of the polytechnics has changed over the past twenty years.

On the other hand, the polytechnics have been struggling to develop an identity as high level skills training institutions outside the shadow of the universities. There have been agitations and demonstrations in the past by teachers and students over one demand or the other. At one time, students were out in the street demanding recognition of the Higher National Diploma, avenues for academic progression and appropriate placement of polytechnic graduates in the Public Service. Polytechnic teachers on their part have been unhappy about their conditions of service, often basing their discontent on salary disparities between them and their counterparts in the universities, where “counterparts” means a person possessing the same level of academic qualification. Briefly put, the polytechnics for most of their 20-year history have been in a state of flux searching for their true identity and place in the tertiary education system.

Although the polytechnics have come a long way since those turbulent days, there are still too many people at decision-making positions in the country today who do not understand the philosophy and orientation of polytechnic education. There are many well-meaning citizens today who still regard the polytechnics as junior universalities! It is this lack of understanding of the career-oriented, skills-driven and industry-focused nature of polytechnic education and training that has been largely responsible for some of the staff and student agitations in the past.

The National Council for Tertiary Education (NCTE), which is the supervising body for both the universities and the polytechnics, is not unaware of the challenges the polytechnics have been grappling with all these years. In an attempt to realign the mandate of the polytechnics, the NCTE set up a Technical Committee on Polytechnic Education in September 2000 to, among other things:

- Assess the role of polytechnics in national development
- Review the progress made by the polytechnics since they were upgraded to tertiary status, and
- Determine the relationship that should exist between the universities and polytechnics within the tertiary sector.

The recommendations of this Technical Committee, known as the Kwami Report, have only been partially implemented.

A more recent initiative to strengthen polytechnic education in the country was the promulgation of a new law to govern the operations of the polytechnics. The aims and objectives of the polytechnics are clearly spelt out in the new Polytechnic Act of 2007 (Act 745 of Parliament) which revised the original Polytechnic Law (PNDC Law 321) of 1992. The current mission and mandate of the polytechnics are:

- i. to provide tertiary education in the fields of manufacturing, commerce, science, technology, applied social sciences, applied arts, and any other field approved of by the Minister responsible for Education; and
- ii. To offer opportunities for skills development, applied research and publication of research findings.

I intend in this presentation to assess the mandate of polytechnic education in the area of skills development and innovation within the Polytechnic Act of 2007.

The Polytechnics as Tertiary Institutions

In most of Anglophone Africa, higher education is now generally referred to as tertiary education. The government of Ghana in its 2004 White Paper on the Report of the Education Reform Review Committee endorsed the definition of tertiary education to embrace all post-secondary education institutions that offer training leading to the award of a diploma or degree. The higher education landscape in Ghana is therefore no longer totally dominated by the universities. Apart from the polytechnics, the universities and university colleges, the tertiary education sector now includes institutions like the Institute (now University) of Professional Studies, the Ghana Institute of Journalism, the Regional Maritime Academy, the National Film and Television Institute (NAFTI), and the College of Education. The tertiary education system in Ghana is therefore binary, consisting of university and non-university tertiary institutions, with the polytechnics dominating the non-university sector.

What should be the role of the polytechnics as tertiary institutions in the development of human capital for the country? Because tertiary education institutions have to train students to meet the diverse developmental needs and challenges of the country, a single institutional model cannot suffice. Ghana's developmental proprieties require its tertiary education institutions to fulfill a multiplicity of roles which include the training of different types of graduates with diverse skills. The traditional research university is not sufficiently versatile to play this role. A tertiary education system that can accommodate students from different academic and economic backgrounds is required. This calls for a differentiated tertiary education system.

Differentiation in tertiary education

Within tertiary education systems, differentiation may occur vertically or horizontally. Vertical differentiation is about distinct types of institutions such as traditional universities, university colleges, polytechnics, professional institutes, and colleges of education. Horizontal differentiation is about similar institutions within the same category but are operated differently, as public or private institutions, for-profit, non-profit, religious, or same-sex, or run on residential, nonresidential, distance education or online basis. Horizontal differentiation is generally a response to increased demand for student access to higher education. But vertical differentiation is normally a reaction to labor market needs for a greater diversity of graduate skills and levels of training.

State of Ghana's development

Ghana requires a diversified workforce in order to respond effectively to the country's development priorities and challenges. As we all know, Ghana is still developing country that is recently reported to have just crossed into the lower middle income category of rich countries. According to the 2011 Human Development Report, Ghana is ranked at the 135th position out of 187 countries on the international development league table with a human development index of 0.541 on a scale of 0 to 1.0. The human development index measures average achievement in three basic dimensions of human development, namely:

- a long and healthy life
- knowledge
- a decent standard of living

The report indicates that 30% of the country's population of nearly 25 million people lives below the poverty line, surviving on less than \$1.25 a day. The gross national income per capita is now a respectable \$1584 and life expectancy is about 64 years. However, some important lessons may be drawn by comparing the corresponding figures for South Korea, a country whose post-independence development history is often contrasted with that of Ghana, both countries having attained political independence at about the same time in 1957. Korea is ranked a number 15 with a HDI of 0.897, a GNI per capita of \$28,230 and a life expectancy of

about 80 years. I will come back to the reason Korea has outpaced Ghana in a few minutes, but for now let us remind ourselves of the state of our underdevelopment.

Our transport infrastructure is poor, access to potable water supply is limited and the provision of primary healthcare is inadequate and inequitable. Seventy-five percent of the total feeder roads in the country are in fair to poor condition. Only 4% of rural households get their potable water from indoor plumbing systems and only 1.5% of households have access to a WC or flush toilet. Households in the country are generally overcrowded, with about 10-20% of the population sleeping in rooms with more than four people. Only about 39% of our agricultural land of 13.5 million acres is under cultivation and only 0.2% of the total is under irrigation, meaning that agricultural production is mainly rain-fed. Even more worrisome is the fact that about 30% of the agricultural production is lost annually as a result of poor post-harvest handling and inadequate storage and preservation facilities. And our manufacturing industry is in a state of depression.

Need for Skilled Workforce

The country needs a skilled workforce to support the manufacturing sector to help increase productivity and economic growth, which in turn will lead to greater national wealth creation, the raising of individual incomes and living standards. We need trained people who possess the requisite technical knowledge and skills to transform our abundant natural resources into economic goods that we can sell to other countries at competitive prices on the international market. We need to recognize that as a country, we can only become rich if we are able to produce quality goods that we can sell to others, not when we continue to buy from other countries and sell to ourselves. We only make those countries richer and ourselves poorer. We need competent technicians and engineers who have the ability to adapt imported technology to suit local needs and conditions. We don't necessarily have to re-invent the wheel. The polytechnics therefore have their role carved for them. The polytechnic Act requires of the polytechnics to offer skills development opportunities for learners, particularly in the fields of manufacturing, science and technology.

In this regard, the polytechnics can adopt the East Asian model of industrialization which started with reverse engineering, adaptation and finally innovation and creation. China, which is a manufacturing powerhouse, adopted this same model and is now moving to the concept of *Created in China* and no longer *Made in China*. In effect, innovation, driven by knowledge and skills, engenders the greatest economic returns. It is estimated, for example, that the price components of an iPad are 80% for the innovation, 16% for marketing and after-sales service, and only 4% for the production or assembly line activity. This means that the Polytechnics should also engage in applied research and development activities that support innovation and higher returns to the economy.

The Rise of Korea

The rise of Korea to within the first ten ranks of the world's economic superpowers is a journey that started with the manufacture of simple industrial goods to ship building and technological innovation with the creation of smart phones, smart TVs, interactive electronic devices and a household trademark: SAMSUNG. The Korean success story is based on robust human resource development strategy. Education and training is the secret behind the Korean miracle.

First, the Korean Government created an enabling environment that facilitated technological development in the private sector and devoted resources to the development of a highly skilled workforce. After the destruction of the country during the 2nd World War, the Government had the choice to either import food and luxury items from abroad or devote the meager resources at their disposal to education and training. The Koreans chose the latter while we in Ghana at about the same time were busily importing sardines and milk.

The Role of Government

The role of Government in shaping our country's future cannot be overemphasized. Visionary political leadership with a clear vision and appropriate priorities for development of higher order human capital is critical to market-oriented technological development. The polytechnics are uniquely placed and legally mandated to play this role. What is required is Government support to train polytechnic teachers to the highest level of skills competence to enable them enter into meaningful public-private partnerships with industry and the private sector in the areas of collaborative R&D and workforce development. It is important for the polytechnic to reposition themselves as skills development and innovation driven institutions. What matters is not where the polytechnics are today but where they want to go. In my opinion, the polytechnics should be moving towards industry and the private sector, rather than walking down the path of the universities. The natural ally of the polytechnics is industry and the private sector.

The Role of the Polytechnics and their Relationship with the Universities

The polytechnics should therefore build institutional capacity to design and deliver courses that respond to the economic demands of the market:

- what is the current and future demand for skills, based on the growth sectors of the economy
- in which direction is the employment market moving
- in which direction is the economy moving in terms of technological development and innovation
- what skills will the country require in response to FDI inflows
- what are the skills needs of formal industry as well as medium and small enterprises

However, this does not mean that the polytechnics and universities should not talk to each other. As two institution types within the same tertiary education family, there is need for some articulation arrangements between the polytechnics and universities. Articulation refers to student mobility or the movement of students and their academic credits between institutions, staff exchanges, and inter-institutional collaboration in the form of resource-sharing, partnerships and affiliations. It could be argued that articulation undermines differentiation to the extent that it reduces diversity of qualifications. Differentiation and articulation are therefore important issues in any policy dialogue on tertiary education, since they bring into contrasting focus the imperative to have different kinds and levels of tertiary education and the need to provide articulation mechanisms and pathways for academic progression and professional development of learners.

There is no danger in creating formal dialogue and articulation channels with the universities and encouraging actual articulation within which emphasis on differentiation and diversity is retained. But this does not mean that the polytechnics should be transformed into universities. The danger does not lie in upgrading the polytechnics into universities, but rather in doing so without catering for their replacement and the instructional gap that they leave behind. It is therefore prudent for the polytechnics to remain polytechnics even as they aspire to higher levels of skills and training.

Polytechnic Degrees

Within the last couple of years, some polytechnics have started to move toward the award of Bachelor of Technology degrees. This shift in orientation of traditional polytechnic training, from diploma to degree studies, raises some critical issues of differentiation and articulation in polytechnic education. How different are the new polytechnic degrees from the traditional university degrees? How will employers and industry accommodate the polytechnic degrees? These concerns merit the attention of all stakeholders, in particular the leadership of the polytechnics. the argument is not that the polytechnics should not offer degree programs but how differentiated these new polytechnics qualifications are and how they are responding to the diverse educational needs and economic situations of aspiring students and learners as well as the skills needs of industry. How effectively are the polytechnics following the fortunes of their degree graduates in the job market?

There is no doubt that a diversified tertiary education system provides greater opportunities and a broader range of choices for students and employers, based on needs and costs. However, one of the main inhibitors of differentiation is institutional isomorphism, or the gradual adoption of a single set of institutional characteristics within a tertiary education system. Isomorphism in Ghanaian Polytechnic context is evident in two forms: the strategic seeking of status with the universities where some polytechnic are fashioning themselves after the universities and the situation where the polytechnics are running the same programs. Differentiation even within the polytechnic family can lead to healthy competition with positive impact on the Ghanaian economy.

Funding

The contribution of higher education and training to a country's development is widely acknowledged. a good indicator of higher level human capital development is the Gross Enrollment Ratio (GER) at the tertiary level. For Ghana, the tertiary GER is only 8.6% compared with 59% for the UK, 55.3% for France, 85.9% for the US and 100% for South Korea. This means that every Korean in the age group of 18-25 years is a beneficiary of postsecondary education of one kind or the other. Since a strong human resource base is a prerequisite for accelerated national development, wealth creation and the reduction of poverty, the State must invest heavily in the formation of human capital. it may be argued that national resources are scarce and that other sectors of the economy like health and agriculture are equally deserving of government attention. Financing of tertiary education in the face of inadequate national resources is a challenge that requires strategic thinking in resource allocation and use. The strategic choice lies in a differentiated tertiary education system which is more cost-effective and less burdensome of the national budget.

Policies and Practices from Other Countries

What lessons can Ghana learn from other countries?

United Kingdom

After decades operating as polytechnics, the UK government took the bold decision to convert all the polytechnic to universities in 1992. Since their conversion to university status, these new or modern universities (as the former polytechnics are now called) have carved a niche for themselves in the UK labor market, working closely with industry and commerce, and have gained in popularity and prestige. The upgraded polytechnics still offer sub-degree and career-focused degrees but as autonomous university institutions, offering in this way a seamless academic progression route to holders of vocational type qualifications to the highest-level possible.

South Korea

Korea's economic success has been due to the development of a broad, differentiated and articulated tertiary education system, a strategically oriented R&D program, policy incentives for industry in key export areas, and linkages among higher education, R&D, and industry. Differentiated and articulation have been constant themes in the country's long-term campaign to develop professional education capacities in support of its export industries. In 1976 a sub-system of two-year vocational junior colleges was created as the market demand for higher skill levels became stronger. This was followed in 1979 by putting in place a broader two-year junior college system of both public and private colleges, similar to our polytechnic. In 1995, the two-year college diploma was replaced by a two-year associate Bsc degree in order to increase attractiveness and emphasize articulation with the four-year degree programs. Today this junior college system accounts for 26% of tertiary enrolments, and 90 percent of these colleges are privately operated.

Recommendations

What recommendations can we make to strengthen polytechnic education within the framework of the 2007 Polytechnic Act?

- The identity and mandate of the polytechnics should be made more distinct. One possible suggestion for strengthening the polytechnics and differentiating them from universities is to customize their admission requirements on a distinct curriculum at the secondary school level that more adequately prepares potential students for high level vocational skills training in terms of acquisition of practical pre-career skills.
- The image and reputation of the polytechnics should be enhanced by improving the quality of their training and through effective collaboration with industry in the design of their training packages and the mounting of vigorous campaigns of sensitization regarding their important role in national development. This will not be an easy task since the polytechnic graduate is still discriminated against by sections of the employment market.
- Linkages between the polytechnics and industry should be strengthened to improve quality and relevance.
- The National Council for Tertiary Education and other regulatory bodies should encourage and facilitate academic dialogue between university and polytechnic institutions;
- Universities and polytechnics should jointly develop policies and strategies for collaborative training, research activities, and the sharing of teaching and learning resources, including the exchange of staff;
- The human resources and academic infrastructure of polytechnics should be strengthened to enable them offer higher-level qualifications, including career-focused degrees, in their own right;
- Polytechnics that qualify for degree-granting status should not shed their practice-oriented training; they should be resourced to offer “skills” degrees and not mimic university degrees;
- Affiliation of degree-awarding polytechnic to universities should be for a limited period only and should be carefully managed in order not to alter the technical and vocational education orientation of the polytechnics;
- Degree-granting polytechnics should tailor their degree courses to specific niches in the job market in order to forestall unnecessary rivalry and confusion with university qualifications;
- The polytechnics, with the support of the relevant government and private sector agencies, should aggressively market their degree offerings to employers and the general public.
- Polytechnic degrees should be seen as offering opportunities for academic progression of holders of polytechnic-type diplomas and certificates and for skills training to the highest level possible.
- Establishment of articulation mechanisms to facilitate the accumulation and transfer of learning credits between university and polytechnic institutions should be actively encouraged by national accreditation agencies as a way of expanding access to higher education while upgrading workforce qualifications;

Conclusion

In conclusion, it must be recognized that universities and polytechnics share the same ultimate goal of contributing to national development, either by advancing knowledge and promoting scholarship, or by directly supporting industrial and economic growth through the application of existing knowledge and the intermediary of a skilled workforce. Without skills, we will forever remain a poor nation of only consumers and not producers of technology. As an American economist, Lester Thurow, said some 20 years ago:

“Show me a skilled individual, a skilled company or a skilled country and I will show you an individual, a company or a country that has a chance to be successful. Show me an unskilled individual, company or country and I will show you a failure in the 21st century. In the economy ahead, there is only one source of sustainable competitive advantage – skills. Everything else is available to everyone on a more or less equal access basis” (Thurow, 1994).

I thank you for your attention.

**KEYNOTE ADDRESS III DELIVERED BY BUSINESS DEVELOPMENT MANAGER OF LESDEP,
MR GEORGE DAKE**

LOCAL ENTERPRISES AND SKILLS DEVELOPMENT PROGRAMME (LESDEP): AN OVERVIEW

Background:

- An initiative of HE The President Prof. John Evan Atta-Mills
- One of many job creation initiatives, others being NYEP, Youth-In-Agric, etc
- The Local Enterprises and Skills Development (LESDEP) is a public-private partnership under the MLG&RD
- Aimed at facilitating training in entrepreneurial, technical and other specialized skills to the unemployed
- Creation and management of sustainable businesses by beneficiaries of the programme

Mission

- To be a strategic partner in the provision of specialized practical and entrepreneurship skills training for the creation of self employed businesses.

Vision

To be a leading business enterprise that provides exemplary training for the development of small-scale local enterprises in Ghana.

Objectives:

- Serve as an employment avenue through the acquisition of technical and entrepreneurial skills.
- Serve as a means of enhancing the socio-economic standards of beneficiaries.
- Develop the informal sector as a means of contributing towards national development.

The Need for LESDEP

- Over the years, successive governments have developed varied interventions to address the seemingly insurmountable problem of unemployment and wealth creation.
- Even though some level of successes have been chalked, most often these interventions lacked sustained strategy to make the desired impact on the people, particularly at the local economy level.
- Indeed, Programmes such as PAMSCAD, Youth-In-Agric, Rural Enterprises Project, NYEP, VIP, CBRDP, etc. Have contributed their quota to the wealth creation and social protection and employment agenda of the country but still left some gaps to be addressed.
- Cost of enrolment onto projects i.e. Registration fees, etc
- Lack of provision of equipments on flexible terms
- Insufficient involvement of beneficiaries in determining choice of business equipments
- Weak collaboration among relevant state and private sector in project management

- Inappropriate repayment term

Strategic Approach of LESDEP

- Provide comprehensive business and entrepreneurial services to beneficiaries
- District-level service delivery using local master crafts persons as much as possible
- Creating a platform for knowledge sharing by stakeholders NBSSI, ICCES, OICG, NYA, NYEP, NVTI, etc in project management
- Continuous development of new business packages through the conduct of needs assessment
- Easy repayment terms, i.e. Susu (daily savings) approach.
- Provision of business set-up equipments after training
- Post set-up support services

Management Arrangement

- National Steering Committee comprises representatives from ministries and other state and private institutions
- ❖ National Secretariat
- Regional Steering Committee
- ❖ Regional Secretariat
- District Steering Committee
- ❖ District Secretariat

Funding Arrangement

- Public /Private Partnership with major funding support from Government
- The money accruing from the repayment of the equipment shall serve as revolving fund
- Other sources e.g. from the donor community are anticipated for future support

Opportunities under LESDEP

LESDEP provides the following:

- Training of beneficiaries on Operational and Technical aspects of chosen trade.
- Provide beneficiaries with needed machinery/ equipment on credit terms for the set up of business.
- The business set-up equipments/machinery shall be paid for by beneficiaries on instalment basis (6 months – 2 years)
- Free registration and training
- Collateral-free equipment supply
- Provide requisite technical, business management and entrepreneurial support services after set up.

- Equip training centers in selected districts for the implementation of the project.
- Support young graduates to actualise business ideas
- Support selected people to undergo special training
- Provide business support services
- Provide beneficiaries with equipments
- Promotion of group business to enhance coverage

Businesses under LESDEP

- Mini cargo transport services
- Water services using mini tankers
- 5-Star motorbikes for intra-city goods transport
- Catering services
- Mobile and Laptop assembling and repair services
- Mobile goods sales vans
- Farm gate intermediary transport
- Farming equipments services
- Dressmaking and fashion designing
- Beauty care
- Basic computer hard/software training
- Barbering services
- Fruit juice processing
- Fishing gear support (OBMs, etc)
- Block making machines
- Concrete mixers
- Auto tippers for construction purposes
- Goods delivery vans
- Load carriers
- Bottle/Can carriers
- Walk behind rollers for road works
- Dump trucks

- 5 tonner dongfeng trucks
- Machine shop equipments
- Palm fruits processor
- Mini irrigation equipments
- Mobile toilets
- Canopies and Chairs rentals

CAN THE EXPANDING SERVICES SECTOR WITH STAGNATING INDUSTRIAL CAPACITY LEAD GHANA INTO SUSTAINABLE GROWTH?

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Abstract

This paper seeks to contribute to the current discourse on the services-led growth of the Ghanaian economy. The study is a conceptual one, which dwells on available literature and experiences of the Ghanaian economy to draw conclusions on study objectives. The objectives are to assess effects of stagnating industrial sector on general productivity and also analyze the opportunity cost of services led growth process. The study concludes that at the current stage of the economy which is still raw-material-based, industrialization remains the trusted engine of transformation for sustainable growth as compared to services-driven strategy because of weaknesses in the latter in terms of generating requisite linkages in the economy to boost productivity. The current situation of services-led growth over raw material production base-structure (of the economy) creates import-dependency with associated balance of payment and foreign exchange instabilities.

Keywords: Industrialization; service-led; import-dependency; balance of payment; foreign exchange.

Introduction

The rebasing of the economy of Ghana using 2006 as the base year scored the services sector as the largest contributor to Gross Domestic Product (GDP), with an average contribution of 49 % between 2006- 2010 (GSS,2010). Prior to the base-year change, agriculture used to be the largest contributor to GDP with an average performance of 35% of GDP within the same period (GSS, 2010). In contrast, the industrial sector had experienced decline or at least stagnation (GSS, 2010). This is interesting to growth theorists as the country is emerging as knowledge based society without going through the intervening stages of industrialization. The implication then is Ghana did not benefit from the sophistications a vibrant industrialized economy offers its people.

Industrialization generally facilitates innovations and inventions which pivot entrepreneurship to spearhead risk-taking ventures essential for mass production. This process leads to the exploitation of economies of scale that first guarantees self-sufficiency and eventually builds a nation's balance of payment position via export (Baer, 2008).

As long as development policies concentrated on raw material production, rural incomes would continue to fluctuate unless it is linked to a process that adds value to the production output. This value process is what guarantees favorable prices for profitability; thus leading to expanded factor utilization in the agricultural enterprises. Industry is one major factor required in the value chain matrix to transform agriculture from its subsistence levels; as it facilitates market for agricultural produce, minimize post-harvest lost and manufacture input for farming. This is what we have not been able to achieve due to the country's over-reliance on services-driven economic system to the detriment of industrial development (NDPC, 2010). There is no historic precedent of increase in per capita without diversion of both capital and labor from the agricultural sector (Jose et al, 2011).

In the absence of a strong industrial capacity to support agriculture and infrastructure, a large number of the production population has been displaced from agriculture to other sectors of the economy with the informal sector being the largest beneficiary (Hilson and Potter, 2005). This phenomenon is exacerbated by the seasonality of crop husbandry and its associated unpredictable returns. This situation of increasing informal sector of the economy affects the application of modern practices in production activities, formal financial transactions to increase capital worth of the financial services and difficulty in tax administration to increase government revenue (Sutton and Jenkins, 2007).

Ghana's current economic growth process that is sidestepping industrialization to a service-led production system has a lot of implications for integration of domestic production processes, and this paper is of the view that sustainability of the growth process will be affected in the future.

Problem Statement

Ghana's quest for sustainable middle income economic status has influenced the direction of state policy from the 1980s. Several economic policies have been pursued, like the Economic Recovery Program and Structural Adjustment Programme led by the Breton Woods Institutions with the sole objective of transforming the economy from its traditional raw material base to a more industrialized economic powerhouse. Since the rebasing of the economy from the 1993 base year to 2006, the services sector has outpaced agriculture whilst the industrial sector trails these two sectors. This paper looks at the effects of stagnating industrial sector and its effect on the overall growth agenda of the economy. It further queries the cost of sidestepping industrialization in the quest for achieving sustainable growth and development.

Study Objectives

The objectives of this paper are:

- To assess the effects of stagnated industrial sector on general productivity
- To assess the opportunity cost of the expanding services sector of the economy.

Literature Review

The Structure of the Ghanaian Economy

The economy of Ghana is a raw-material base economy. All the major commodities that generate revenue for the country are largely exported in their raw state. Cocoa which is the leading cash crop is exported largely in the form of unprocessed beans; Gold is exported in the form of gold bars, bauxite and manganese are exported in their ore state; timber is exported in its log form and recently oil which is being produced in commercial quantities is being exported in its crude form.

For over half a century, the country has not been able to add significant value to its export commodities and, therefore, returns are subject to dynamics of international market prices (GPRS, 2003). When international market prices become unfavorable, like it happened in the 1960s and 1970s (Donkoh Fordwor, 2010), it affects virtually every economic life of the country, including food prices and transportation.

It is important to emphasize that about 60% of Ghana's labor force is engaged in agriculture (GPRS, 2003). However Ghana's agricultural sector is bedeviled with myriads of problems, including application of rudimentary farming methods and tools like cutlasses and hoes, over-reliance on the generosity of local climate and limited use of improved seeds. Other challenges are post-harvest lost and transportation which negatively affect farmers' principal production objective of maximizing profit.

These factors have over the years not received adequate attention in the country's planning process and have contributed immensely in constraining agriculture to subsistence levels, thus affecting livelihoods and food security (GPRS, 2003).

From the early days of Ghana's independence, state policy targeted industrial development within the framework of import-substitution paradigm. Under this policy, industries were meant to produce goods and services which were hitherto imported for domestic consumption to save import bills and build political confidence with the people. Under this regime, government needed to intervene in the trade process by adopting tariffs and other protectionist measures to ensure that production objectives are not influenced by overbearing external sector variables (Palley, 2007). This policy direction led to an increased state involvement in the productive sector of the economy.

The implications of the import-substitution industrial policy led to serious implementation challenges. These included the fact that some industries were hugely dependent on imported raw materials which did not come cheap, others were too ambitious and finally others did not have the requisite comparative advantage needed to sustain them in competition. Eventually, some of the industries produced goods and services that were more expensive than imported goods, thus defeating the very purpose of the industrial policy (Edjekumhene et al., 2001).

The sharp fall in cocoa prices and other export commodities on the international market destabilized the country's ability to sustain most of the industries which were operating below break-even point. In the face of inflexible exchange rates that produced an over-valued local currency, the economy was not able to mobilize adequate revenue to support the market intervention policies required to sustain import-substitution economic policy, leading to inflation and under-employment (Hilson & Potter, 2005; Donkoh Fordwor, 2010).

By the late 1970s, most of these state-owned industries were pale shadows of themselves (Donkoh Fordwor, 2010; Edjekumhene et al., 2001). They became breeding grounds for corruption, administrative ineptitude and nepotism.

The post 1980s were characterized by export led development policies with the IMF's Structural Adjustment Programme being the leading policy documents executing an open market economic system (BoG, 2007).

Among the high points of the policy was the refocusing on industrialization based on comparative export advantage. The country was expected as demanded by policy to refocus on the type of industrialization that would produce goods and services with competitive advantages on the international market. This led to the creation of an export processing zone referred to as the Free Zones, which produce goods and services mostly for exports. This industrial policy was thought to create needed jobs for the teeming unemployed youth and also shore up the country's balance of payment imbalances (www.gfzb.com.gh).

Another important highlight of the policy was the divestiture of some state-owned industries which were described as overstaffed, technically and managerially ineffective and virtual liabilities on taxpayers' expense (www.dic.com.gh). Prior to the rolling out of the divestiture program, the government had about three hundred enterprises in all sectors of the economy including food and beverages, hospitality, manufacturing and finance. The intention of the program was to reduce the overbearing impact of the public sector to create way for increased private sector participation in the economy as a means of increasing private capital and entrepreneurship in the country's production capacity (BoG, 2007).

The period beyond 1980 saw the transformation of the economy, from state dominance to a more liberal and open system. The transformation process resulted in some successes over the period; however the gains were not sustainable over the medium to the long term to change the structure of the economy (GPRS, 2003). The policy failed to achieve expansion in the agriculture and manufacturing sectors, and the only remarkable growth occurred in the service sector which was as a result of "debt financed import boom" (GPRS, 2003).

Theoretical Underpinning

This paper contends that a quick leap from agriculture/ raw material production to services-led economy will not have the requisite impetus to pull the other sectors of the economy to create sustainable employment for its large number of unemployed youth, majority of them being basic education graduates.

The paper is based on the neo-classical view that excess labor in agriculture will be absorbed by industry when marginal productivity of labor at the agricultural sector tends to zero. This, in the long term will improve the supply elasticity of labor between agriculture and industry and will eventually improve the linkages in these two sectors.

The history and philosophy of development of most countries have been associated with structural transformation of production capacity with industrial output exceeding that of agriculture (Chenery, 1982).

Chenery (1982) argues further that the rapid growth of industrialization affects composition of demand, international trade and occupation of labor such that the post-agricultural industrial growth expands the volume and types of goods and services which improves domestic income.

The rise in income facilitates consumption and investment which sustains growth of the economy, especially when the proportion of food expenditure falls. It is estimated that a raw material-based low production economy spends an average of half of its domestic incomes on food whilst growing semi-industrialized countries spend a quarter (Chenery, 1982). This means that a thriving industrial sector increases the income elasticity of food.

So in summary, Chenery (1982) points out that irrespective of size and natural resource endowments of countries, structural changes that propel a transformation from developing to developed economy are marked by three factors such as: (i) Changes in consumption with rising income and declining share of food expenditure (ii) Increasing physical and human capital to raise the level of per capita output (iii) Access to common sources of technology and international trade

In effect, it is very costly for a raw material producing economy to by-pass industrialization in its attempt to achieve optimum productivity. When local human resource capacity is weak, the by-pass process creates an import dependency that is incapable of guaranteeing sustainable employment and growth. It becomes convincingly clear that a post-agricultural industrial growth is very critical to sustaining agriculture and the service sectors, else the sectorial linkages required for growth and employment generation cannot be achieved (NDPC, 2010).

Methodology

This paper is conceptual and non-experimental in nature and dwells on literature and experiences of the economy of Ghana to conclude on the study objectives.

The literature component dwelled on the structure of the economy of Ghana from independence and how policy influences over the years have impacted on the economy. The literature was further analyzed within the framework of study objectives leading to the conclusion and recommendations.

Analysis and Discussion

The Stagnated Industrial Sector

From independence through the 1960s manufacturing grew considerably riding on a push industrial policy aimed at cutting down dependence on foreign imports for local production (Kolavalli et al., 2011). However all these gains were eroded in the 1970s due to poorly designed industrial policies that over-emphasized trade restrictions leading to what analysts refer to as the period of de-industrialization (Dinye and Nyaba, 2001; Ackah and Kutsoati 2008).

This period of de-industrialization impacted on foreign exchange availability and unemployment in a way that compelled a number of working populations to leave Ghana for greener pastures in other countries in the sub-region (Kunadu-Agyeman, 2001). The post Adjustment period also witnessed a period of rapid redeployment which led to loss of jobs, especially in the Public Sector leading to a biting social cost of the adjustment process in the late 1980s to early 1990s (Hilson and Potter, 2005).

From the year 2000 – 2009, the industrial sector's contribution to GDP has stagnated around an average performance of 24%. The manufacturing sector is small in size and it is dominated by small scale agricultural and wood processing enterprises, which are predominantly informal (Kolavalli et al., 2011).

As compared to countries like South Africa and La Cote d'Ivoire, Ghana is one of the countries in Sub Saharan Africa with a weak manufacturing sector. Whilst South Africa and Cote d'Ivoire records an average of 17 – 20

percent of manufacturing sector contribution to GDP, Ghana's share stands at 7 – 10 percent of GDP (after rebasing).

The thin industrial-sector space in Ghana means that there is little value-added process to export merchandize and this trend may persist for some considerable number of years into the future. This implies that employment, balance of payment, exchange rate and inflation remain at considerable threat at the least displacement in international prices.

The country needs a vibrant industrial sector to absorb excess labor from agriculture who consider themselves unemployed (BOG, 2007). Majority of these human resources are less educated and lacks requisite skill-set for service sector jobs. According to Agyeman-Dua (2008), Ghana has not invested into required modern technology for the transformation of the economy. This has given room for Asian entrepreneurs from Vietnam and China who have taken over traditional Ghanaian products like *Kente* and Basket weaving, and have applied modern production methods for the international market.

The industrial sector holds the key to the transformation of the economy from its current raw material base. It is therefore necessary to work assiduously to correct all institutional and environmental bottlenecks affecting the sector including finance, capital and energy. Brazil, for example, had a similar experience especially with energy however the government took a commanding lead to provide the energy infrastructure required for industrial growth (Baer, 2008). Brazil after the World War II depended on fuel wood to supply 70% of its energy needs; however, by 2003, 92% of its energy was drawn from oil and hydroelectric sources (Baer, 2008).

Opportunity Cost of Service –Led Developing Economy

According to Kolavalli et al., (2011) about one-third of the services sector in Ghana is driven by the public services and government departments in the form of administration, health and education. The private sector's share is in the area of telecommunication, trade, tourism, business services among others. Due to its domestic market focus, it is not able to generate requisite foreign exchange as compared to their Asian counterparts and thus its leadership in the transformation process of the economy is quite much of a challenge.

The services sector is knowledge based and relies heavily on deployment of modern technology. However, Ghana has one of the unfavorable literacy rates (57.9%) with low technology development in Africa (only 1.3 million of the population has access to the internet) (CIA, 2012). This means that its services sector may not compete favorably on the international market because it will not be price and process efficient to generate required bottom-lines. Another issue with the services-led growth is the problem of facilitating linkages in the economy to catalyze the growth process sustainably. Given the weak industrial sector, a backward linkage between services and manufacturing would not be effective and similarly between manufacturing and agriculture. This will create spaces for idling labor force in agriculture, low capacity industry leading to unemployment and import dependency.

Ghana's economy can benefit from services-led growth strategy only when it has the capacity to export its skills and services overseas to earn considerable foreign exchange in the form of health services, tourism and telecommunication. At the moment the country does not have local capacity to train the required volume of human resources to feed both local and foreign markets with respect to services. The country has a lot of problem confronting its educational system including infrastructure, personnel and logistics at all levels.

It can therefore be said that the current pattern of services-led growth superimposed on subsistence agriculture is only creating a clog of import-dependency and balance of payment instability. This will create a cyclical inflation and exchange rate fluctuations that will subsequently worsen its unemployment situation.

Conclusion

This paper concludes that stagnating industrial sector will thwart the process of building strong sectorial linkages to facilitate employment, productivity and sustainable growth of the economy. Also, whereas the services sector is significant, Ghana's services industry suffers weak competitive capacity because of low caliber human resource and technology deployment required to wheel the services industry. That is, when we sidestep the industrial sector in the country's development efforts, it will create high import-dependency with associated balance of payment and exchange rate instabilities. Therefore an expanded services sector with stagnated industrial capacity cannot facilitate a well oiled production process for sustainable growth.

Recommendations

The study recommends that:

- The country should focus on transforming its agriculture to provide adequate food and raw material
- The government should put in place a strategy to increase formalization of the informal sector to make attractive to financial services.
- Government should find a way to use state purchasing power to bolster local demands for home-produced goods and services and use it as a way of demanding excellent products that can compete internationally.
- The government must support the fledgling industrial sector and protect it from crushing under the weight of foreign competition.
- Government and the private sector should develop local technologies through collaboration with educational and training institutions

References

- Ackah, C. (2008). *Towards an Economic Transformation in Ghana: Strategic Learning from High-Growth Nations*. In: and E. Kutsoati. ACET Working Paper 3. Accra: African Centre for Economic Transformation.
- Baer, W (2008). *The Brazilian Economy: Growth and Development*, Lynne Rienner Publishers Sixth Edition pp 1- 8
- Bank of Ghana (2007). *Issues on wages and Money Market Competitiveness in Ghana*, Research Department, July 2007
- Becker, K. F. (2004). *The Informal Economy, Fact Finding Study*, SIDA
- Chenery, H.B. (1982). *Industrialization and Growth: The Experience of Large Countries*, World Bank Staff Working Papers, No 530
- Central Intelligence Agency, The World Factbook (2012): www.cia.gov
- Donko Fordwor, K. K (2010). *The Danquah-Busia Tradition in the Politics of Ghana (the origins, mission and achievements of the New Patriotic Party)*, Unimax MacMillan
- Demery, S (1987). *The Alleviation of Poverty under Structural Adjustment*, In: Addison, T. Washington DC: The World Bank
- Dinye, R. (2001). *Trade Policy and Domestic Manufacturing in Ghana*. In: and Nyaba, C. F. A. SAPRI Research Report Draft
- Divestiture Implementation Committee website (2012): www.dic.com.gh
- Edjekumhene, I (2001), *Power Sector Reform in Ghana: The Untold Story*, In: Amadu, M.B, and Brew-Hammond, A. Kumasi Institute Of Technology And Environment (KITE)
- Ghana Free zones Board website (2012): www.gfzb.com.gh

- Ghana Poverty Reduction Strategy (2003). *An agenda for Growth and Prosperity*, Vol. 1, Analysis and Policy Statement, February 2003
- GSS (November 2010). Information Paper on Economic Statistics. *Rebasing of Ghana's National Accounts to reference year 2006. Ghana Statistical Service Newsletter No. B 12-2003*
- Hilson, G (2005). *Structural Adjustment and Subsistence Industry: Artisanal Gold Mining in Ghana. In: Potter, Clive. Development and Change*, 36(1): 103 – 131
- IFAD (2005). *Achieving the Millennium Development Goals: Rural Investment and Enabling Policy*. Panel Discussion Paper IFAD Governing Council – Twenty-Eighth Session
- Jose P. Chacko, Rajan K., Shabeer S. K. P. *Microeconomics 1* Calicut, School of Distance Education. India
- Kolavalli, S (2011). *Understanding Economic Transformation in Sub Saharan Africa*”, In: Robinson, S, Diao, X, Alpuerto, V, Folledo, R, Slavova, M, Ngeleza, G, and Asante, F. A paper presented at IFPRI – University of Ghana Conference, May 10 -11, 2011
- Konadu-Agyemang, K. (2001) ‘*Structural Adjustment Programs and Housing Affordability in Accra, Ghana*’, *The Canadian Geographer* 45(4): 528–44.
- NDPC (2010). *Medium Term National Development Framework: Ghana Shared Growth and Development Agenda 2010 – 2013*, Vol. 1: Policy Framework
- NEPAD (2001). *The New Partnership for Africa's Development*, October 2001, www.dfa.gov.za/au.nepad/nepad.pdf
- Palley, T. I (2003). *Export-led Growth: Evidence of Developing Countries Crowding-out*, published in *Economic Integration, Regionalism and Globalization*, Arestis, Baddeley & McCombie (eds.), Cheltenham: Edward Edgar 2003
- Quaye, W (2008). *Food security situation in northern Ghana, coping strategies and related constraints*. *African Journal of Agricultural Research* Vol. 3 (5), pp. 334-342
- Reed, D (ed.) (1996). *Structural Adjustment, the Environment and Sustainable Development*. London: Earthscan Publishers
- Sutton, C. N (2007). *The Role of the Financial Services Sector in Expanding Economic Opportunity*, In: Beth Jenkins. 2007. *Economic Opportunities Series*. Harvard University, John F. Kennedy School of Government

DESIGN AND CONSTRUCTION OF A LIGHT WEIGHT FRAME FOR A RUGGED TWO-SEATER OFF-ROAD RECREATIONAL VEHICLE

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Abstract

This research aimed at the construction of a vehicle frame (Chassis) for a rugged two-seater off-road recreational vehicle. This frame is to carry a front engine rear transmission type and can carry two humans including the driver averaging 100kg each. The Computer Aided Design and Engineering tool, Solidworks, was used for the model and subsequent optimization. Frontal and Side collision tests were carried out to find the safety factor and maximum load bearing capacities of the design. ANSYS MECHANICAL, a Computer Aided Engineering tool, was used for Linear Static, Non-linear Static and Linear Buckling tests. Galvanized Hot-Rolled steel (Galvanized Steel) was chosen for the frame due to its good strength and corrosion resistant properties. Both round and square pipes were used to ensure easy welding. The original frame design passed all the necessary tests and has subsequently been fabricated. The engine has been mounted and vehicle successfully driven. It is recommended that further research consider designing the frame to accommodate four individuals including the passenger. A foundry application could also be employed to strengthen the Chassis design to ensure it is road worthy.

Keywords: Crash testing; Dune buggy; Mini baja; Chassis; Structural analysis; Ansys; Explicit dynamics;

Introduction

A dune buggy is a recreational vehicle with large wheels, and wide tires, designed for use on sand dunes or beaches. The design is usually a modified vehicle and engine mounted on an open chassis. The modifications usually attempt to increase the power-to-weight ratio by either lightening the vehicle or increasing engine power or both. Dune buggies designed specifically for operation on open sand are called sandrails. A similar, more recent generation of off-road vehicle, often similar in appearance to a sandrail but designed for different use, is the "off road go-kart". The difference may be little more than fitting all-terrain tires instead of sand tires. The most common form of non-racing buggy consists of a tube frame, which is sturdy and simple to construct and repair. Steel tubing is preferred to pipe (pipe is rolled and welded, whereas tubing is mandrel drawn, giving it consistent wall thickness and superior strength). Engine size varies depending on the suspension, frame strength and performance needs. Engine size has varied from 50 cc for small light buggies to 7-liter engines and up, designed for professional racing. Dune buggies use both automatic and manual transmissions, sometimes based on application and engine power, but often based simply on personal choice.

Dune buggies are usually created using one of two to three different methods. The first involves alteration of an existing vehicle, most notably the original Volkswagen Beetle. The model is nicknamed Bug, therefore the term "buggy". The Beetle automobile platform is preferred for a variety of reasons. Most significant is the position of the rear mounted Volkswagen engine, which with removal of bodywork transfers a high proportion of the weight to the rear driven wheels for extra traction. The engine is air cooled, simplifying engine modification, and the absence of a radiator eliminates a source of failure. The low price, robustness of the front suspension, and the sizable quantity of spare parts from other VW Beetles and Type 2 (Microbus) are a further advantage. Chevrolet Corvair engines are also a popular way to upgrade to 6 cylinders and sometimes vehicles are fitted with turbochargers to provide as much as 180 horsepower (130 kW). For example, one such conversion was a 1970 Manx 2 on a 1961 VW chassis. It was fitted with a 180 hp (130 kW) turbocharged Corvair engine, with reverse rotation, mated to a VW transaxle.

The second method involves construction of a vehicle frame from formed and welded steel tubing. The advantage of this method is that the fabricator can change fundamental parts of the vehicle (usually the

suspension and addition of a built-in roll cage). Buggies of this type are called sandrails because of the rail frame. Sandrails, as with the VW Bug, often have the engine located behind the driver. Sizes can vary from a small-engine one-seat size to four-seat vehicles with eight or more cylinders. Sandrails can have panels or custom-shaped body coverings over frame, though many are left bare. Another type represents a mix of the above two design philosophies, typically constructed from a converted vehicle that has sustained damage from age, hard use, or accidents. This type of creation is called The Boston-Murphy style.

The aim of this research has been to design and fabricate a light weight frame or Chassis for rugged two-seat off-road recreational vehicle.

The Chassis design is to accommodate the following features:

- Four-speed transmission with reverse
- A rear wheel drive (Nissan Sunny (GL)-B211 engine) manufactured from 1976 in Japan.
- Rack and pinion steering with modified Ackerman geometry
- Double A-Arm front and rear suspension
- Two seats including the driver's seat
- Four-unit Wilwood hydraulic disc braking system
- Six-point release safety harness

Solid Works Software

The Solid Works® CAD software is a mechanical design automation application that lets Designers quickly sketch out ideas, experiment with features and dimensions, and produce models and detailed drawings. It is a feature-based, history-based, associative, parametric 3D CAD programme. In Solid Works, you build 3D parts from a series of simple 2D sketches and features such as extrude, revolve, fillets, and holes, among others. You can then create 2D drawings from the 3D parts and assemblies (Matt Lombard, 2010).

Methodology

Solid works Model

Throughout the design of the chassis a 3D solid modeling program called SolidWorks was used. SolidWorks allowed the team to visualize the design as well as integrate all of the systems with the chassis before manufacturing began. As in Figure 1 The frame has a length of 3120.66mm with 1117.60mm for the width whilst the height is 1149.27mm.

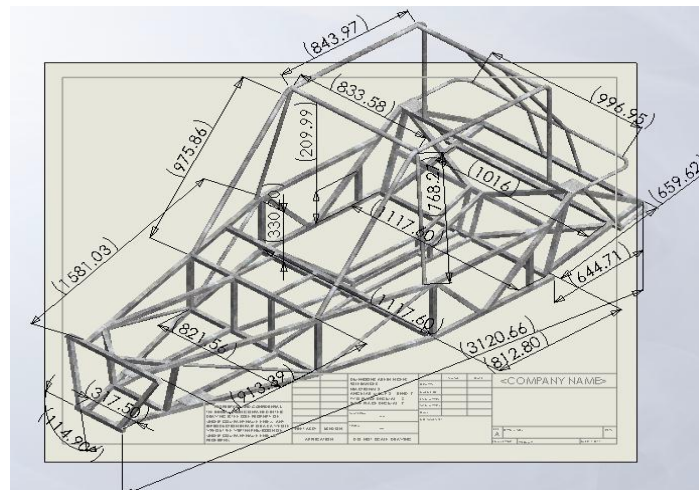


Figure 1 Frame Design and Dimensions in SolidWorks 2012

Chassis Goal

The goals for the chassis design include:

- Increase comfort for the driver
- Decrease weight, and overall length
- Improve packaging for subsystems

The chassis is the most integral part of any car due to its interaction with every system on the car as well its primary and most important role, keeping the driver safe (Crolla David, 2009). With this in mind the frame was designed around the driver, focusing on safety and comfort first. A second goal of this year's car was to reduce excess weight without compromising any structural rigidity or the safety of the driver. A weight of 66kg was achieved (Figure 2).

Due to the interaction with a vast majority of the vehicle, the chassis design can only begin after every other system is roughly designed. The most important factor in the design of the chassis is the positioning of the driver. Because the driver will be strapped into the vehicle for long periods of time, comfort is a necessity. With this in mind the rear roll hoop was the first section of the chassis to be designed. The driver was also accounted for in the design of the side impact bars. In order to provide the driver with the most possible knee room the side impact bars were angled out from the rear roll hoop before angling back in to meet the front bracing members. Another key component that allowed a decrease in overall length was the bending of the front nose bracing. Venturing away from an angled bar and into a more spacious bent tube allowed for a good amount of foot clearance and also provided a compact area to package the pedals, rack and pinion system, and the master cylinders.

The main properties of the rear chassis are all constrained by the driveline. Before the base of the rear chassis can be designed, the length of the drive axel must be determined. This value was defined as 5.9 inches, which also defines the width between the inside faces of the chassis. The height of the lower rear chassis is defined by the rear suspension mounting points. From this point the rest of the lower chassis is designed to allow for easy mounting of the transmission, engine, and drive.

Mass = 66.05 kilograms		
Volume = 8468540.55 cubic millimeters		
Surface area = 9792432.09 square millimeters		
Center of mass: (millimeters)		
X = 1.36		
Y = 374.24		
Z = -1774.28		
Principal axes of inertia and principal moments of inertia: (kilograms * square millimeters)		
Taken at the center of mass.		
Ix = (-0.01, -0.12, 0.99)	Px = 17603727.42	
Iy = (1.00, -0.07, 0.00)	Py = 56493474.36	
Iz = (0.07, 0.99, 0.12)	Pz = 57784502.50	
Moments of inertia: (kilograms * square millimeters)		
Taken at the center of mass and aligned with the output coordinate system.		
Lxx = 56496123.11	Lxy = -44352.60	Lxz = -346882.49
Lyx = -44352.60	Lyy = 57221456.44	Lyx = -4699232.56
Lzx = -346882.49	Lzy = -4699232.56	Lzz = 18164124.72
Moments of inertia: (kilograms * square millimeters)		
Taken at the output coordinate system.		
Ixx = 273691354.47	Ixy = -10691.75	Ixz = -506467.25
Iyx = -10691.75	Iyy = 265165284.91	Iyz = -48560336.84
Izx = -506467.25	Izy = -48560336.84	Izz = 27415772.55

Figure 2 Mass Properties of Chassis designed with SolidWorks 2012

Material Selection

The material chosen for the manufacturing of the chassis was A653 Galvanized Steel. Galvanized steel is simply hot rolled steel to which a zinc coating has been applied for protection against corrosion. This feature is appropriate since the vehicle chassis is likely to be drenched in rain. Although thousands of steel alloys exist, it is that which is reasonably priced, readily available and able to withstand the design loads must be chosen. Hot rolled Steel is known in industry for its high strength and outstanding welding characteristics. As a result of these characteristics A653 Galvanized Steel (Table 1) was chosen.

Table 1 Properties of A653 Galvanized Steel

ASTM A653 Mild (low-carbon) Hot Dipped Galvanized Steel		
Minimum Properties	Ultimate Tensile Strength, psi	58,000 - 79,800
	Yield Strength, psi	36,300
	Elongation	20.0%
Chemistry	Iron (Fe)	99%
	Carbon (C)	0.26%
	Manganese (Mn)	0.75%
	Copper (Cu)	0.2%
	Phosphorus (P)	0.04% max
	Sulfur (S)	0.05% max

Finite Element Analysis with ANSYS

A finite element analysis was conducted to determine the suitability of the design and also for optimisation. The following tests were conducted in ANSYS WORKBENCH

- Structural Analysis (Using Ansys Multiphysics and Ansys Mechanical)
- Explicit Dynamics to determine Crash Worthiness (Frontal and Side impacts using Ansys AUTODYN).

ANSYSAUTODYN is an explicit analysis tool for modeling nonlinear dynamics of solids, fluids, gas, and their interaction (Kohnke, 2009). With a fully integrated, easy-to-use graphical interface enabling the set-up, running, and post-processing of problems, AUTODYN offers:

- Finite element solvers for computational structural dynamics (FE).
- Finite volume solvers for fast transient Computational Fluid Dynamics (CFD).
- Mesh-free particle solvers for high velocities, large deformation, and fragmentation (SPH).
- Multi-solver coupling for multi-physics solutions including coupling between FE, CFD, and SPH.
- A wide suite of material models incorporating constitutive response and coupled thermodynamics.
- Serial and parallel computation on shared and distributed memory systems.

AUTODYN has been used in a vast array of projects and nonlinear phenomena. Here is a sample of real projects where it has been used:

- Optimization and design of armor and anti-armor systems.
- Designing mine protection schemes for personnel carriers.
- Building protection measures and insurance risk assessment for blast effects in city centers.
- Aircraft impact risk assessment for power stations.
- Performance studies of oil-well perforating charges.
- Decommissioning of offshore platforms.
- Designing the shielding system on the International Space Station.
- Safety assessment of particle accelerators.
- Characterization of materials subjected to high dynamic loading.
- Drop test of electronics devices.
- Nuclear reactor safety.
- Nuclear waste transportation safety

ANSYS is the single largest provider of CFD technology in the world and has the broadest CFD product line, with general purpose and application-oriented CFD offerings. Today, almost all of the top 100 industrial companies on the "FORTUNE Global 500" invest in engineering simulation as a key strategy to win in a globally competitive environment.

ANSYS Structural Theory

ANSYS Structural works on certain theories (Khonke, 2009). The principal strains are calculated from the strain components by the cubic equation:

$$\begin{vmatrix} \epsilon_x - \epsilon_o & \frac{1}{2}\epsilon_{xy} & \frac{1}{2}\epsilon_{xz} \\ \frac{1}{2}\epsilon_{xy} & \epsilon_y - \epsilon_o & \frac{1}{2}\epsilon_{yz} \\ \frac{1}{2}\epsilon_{xz} & \frac{1}{2}\epsilon_{yz} & \epsilon_z - \epsilon_o \end{vmatrix} = 0$$

where:

ϵ_o = principal strain (3 values)

$$\epsilon_1 = \text{MAX}(|\epsilon_1 - \epsilon_2|, |\epsilon_2 - \epsilon_3|, |\epsilon_3 - \epsilon_1|)$$

The von Mises or equivalent strain ϵ_e (output as EQV with strain items such as EPEL) is computed as:

$$\epsilon_e = \frac{1}{1+\nu} \left(\frac{1}{2} [(\epsilon_1 - \epsilon_2)^2 + (\epsilon_2 - \epsilon_3)^2 + (\epsilon_3 - \epsilon_1)^2] \right)^{\frac{1}{2}}$$

The principal stresses ($\sigma_1, \sigma_2, \sigma_3$) are calculated from the stress components by the cubic equation:

$$\begin{vmatrix} \sigma_x - \sigma_o & \sigma_{xy} & \sigma_{xz} \\ \sigma_{xy} & \sigma_y - \sigma_o & \sigma_{yz} \\ \sigma_{xz} & \sigma_{yz} & \sigma_z - \sigma_o \end{vmatrix} = 0$$

where:

σ_o = principal stress (3 values)

$$\sigma_1 = \text{MAX}(|\sigma_1 - \sigma_2|, |\sigma_2 - \sigma_3|, |\sigma_3 - \sigma_1|)$$

The von Mises or equivalent stress σ_e (output as SEQV) is computed as:

$$\sigma_e = \left(\frac{1}{2} [(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2] \right)^{\frac{1}{2}}$$

or

$$\sigma_e = \left(\frac{1}{2} [(\sigma_x - \sigma_y)^2 + (\sigma_y - \sigma_z)^2 + (\sigma_z - \sigma_x)^2 + 6(\sigma_{xy}^2 + \sigma_{yz}^2 + \sigma_{xz}^2)] \right)^{\frac{1}{2}}$$

$$\sigma_e = E\epsilon_e$$

where:

E = Young's modulus (input as EX on MP command)

Results & Discussion

Static Structural Test

Static loads of 2000N (driver and passenger weight) applied in the seats plus 3000N (engine weight) applied at the rear were simulated. The result is as shown below. The minimum Factor of Safety (FOS) was 1.8 as shown in Figure 3 below.

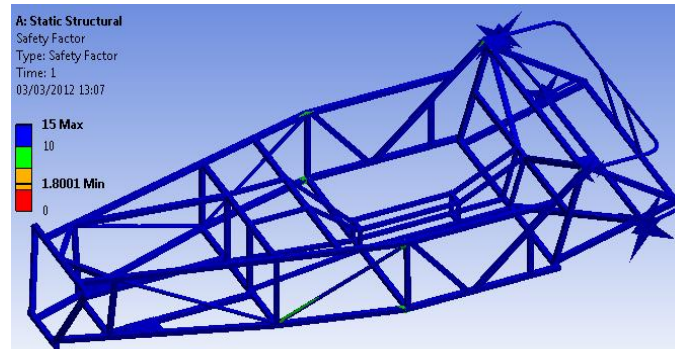


Figure 3 Static structural test results

The weakest member as indicated by the FOS occurred in the member magnified in Figure 4. Although failure occurs only below FOS of 1 it will be prudent if the side cages are further re-enforced with steel plates to protect the driver. This was followed through during the manufacture.

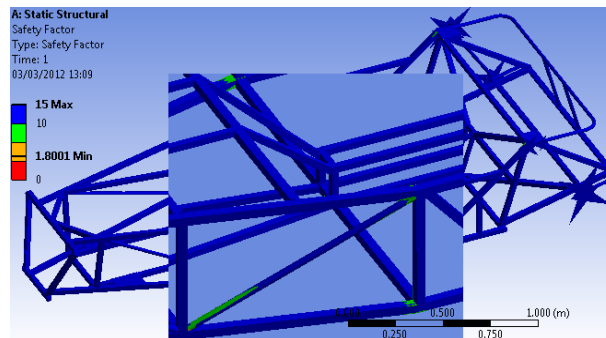


Figure 4 Magnified portion of members with lowest FOS

Taylor Impact Tests

In the United States, National Highway Traffic Safety Administration (NHTSA) is responsible for determining crash worthiness of vehicles (Blundell and Harty,2004).For Full-width frontal impact crash testthe vehicle crashes head-on into a rigid concrete barrier at 35 mph (56 km/h).Full-widthfrontal crash-test rating categories:
Chance of life-threatening injury

- Less than 10% chance (5 stars)
- 10-19% chance (4 stars)
- 20-34% chance (3 stars)
- 35-45% chance (2 stars)
- More than 45% chance (1 star)

Frontal Impact Test

In ANSYSAUTODYN, an explicit dynamic analysis was simulated at 35mph. The result in Figure 5, depicts a couple of failure regions (FOS below 1). Since the aim of the crash test is not to determine failure but to determine chances of life threatening injury, the crashed body was examined.

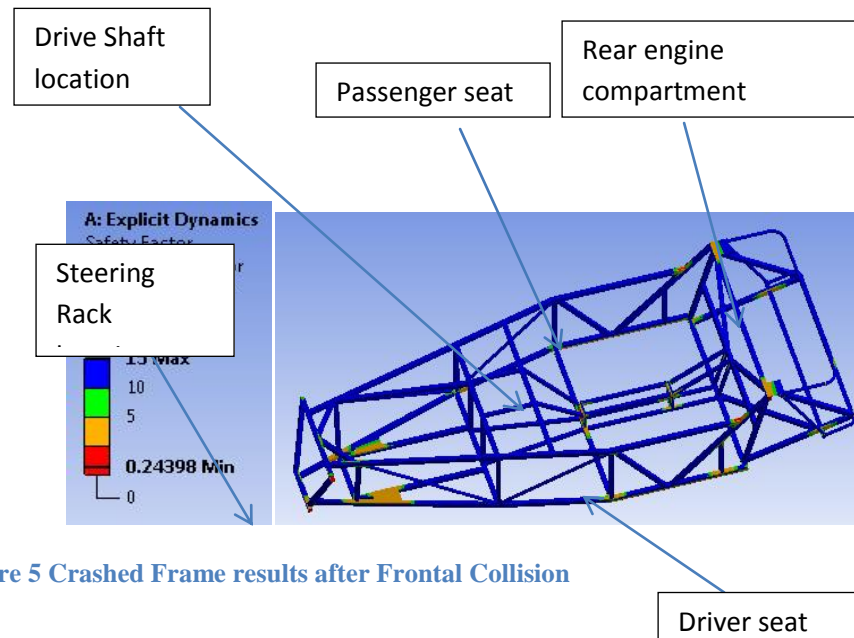


Figure 5 Crashed Frame results after Frontal Collision

Further magnification indicates that the failure regions will occur in the areas colored red. This merits a Three (star) since chances of life threatening injury could be placed under less than 20- 34%. For an off-road chassis this is a good result. However, further re-enforcement with steel plates was carried out in the side members during manufacture.

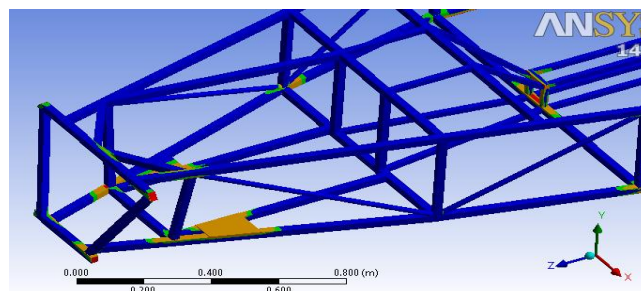


Figure 6 Magnified portion of failed members after Frontal Impact

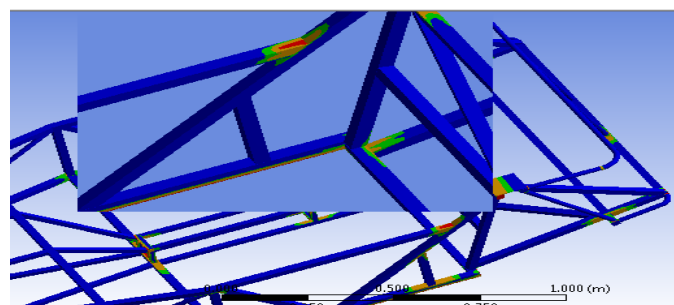


Figure 7 Depiction of failed side members after Frontal Impact

Even after impact, the deformations were really small. Areas in blue show where the worst deformations could occur. This is quite alright since they are far off from the occupants.

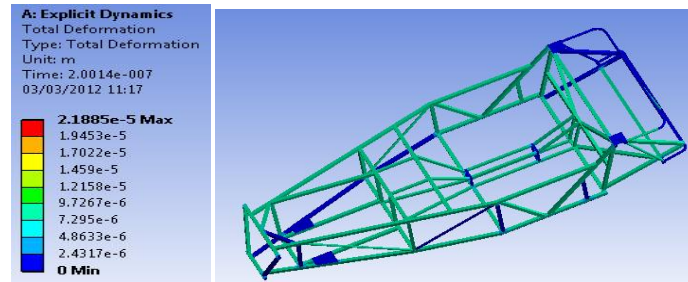


Figure 8 Pattern of Total Deformation after Frontal Impact

Side Impact

Side impacts were carried out at the same speed (35m/h) as Frontal Impact.

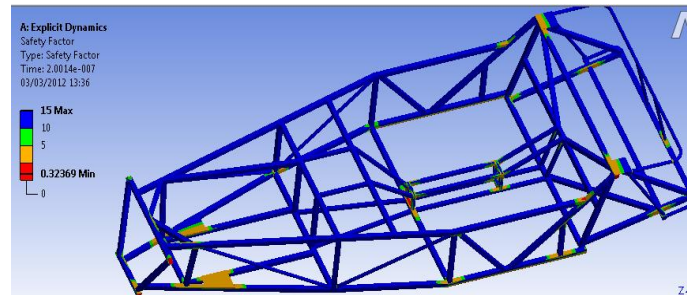


Figure 9 Results of Side Impact test at 35mph

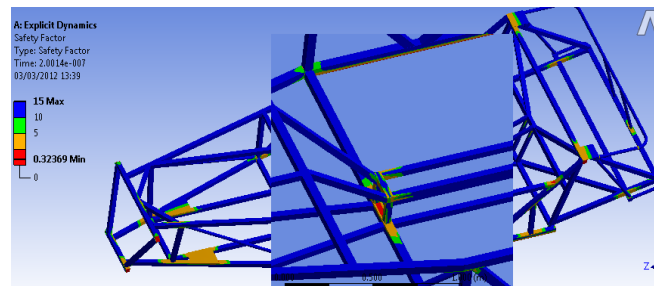


Figure 10 Failure of Side Impact test occurring in the Transmission passage

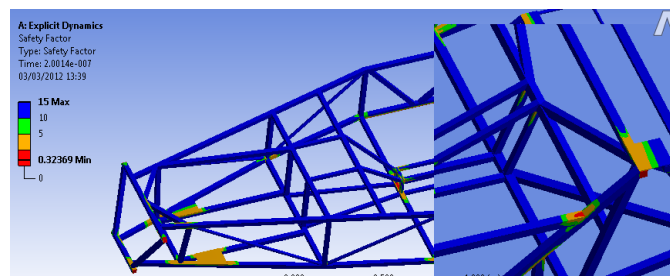


Figure 11 Failure of Side Impact test occurring in the side member



Figure 12 Completed frame with engine mounted

Conclusion

The focus of this research has been to design and fabricate a frame for a two-seater go-cart (dune buggy). The design and fabrication of the two seater off-road vehicle with a weight of 66.05 Kg has been achieved. Both Frontal Collision and Side Impact carried out at 35mph in ANSYS WORKBENCH prove that the buggy design was road worthy. A further fabrication of the frame has been carried out and the all systems mounted. The vehicle has been moved already and no visible failure has occurred although further testing need to be carried out.

Recommendation

It is recommended that further modifications to the frame geometry to make it more aerodynamic be carried out. A lighter yet robust frame that will incorporate the use of local materials such as wood, sawdust is much encouraged. Further frames could also be developed for single-seaters such as mini bajas. Zoomlion, currently runs an assembly plant for some of its tricycles. Further frame development to help Zoomlion will be very appropriate as well.

List of Reference

- Blundell Michael and Harty Damian (2004) *Multibody Systems Approach to Vehicle Dynamics*. Linacre House, USA Butterworth-Henemann ,Elsevier Inc.
- Crolla David (2009) *Automotive Engineering Powertrain, Chassis System and Vehicle Body*. Linacre House, USA Butterworth-Henemann ,Elsevier Inc.
- Matt Lombard (2010) *SolidWorks® 2010 Bible*. Indianapolis, Indiana.Wiley Publishing, Inc.
- Kohnke Peter (2009) *Theory Reference for the Mechanical APDL and Mechanical Applications*. Southpark, USA. Ansys Inc.

CREATION OF ARTEFACTS FROM PLASTIC WASTE MATERIALS AS MEANS OF ENVIRONMENTAL PROTECTION AND MANAGEMENT IN GHANA

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Abstract

In Ghana, plastic waste is becoming a social canker as drinking water and other products are sold and packaged in plastic bags and containers. The gutters, beaches and drains are choked with abandoned plastic waste. Virtually, the plastic wastes have also become a threat not only to humans but also to livestock and aquatic animals, which mistake pieces of plastics for food and eventually, choking to death. The plastics are also durable and decompose very slowly in the soil, thereby affecting the fertility of soil. It is against this backdrop that the researchers seek to create artefacts from plastic waste materials through casting in order to help keep the environment clean. The objective of the study was therefore to find out whether plastic waste materials could be recycled into artifacts through casting. The experimental research method was employed. Samples of plastic waste containers and sachets were picked from the surroundings of Takoradi Polytechnic. A mix ratio of 3:2 (3 parts of sachets and 2 parts of containers) was used. The mixture was melted between 150°C – 160°C and poured into a Plaster- of- Paris (P. O. P) mould for casting as artefacts. The findings of the research revealed that the cast artefacts were lighter and stronger, and could be decorated to serve as decorative pieces. It was recommended among others that this technique could be used to produce teaching aids and artefacts for pre-school levels, and also decorative pieces thereby managing and utilizing the plastic waste materials that have become nuisance to the environment.

Key words: Materials; Plastic Waste; Recycle; Casting; Artefacts.

Introduction

A plastic material is any of a wide range of synthetic or semi-synthetic organic solid used in the manufacture of industrial products. In July 2004, Ghana declared a recycling war on plastic waste in a project that was to cost some \$1.5 million but it appears the impact has not been very much felt in both urban and rural areas. The amount of plastic waste generated in Ghana in recent times is overwhelming. As stated by Yankson (1988), in recent times, there has been an upsurge in the use of plastic products resulting in a proportionate rise in plastic waste in the municipal solid waste streams in large cities. Plastics have been used extensively in both food and water packaging because of their inherent properties such as low bulk density and inertness that make them convenient carrier materials and low risk contaminants.

As observed by Adarkwa and Edmundson (1993), the adoption of a more hygienic mode of packaging food, beverages, “iced water” and other products brought plastic packaging to replace the existing cultural packaging methods (leaf wrappers, brown papers and metal cups uses) in cities and towns. Due to some of the above special properties of plastics, they have become obvious choice for food items in markets, workplaces and almost cities like Accra, Kumasi, Takoradi, Cape Coast and Koforidua.

Statement of the Problem

In Ghana, plastic waste is increasing as products sold and packaged in plastic bags and containers increase. The gutters, land, roadsides, beaches, and drains are choked with abandoned plastic waste. Drinking water is produced and stored in plastic containers and sachets. These plastic sachets when thrown away, could be filled with rainwater, which are ideal breeding grounds for malaria – carrying mosquitoes and other disease – carrying insects. The plastics are also durable and decompose very slowly. Plastics stay put, for decades, even centuries, and far into eternity. Antwi (2004) noted that plastic waste has become a threat not only to humans but also to livestock and aquatic animals, which mistake pieces of plastics for food and choking to death eventually. It is an undisputable fact that plastics are contributing toward the death of some of our rivers and streams. Even the mighty Atlantic Ocean is suffocating on plastics. When it cannot take it any longer, it does

what is natural –vomit the stubborn creatures back on shore (Impact on Oceans 2003). It is against this backdrop that the researchers seek to recycle plastic waste for casting artifacts to help keep the environment clean.

Objectives of the study

The objectives of the study are;

- (i) To recycle plastic waste.
- (ii) To create artifacts using plastic wastes as raw materials.

Research Question

Plastic wastes could be used for creating artifacts.

Brief Historical Overview of Plastic

According to Steele (1977), John Wesley Hyatt and his brother Isaac of Albany, New York, patented cellulose nitrate, which they called celluloid in the year 1868. Hyatt is called “the father of the plastics industry” by many people. He combined cellulose fibres and nitric acid (nitrocellulose or gun cotton) with solid camphor. Other people had worked with cellulose nitrate and solid camphor before he did. However, it was Hyatt who developed the right combination to make the first plastic.

Hyatt’s celluloid was used for the first billiard balls made of synthetic material. About 41 years after Hyatt’s success with cellulose nitrate, Baekeland (1909) developed phenolic plastic resin which was moulded into bobbin ends, electrical insulators, distributor caps, timers and other automobile ignition parts. A number of plastics have been invented since these first discoveries. A selected group includes polyethylene, polyester, polyvinyl chloride (PVC), acrylic polystyrene and polypropylene.

Today, products, made from plastics are found everywhere. People buy detergents, milk, water and other liquids in plastic bottles and containers.

Classification of Plastics

Steele (1977) also states that all plastics can be put into one or two groups namely,

- (i) Thermoplastic (meaning heat softening) and
- (ii) Thermosetting (meaning heat curing)

Thermoplastics are synthetic materials which become soft when they are heated and hard when they are cooled. The solid plastic particles are heated until they are soft and moulded into a shape (a physical change). The soft moulded plastic is cooled into a solid state to hold the mould shape. Examples are acrylic, cellulose nitrate, polyvinyl, polystyrene, polyethylene, fluorocarbon and polypropylene.

Thermosetting plastics are cured (set) into permanent shape during moulding. Heat or heat and pressure cause a physical change followed by a chemical change in solid – form thermosetting plastics. They cannot be softened or recycled by reheating. However, they may be degraded by extremely high temperature. Examples are; phenolic, polyester, silicone, and epoxy.

Properties of Plastics

- Plastics can be made hard and stiff or soft and flexible, or they can be made to have qualities in between these.
- Most plastic products should be able to withstand being dropped without breaking. This is called **impact strength**.
- Plastic, in their natural state, are good electrical insulators. That is, they will not carry an electric current. Plastics are generally classified as light-weight solid materials. They are lighter than most metals. Plastics are good heat insulators. That is, they are slow to heat.
- Some plastics can be stretched liked a rubber band. They are called elastomer (stretchy) plastics.
- Plastics vary with transparency or clearness. Some are as clear as glass. Others cannot be seen through and are called opaque plastics. Plastics that can be partly seen through are called translucent.

- Plastic foam is used as cushioning. Cushioning is the ability of a material to absorb a shock or impact. It is usually used to protect something from damage. Plastics should not be identified by colour except in the natural state since different plastic families may be coloured alike. Most plastics are coloured before they are made into products (Steele, 1977).

Methodology

The researchers employed the experimental research method for this study. An experiment usually involves two groups of subject; an experimental group and a control or a comparison group, although it is possible to conduct an experiment with only one group (the experimental) that receives a treatment of some sort (Fraenkel and Wallen 2000).

In this study, the researchers conducted the experiment with only the experimental group to recycle plastic wastes into artefacts. The researchers also employed thermoforming and casting techniques to make the artefacts.

Equipment and Materials used

(a). Equipment



Fig. 1 Gas Cylinder for Heating



Fig. 2 Melting Container



Fig. 4 Scale for measuring temperature materials



Fig. 3 Pyrometer for measuring

(b). Materials used



Fig. 5 Plastic waste containers



Fig. 6 Plastic waste sachets

Preparation of the Plaster-of-Paris (P.O.P) Mould and Plastic Waste

The **model** was made in solid form using clay. Correct amount of water and Plaster-of-Paris (P.O.P) were weighed. The plaster was sprinkled into the water evenly to avoid lumps. It was gently stirred to allow air bubbles to rise to the surface and skimmed off the top and thrown away.

As soon as the plaster changed from the consistency of milk to creamy, it was poured on to the prepared model. The plaster was left to solidify before removing the model. The prepared mould was allowed to dry and oiled for the casting processes.

Initial tests were carried out and the table below shows the compositions of materials used until a mix ratio of 3:2 (3 parts of sachets and 2 parts of containers) was obtained.

Table 1: Results from Initial Tests

Materials	Proportions	Temperature	Impact Strength
Sachets	1 Part	150°C	Not Strong
Containers	1 Part	150°C	Slightly Strong
Containers and Sachets	1 : 2 Parts	150°C - 160°C	Strong
Containers and Sachets	2 : 3 Parts	150°C - 160°C	Very Strong

Source: Preliminary Tests

The samples of plastic waste containers and sachets were picked from the surroundings of Takoradi Polytechnic. From the above table showing the results of the preliminary tests, the following plastic waste materials were measured;

- 3 parts of plastic sachets
- 2 parts of plastic containers

The weighed materials were melted in a tin container until a suitable maturing temperature between 150°C-160°C was achieved. A pyrometer was used to measure the maturing temperature. The melted solution was then poured into the prepared Plaster of Paris (P.O.P) mould and allowed to cool at room temperature for 30 minutes before removing the cast artefact. After each cast, the mould was oiled before use to ensure easy removal. The

same processes were repeated until enough artefacts were produced. Figures 7, 8, 9 and 10 below briefly explain the processes of melting to the pouring of the solution.



Fig. 7 Melting of the material



Fig. 8 Oiling of the P.O.P mould



Fig. 9 Pouring of the solution
in P.O.P mould



Fig. 10 Poured Solution in P.O.P mould

Figures 11 and 12 below show sample of how to remove cast piece from the mould after it had been cooled, solidified and then sand papered.



Fig. 11 Removing the cast
artefact.



Fig.12 Cast artefact.

Decorating the Cast Artefact

Value as added to the cast artifact by painting with acrylic paints. The painted artefacts could be framed for decorative purposes.



Fig. 13 Painting of the artefact.



Fig. 14 Finished artefact

Results and Discussion

It came to light that when only plastic sachets were melted, that solution could not be well compacted as compared to the mixture of the plastic waste containers and sachets. It could be due to the fact that, the plastic sachets alone contained certain chemical properties that could not be softened or recycled by reheating. It could also imply that the sachets were thermosetting plastics and this affirms Steele's (1977) classifications of plastics. From table 1, it was found out that even though only melted plastic containers solution had slightly impact strength, the proportions of 2:3 (2 parts of containers and 3 parts of sachets) yielded very strong impact strength. It could therefore be deduced that the plastic containers were thermoplastics as classified by Steele (1977). Additionally, there was no emission of heavy smoke from the melted solution between 150°C -160°C thereby making the melting processes environmental friendly.

The researchers also melted the same proportions of 2:3 (2 parts of containers and 3 parts of sachet) above 160°C and the cast piece lost its plasticity (ability to bind together). The over melted solution emitted heavy smoke that could be nuisance to the environment. Figures 15 and 16 below show the over melted solution and cast piece.



Fig. 15 Over-melted solution



Fig.16 Disfigured fish cast piece

Conclusion and Recommendations

In conclusion, the researchers were able to recycle plastic waste materials by casting into artefacts.

- It is recommended that this technology could be practiced in the vocational and technical schools to make teaching aids for pre- schools to promote and develop basic education in Ghana.
- It is also recommended that further scientific research could be conducted to ascertain the very strong impact strength of the mix ratio of 3:2(3 parts of sachets and 2 parts of containers)

- The researchers intend to partner artisans and artists to transfer this technology since it could also serve as a source of income and employment.
- It is proposed that producers of plastic products should be made to pay a weighted proportion of levy for the pollution that the plastic may cause in the environment in a levy system called the plastic polluter pay fund or polluter pay principle fund (PPPF) to pay for people who collect the plastic bag sachets for recycling.
- It is also proposed that the Metropolitan, Municipal and District Assemblies should establish several plastic collection points in various towns and cities across the country. This should give plastic consumers or thrash pickers an opportunity to be given cash back from the fund when they return plastic wastes to any of these points. Cash back may depend on and kilogramme of plastic returned or any other acceptable calculation.
- It is suggested that parliament as a legislative arm of government should put in place a legislation to control the inflow of plastic products so that the plastic wastes generated could be recycled into artifacts and other products.
- Vocational and technical schools practising this technology should have to access the PPPF to carry out research and teaching activities with regard to reaching of plastic wastes. The funds could also be used for infrastructure development of the schools.

References

- Adarkwa, K. K. and Edmundson, A. R. (1993). Urban Waste Management in Ghana, a Study of Eleven Urban Centres. Kumasi. University of Science and Technology. Retrieved from <http://www.ghanaweb.com/GhanaHomePage/blogs/blog.article.php?blog=4230&ID=1000010692>. [Accessed Date: May 06, 2011].
- Antwi, M.K. (2004). Indiscriminate Disposal of Plastic Waste Affects Food Chain. Ghana News Agency (GNA), Cape Coast. July 9, 2004. Retrieved from <http://www.modernghana.com/news/58502/1/indiscriminate-disposal-of-plastic-waste-affects-f.html>. [Accessed Date: May 07, 2011].
- Fraenkel, J.R. and Wallen, N. E. (2002). How to Design and Evaluate Research in Education (4th edition), McGraw Hill Companies Inc. U.S.A, p. 284.
- Impact of Plastic Waste on Oceans, Beaches and the Environment(2003). Retrieved from <http://www.reuseit.com/learn-more/top-facts/impact-on-oceans>. [Accessed Date: June 17,2011].
- Steele, G.L, (1977). Exploring the World of Plastics; McKnight publishing company: Bloomington, Illinois. U.S.A, pp. 1-19.
- Yankson, P.W.K. (1988). The Urban Informal Economy, Accommodation, Growth, Linkages, Health and Environmental Impact; The Case of Greater Accra Metropolitan, Accra (GAMA). Ghana University Press, Accra.

THE PESTICIDAL EFFECT OF VARIOUS NEEM TREE EXTRACTS, FOR USE IN THE AGRICULTURAL INDUSTRY

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Abstract

Neem (*Azadirachta indica*) has some medicinal properties resulting from its components, including a secondary metabolite, call azadirachtin. Experimental research was conducted in the laboratory to study the pesticidal properties of extracts from the seed, the leave, the stem and the root of the neem tree on termites, weevils, cockroaches and mosquito larvae, which are nuisance to agriculture. The lethal effect was more pronounced with the seed extract (40-55 %), followed by the leave extract (30-45 %), the stem extract (30-40 %), and the root extract (10-30 %), as compared to the control (distil water) which registered 0 %. The termites and the weevils were seen to be more susceptible to the various extracts, compared to the cockroaches and mosquito larvae. Oil extracted from the neem seed kernel showed even greater lethal properties on the insects; with a minimal lethal concentration, in all cases, being 0.50 % ^V/_V. Again the termites and the weevils responded faster, recording total deaths within 2-5 minutes, compared to the cockroaches and the mosquito larvae where total deaths were experienced only after 30-90 minutes. It was also found out that there was a direct relation between the concentration and degree of lethal effectiveness of the oil. The neem, especially the seed oil, has great potential in biological pests control systems.

Keywords: Metabolite; Azadirachtin; Insecticidal; Lethal; Kernel; Pests.

Introduction

Medicinal Potential of Neem

The neem tree has over centuries been used as a herbal plant, including its effects against insect pests. Various parts of the neem tree: the bark, leaves, flowers, seeds and fruit pulp are used, mostly in the powdery or the fluid form. The powdery extract is normally used for the preservation of stored seed-bean grains against weevil attacks or mixed with dry grounded clay or sawdust and sprinkled over young plants, such as maize and sorghum, against pests' infestation. Rain water or dew helps dissolve the extract active substance, which get into the plant through translocation. The extracts, however have some application problems including their effect period, lasting for 4-8 days, thus there is a need for many applications in a season. The fluid extracts are sprinkled on field crops against various pests in the fields. The increasing demand for high quality food, free from chemical residues, makes it imperative that non-chemical means of protecting stored products or crops against insect damage be used. Investigations on the effectiveness of neem extracts as organic pesticide is vital; but the development of standardized formulation and certification of the neem-pesticide products is even more crucial.

Many people have expressed concerns about harmful effects of chemical pesticides and interest in organic farm products. Thus to address these concerns there is the need to reduce the use of chemical pesticides and supplement with relatively lesser toxic ones. The neem extracts could play this role, but there is the need to assess their degree of effectiveness on various pests.

The study was aimed at assessing the efficacy of various neem extracts on some agricultural pests and the following underlined objectives were looked at.

1. To determine the pesticidal properties of various extracts of the neem tree;
2. To determine the effect of concentration, time and degree of lethal effectiveness of the various neem extracts on some selected-insects;
3. To determine any form of correlation amongst these parameters.

Neem (*Azadirachta indica*) is a tropical or semi-tropical evergreen, drought resistant tree in the mahogany family, Meliaceae. It grows to an average height of 15-20 m, with wide branches. Though known to have great

medicinal (anthelmintic, antifungal, anti-diabetic, antibacterial, antiviral, anti-fertility and sedative) properties, the neem extracts do not normally kill pests right away rather they repel them or affect their growth; and it's repellent and pesticide properties are broad spectrum in nature (Ganguli, 2002). Also neem cake, a residue after oil is extracted from the seed kernel, is used as an insect repellent in rice paddies (Levetin and MoMahon, 1999), as well as being effective on soil-borne fungal pathogens and plant parasitic nematodes (Locke, 1990; Schmutterer, 1990b). The neem has bitter compounds including nimbin, nimbinin and nimbidin, capable of providing relief from minor muscle to joint pain; as well as a complex secondary metabolite, azadirachtin, a mixture of seven isometric compounds, labelled as azadirachtin-A to-G; with the azadirachtin-A greatest in quantity and the azadirachtin-E being the most effective insect growth regulator (Verkerk *et al.*, 1993). Apart from these there are over twenty other compounds with some biological activities, including salannin and meliantriol (Jacobson, 1990). In an enclosed environment or when the oil coats the insect their respiratory system is blocked, preventing breathing and causing suffocation. It has been found that the effectiveness of the neem extract depends not only on the dosage but also increases with earlier larval stage treatment. The neem extract should be used not more than three months after preparation. It is found that the azadirachtin level is relatively lower in the seed after 8-10 months storage and extracts from such seeds are less effective as a pesticide. The authors also found that the neem extracts have no killing effect on some organisms, including the honeybee workers, spiders, butterflies, ants and ladybugs, at rates of 500 ppm; and that earthworms actually benefit from soil application of neem by-products (Schmutterer, 1990b). In the pharmaceutical industry the minimum lethal concentration, a concentration of a substance that can at any time duration cause death to at least half of a group of some particular species of a living organism, are often determined. Fine extracts (using alcohol) are more active than crude water extracts. Activity is dosage-dependent. Generally 50-75 g seed / liter of water give optimal control of most pests (Ankra, 1998). Some natural additives such as garlic (*Allium sativum*) and hot pepper (*Capsicum frutescens*) exhibit synergistic effect on the neem product. Studies also reveal some relatively great effectiveness when these extracts are mixed with or applied alternatively with bio-pesticides such as *Bacillus thuringiensis* (Bt) – (Adu-Acheampong, 1997). Emulgators, such as soap cake powder and “rimulgan” are normally used to aid in the application of neem seed oil, as a pesticide. The neem oil and the emulgator are mixed in the rate of 4:1; and then diluted between 0.5 to 1.0 % in water depending on the type of plant or pests to be use on. The 0.5 % is used for plants with soft leaves, like many vegetables; and 1.0 % can be used for plants with hard leaves, like many fruit trees or ornamentals (Moser, 1999).

Termites greatly destroy wood and wood products, damage crops, destroy books and corks of stored bottles, damage fabric and plastics (Eggleton, 2001). Weevils, such as the boll weevil (*Anthonomus grandis*) and grain weevils, *Sitophilus granaries*, attack crops, stored grains, other dry foods and flours. Cockroaches are mostly nocturnal omnivorous, from the order *Blattaria*; found everywhere including homes and hospitals and feed on human and pet's food. They create offensive odour and allergic relations and passively transport microbes, which are potentially dangerous to human (Kutrup, 2003; Santos *et al.*, 1999). Chemical trails in their faeces help them find their routes and air-borne pheromones aid them find their mating partners (Viegas, 2006). Mosquitoes are from the *Culicidae* family and undergo complete metamorphosis. The common ones are the anopheles, aedes and culex types. Adults have piecing mouth parts, feeding typically on nectar and plant juice, but the female, equipped with an elongated proboscis collect blood from their host for the development of her eggs (Harzsch *et al.*, 2006). In so doing they could pick up and transmit plasmodium, a causal agent of malaria, into the blood streams in the host (humans). Out of its 72 odour receptors on its antennae at least 27 are tuned to detect chemicals found in perspiration. Bio-controls, using dragon flies nymph and fishes, are effective on mosquitoes (Taylor *et al.*, 1980; Singh *et al.*, 2003). Preventive measures, such as drainage of stagnant water (breeding sites); as well as biological control agents, using *Bacillus thuringiensis*, are used against mosquitoes.

Authors have indicated the effectiveness of the neem extracts but lament on the short shelf life of neem extracts, losing 50-60 % azadirachtin in the first year storage due to factors such as photo (ultra-violet light) degradation, detoxification by leaf pH conditions, wash off of extract on leaf surface by rains (Wood, 1990).

Methodology

Various parts of neem tree (roots, leaves, bark, stem, seeds) and insect-pests – cockroaches, bean weevils, cockroaches and mosquito larvae were collected into separate containers.

The various selected parts of the neem tree were dried in trays, grounded in crucibles, before extracts were prepared from them. Three forms of extracts were prepared:

Three hundred (300) grams of each of the grinded neem parts were dried and further ground to produce very fine powdery extract, to treat the various insect-test samples.

Another set of 300 grams of each of the grounded neem parts were properly mixed with 1 l of distilled water, allowed to stand for 24 hours, then sieved through a 2 mm mesh and further filtered through a filter paper. The filtrate, the aqueous extract was then used to treat the various selected insects.

Ripped fruits collected from neem trees were pulped to remove the flesh. The seeds were then dried, carefully cracked and the kernels removed. The latter were washed and dried to avoid fungal infection. One kilogram of seed kernel was roasted in an oven at 110 °C for 30 minutes for easy extraction and maximum yield of oil. The kernels were blended and a little water added to it, mixed to form paste, transferred into a saucepan kneaded and heated for 3 hours until enough oil was collected on the surface of the mixture. Further heating and pressing was done to obtain more oil and evaporate any possibly “free” water from the oil.

Dilution of Oil

Various volumes of the oil (0.1 cm³, 0.5 cm³, 3.0 cm³, 6.0 cm³ and 10.0 cm³) were each pipetted into a 100 ml volumetric flask and topped to the 100 ml mark with 99.8 % ethanol, producing 0.1 % v/v, 0.5 % v/v, 1.0 % v/v; 6.0 % v/v and 10.0 % v/v concentrations, respectively.

Collection of Selected Samples

Various methods were used to collect each of the selected insects for analysis. Termite-infested wood and termite moulds were collected to the laboratory and the termites shaken out, cockroaches were trapped from isolated buildings into a net mesh; mosquito larvae were scoop out from stagnant water; and the bean weevils were collected after infested beans were stirred, shaken and sieved out into a pan. Infested bean plant was also used as a source for weevils.

Treatment of Selected Samples

Fifty (50) ml of each of the five powdery neem parts extracts were sprinkled over the insect-test samples, 10 in each glass beakers, which had the tops sealed with a perforated parafilm, to prevent any insect escaping. Water was however poured half-way full in the containers before the mosquito larvae samples were placed on the surface of the water and treated. The control variants had selected insects treated with distilled water. Labelling was done and aseptic measures taken.

The same measurements (50 ml of each of the aqueous neem parts extracts were sprayed on selected insect samples, 10 of each type, with two replicates) and procedure used for the powdery extracts was adopted.

The same procedure was used for the neem seed oil treatment. Various concentrations were prepared and used to spray the insect in their respective containers and the time and nature of their movement observed.

Results

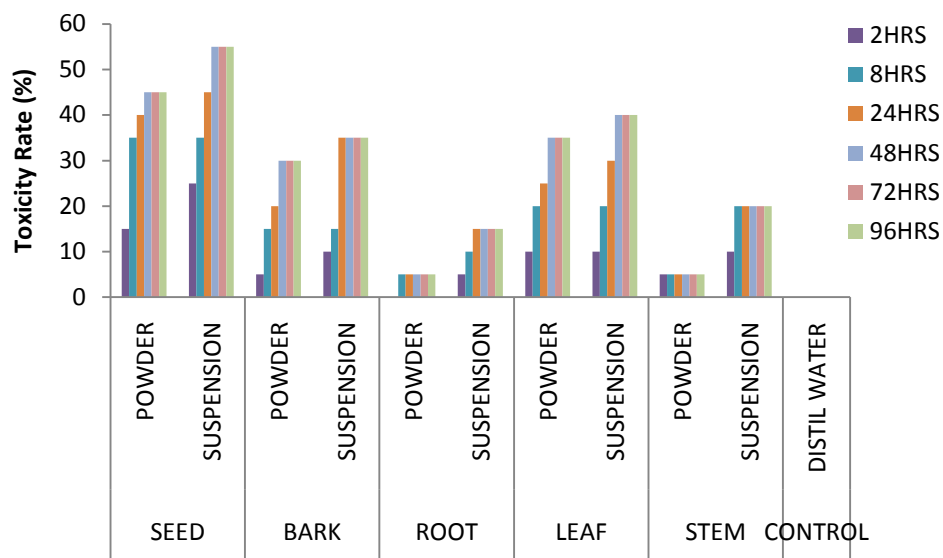


Figure1: Effect of Various Powdery and Aqueous Neem Extracts on Termites

The aqueous suspensions expressed more inhibitory effect than the powder, for all test-samples. Among the extracts, that from the seed had the greatest effect whilst that of the roots and stem had the least. The control (distilled water) showed no effect. Fig. 2, 3, and 4 below, show the effect of the various extracts on the weevils and mosquito larvae-sample, and cockroaches, respectively. The results of these, though varied in terms of magnitudes, took a similar trend as that of the termites, in Fig. 1. In all cases it is detected that the maximum effectiveness of these preparations were mostly attained 48 hours after their application.

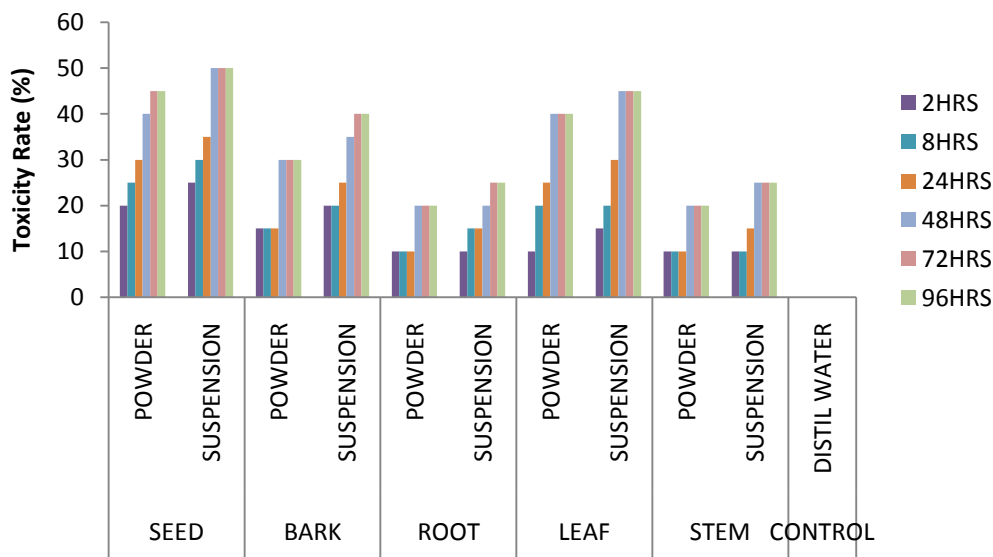


Figure 2: Effects of Various Powdery and Aqueous Neem Extracts on Weevils

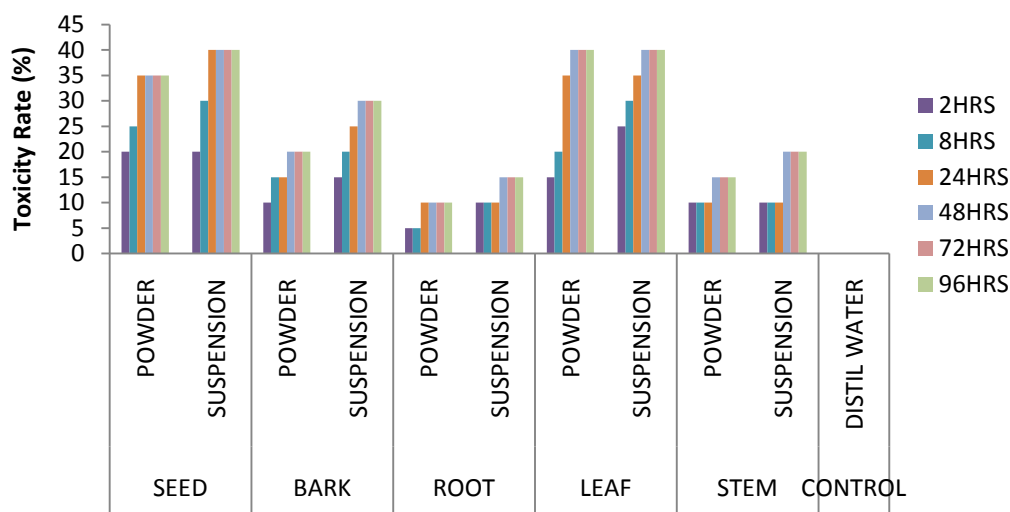


Figure 3: Effects of Various Powdery and Aqueous Neem Extracts on Mosquito Larvae

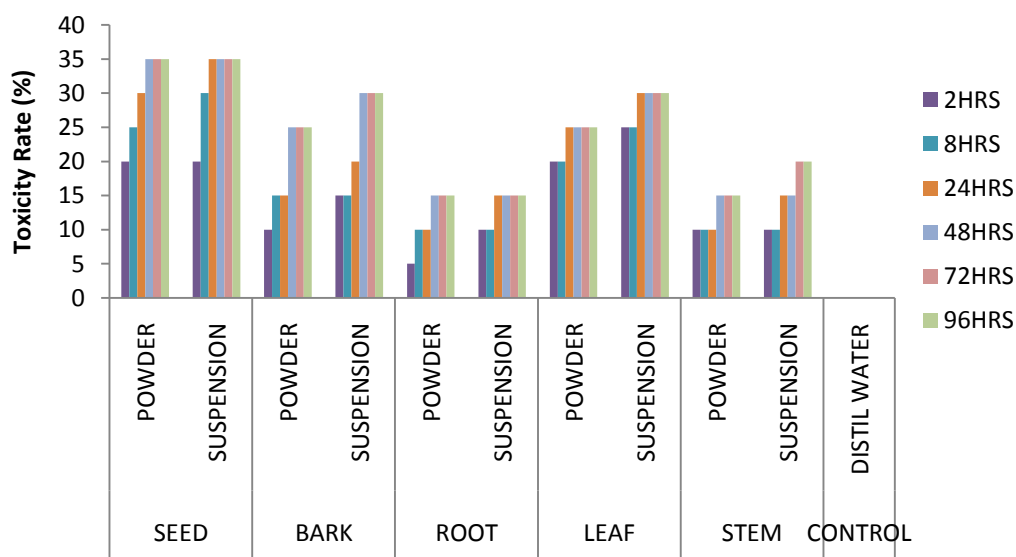


Figure 4: Effects of Various Powdery and Aqueous Neem Extracts on Cockroaches

Generally the toxicity rate of both the powder and suspension extracts ranged from 15-55 %; with the neem seed extracts being the most effective against the insects (35-55 % effectiveness), followed by the neem leaf (25-45 % effectiveness) before that of the bark, stem and roots (15-40 % effectiveness). The control (distil water) was not effective (0 %). Extracts in the aqueous forms gave better effects, compared to the powdered forms. The effects of the extracts were more pronounced against the weevils and termites (50 % and 55 % effectiveness, respectively) and relatively lesser for the cockroaches and the mosquito larvae (35 % and 40 % effectiveness, respectively).

Based on relatively better insecticidal effectiveness of the neem seed extracts (Reference to Fig. 1- 4), the authors found it necessary extracting and assessing the effectiveness of various concentrations of extracted neem kernel oil, to ascertain the minimum lethal dose and the time taken for such doses to be effective. The findings are illustrated in figures 5-8, below.

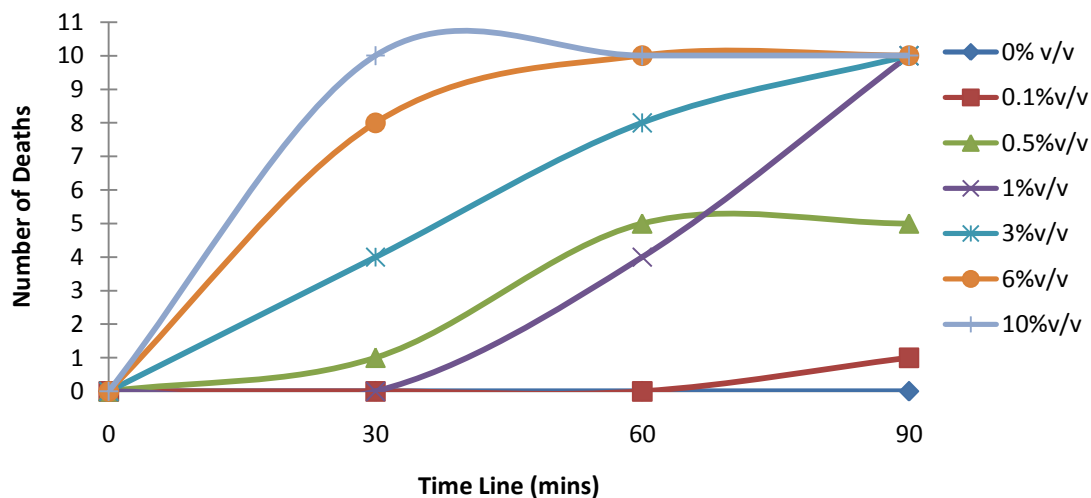


Fig. 5: Effect of Neem Seed Oil on Cockroaches

The death rates for the cockroaches as against the time increased with respect to concentration levels used (Fig. 5). The higher the concentration of the neem seed oil, the faster it's killing effect on the cockroaches. The minimum lethal dose here is 0.50 % v/v as it killed exactly half of the insects in 60 minutes; as compared to the controls (0 %) which had no effect on the insects.

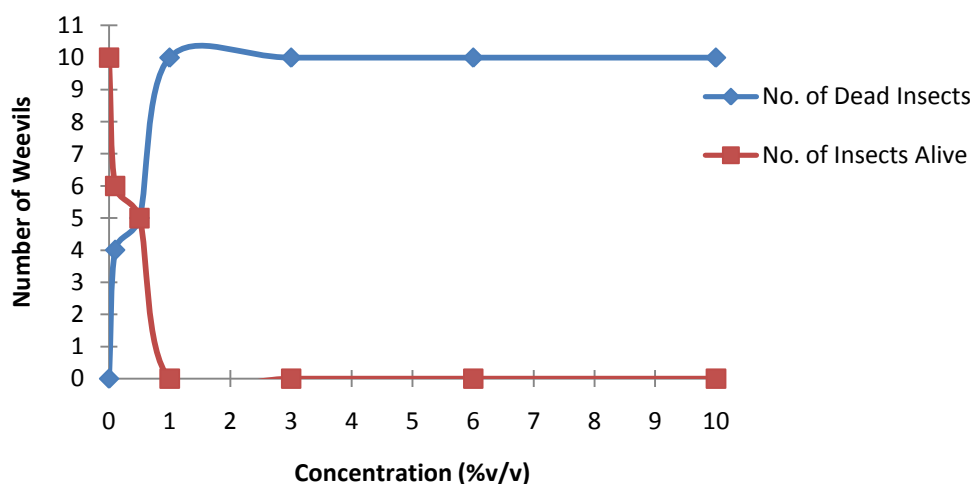


Fig. 6: Effect of Neem Seed Oil on Life Expectancy of Weevils, within 120 seconds.

From Fig. 6 above, the lethal effect of the oil on the weevils was relatively fast and effective especially with the increase in concentration of the neem oil. Concentrations of 0.50 % v/v and above were seen to be effective

since they were able to kill half or more of the total number of the weevils. The sample concentrations of 1 % v/v and above killed all the weevils within the 120 seconds. The control (0 %) did not experience any deaths of the insects.

From figure 3 below, the test carried out for a period of three minutes had fewer numbers of recorded deaths of the insects compared to the number of deaths recorded for the tests that used five minutes. The number of death of the termites increased as the concentration for the neem oil increased. For the 3 % v/v concentration of the neem oil, a drop in the number of deaths for the termites was recorded for less than 3 minutes. This could be attributed to some factors including mutagenic ones. The minimum lethal concentration of the neem oil on the termites was 0.50 %, within five minutes reaction time period and 1.0 % for three minute period; the control (0 %) did not record any deaths.

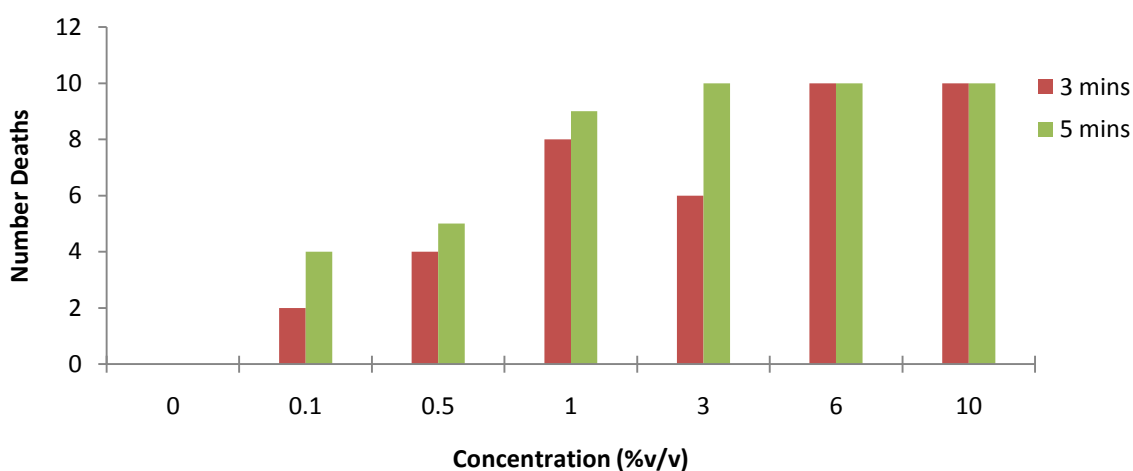


Fig. 7: Lethal Effect of Neem Seed Oil on Termites

From Fig. 8 below, it took a longer period of time (60 to 120 minutes) before the mosquito larvae died with respect to the concentrations of the neem oil used. The minimum lethal concentration for the neem oil on the mosquito larvae was 0.50 % v/v .

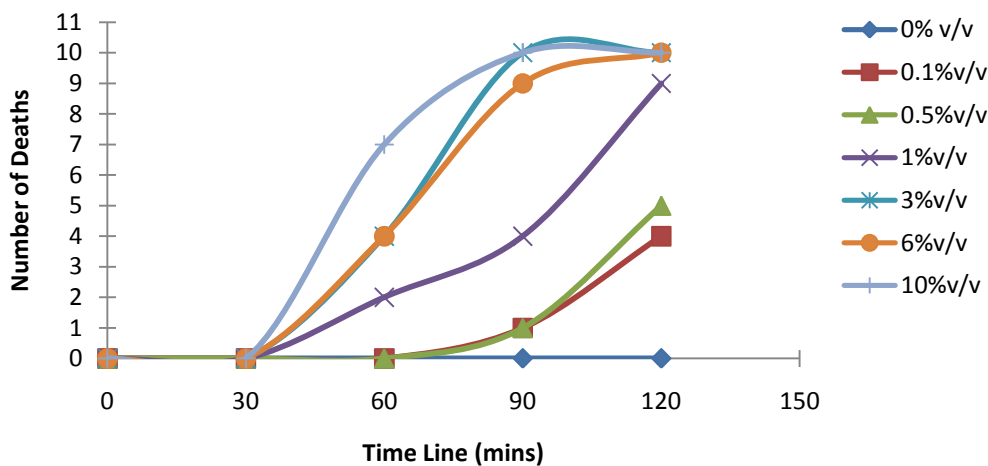


Fig. 8: Lethal Effect of Neem Seed Oil on Mosquito Larvae

Discussion of Results

Researchers indicate that with increase use and overuse of chemical pesticides many insect-pests develop resistivity (Gomez *et al.*, 1993). Neem pesticides, relatively less toxic, environmentally friendly and effective are a desirable substitute for an integrated pest control management. Though with varied degree of effectiveness the various neem extracts were seen to be effective against the selected insects, and this makes it better a product for agricultural use, especially for mix-cropping practices; as a field could be infested with more than one of these insects under study. A general analysis on the data for the effectiveness of both the aqueous and powdered neem extracts on the selected insects revealed an increased in toxicity rate from first day to second day and generally stabilized from the second to the fourth day, with most of the survived insects being weak and less motile. The neem seed kernel oil also showed some correlations between the death rates for the insect-pests as against the time and concentration levels. The higher the concentration of the neem seed oil, the faster it killed the pests. The minimum lethal concentration of the neem oil on the termites is 0.50 % v/v for five minutes reaction period and 1.0 % for the three minute reaction period. Generally the minimum lethal dose in all cases is 0.50 % v/v as it killed exactly half of the insects. In the case of the cockroaches the time duration was 60 minutes. That of the mosquitoes took 60 to 120 minutes and 2-5 minutes for the termites and weevils, as compared to the controls which had no effect on the insects. Results of a research by Padi *et al.*, (1999) recommended a 3 % concentrated Neem Azal as it was effective at laboratory conditions. However this dosage, according to them revealed poor performance in the field. It was found that laboratory trials recorded relatively high effectiveness than field trials, since the latter is subjected to other prevailing environmental factors.

Conclusion

Production of neem pesticides is technically feasible. All the various selected neem extracts exhibited some degree of insecticidal properties and have great potential in the agricultural and industrial sectors. The broad spectral nature of the neem extracts has great benefit to farmers, especially with mix-cropping. Among the extracts the seed kernel oil was most effect, followed by the aqueous and powder types. The minimal lethal concentration of the neem seed kernel oil for the test samples is 0.50 % v/v .

The termites and the weevils were relatively more susceptible to the extract preparations compared to the cockroaches and the mosquito larvae. There is some direct correlation between concentration and time on one side and lethal effect on the other. There is an inverse-relationship between the concentration of a sample and the time required for the effects of the extracts to be felt.

Recommendation

A comparative study on laboratory and field trials is recommended to ascertain the respective needed doses of the extracts and reaction periods for each of the two conditions. For example in this study both the 3-minute and 5-minute reactions periods were effective at laboratory condition, using 0.50 % v/v concentration. Economic-wise the former is preferable; but will it be the same at field trial condition? Padi *et al.*, (1999) indicated that generally field conditions need relatively higher doses of pesticides than the laboratory values.

Studies should also be done to improve upon the smell of the seed oil so that it can comfortably be used on the skin as a repellent-pomade to drive away mosquitoes and other nuisance insects, during farming activities, if this will not reduce its effectiveness.

Acknowledgement

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References

- Adu-Acheampong, R., (1997). Laboratory and field evaluation of neem (*Azadirachta indica* A Juss) seed extracts for the management of some cocoa mired species, M. Phil. Thesis, Univ. of Ghana, PP.66.
- Ankra, A D., (1998). Efficacy of neem extracts for management of pests of cabbage (*Brassica oleracea* var *capitata* L.), B. Sc. Dissertation, Dep't of Crop Science, Univ. of Ghana, PP.27.
- Ganguli, S., (2002). "Neem: A therapeutic for all seasons", Current Sci., 82(11), 1304.
- Harzsch, S., Hafner, G., (2006). "Evolution of eye development in arthropods: Phylogenetic aspects", Arthropod Structure and Development, PP. 319–340.
- Gomez, D., Miranda, F., Guerra, B., Rivas, I., Mercado, J. and Guharay, F. 1993. Neem for vegetable IPM in Nicaragua: Experiments and small farmers' perspective. World Neem Conference, Bangalore, India: 81-90.
- Jacobson, M, (1990). Review of neem research in the United States, In: Locke, J. C., and Lawson, R. H., (eds.), Proceedings of a workshop on neem's potential in pest management programs, USDA-ARS, Beltsville, MD., ARS-86, PP. 4-14.
- Kutrup, B., (2003). Cockroach Infestation in Some Hospitals in Trabzon, Turkey, Turk. J. Zool., pp 27, 73-77.
- Levetin, E., McMahon, K., (1999). Plants and Society, 2nd Ed., USA.
- Locke, J. C., (1990), Activities of neem seed oil against fungal plant pathogens, In: Locke, J. C and Lawson, R. H., (eds.), Proceedings of a workshop on neem's potential in pest management programs, USDA-ARS, Beltsville, MD., ARS-86, PP.132-136.
- Moser, G., Förster, P. (2000), Improving the Quality of Agricultural Produce Neem Usage Status Report on Global Duetsche Gesellschaft Technische Zusammenarbeit (GTZ) GmbH, Eschborn, Germany.
- Padi B., Adu-Acheampong R (1999), Preliminary results on laboratory and field trials on "Neem Azal" for cocoa capsid control in Ghana, In: Efficacy and Commercialization of Neem Products, Edited by A. K. Brimah, Proceedings of the Open Forum organized by Goethe-Institut from 19 to 21 October, 1999, PP. 52, 53.
- Santos, A.B., Chapman, M.D., Alberse, R.C, Vailes, L.D, Ferriani V.P, Oliver, C., Rizzo, M.C, Naspitz, C.K., Arruda, L.K., (1999), Cockroach allergens and asthma in Brazil: identification of tropomyosin as a major allergen with potential cross-reactivity with mite and shrimp allergens. J. AllergyClin.Immunol., PP.329-337.
- Schmutterer, H., (1990b), Properties and potential of natural pesticides from the neem tree, *Azadirachta indica*, Annual Review of Entomology, Vol. 35: PP. 271-279.
- Singh, R. K., Dhiman, R. C. & Singh, S. P. (2003), "Laboratory studies on the predatory potential of dragon-fly nymphs on mosquito larvae". Journal of Communicable Diseases.
- Taylor, J. L., Schoenherr, C., Grossberg, S. E., (1980). "Protection against Japanese encephalitis virus in mice and hamsters by treatment with carboxymethylacridanone, a potent interferon inducer", The Journal of Infectious Diseases, PP. 394–399.
- Verkerk, R. H. J., (1993). Biological activity of neem seed kernel extracts and synthetic azadirachin against larvae of *Plutella xylostella* L., Pesticide Science, Vol. 37: PP. 83-91.
- Viegas, J., (2006), "Cockroaches Make Group Decisions", Discovery Channel. <http://animal.discovery.com/news/briefs/20060327/cockroach.html>; Retrieved 10 June 2006.
- Wood, (1990), Efficacy of neem extracts and neem derivatives, against several agricultural pests, In: Locke, J. C and Lawson, R. H., (eds.), Proceedings of a workshop on neem's potential in pest management programs, USDA-ARS, Beltsville, MD., ARS-8.

PERFORMANCE EVALUATION OF INSTITUTIONAL E-LEARNING IMPLEMENTATION PROCESS: STRATEGY PERSPECTIVES FOR EFFECTIVE INTEGRATION IN TECHNICAL INSTITUTIONS IN AFRICA

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Abstract

The e-learning implementation efforts of many higher education institutions (HEI) have often failed to achieve the desired expectations of its funders and users. Although performance evaluations could provide some useful insights into the possible causes and solutions of the abysmal performance of implementation efforts, available models focus on the learner's experience, rather than providing a holistic perspective of the entire implementation process. Using a variant of Participant-oriented evaluation approach, this paper presents and utilizes a novel model of the e-learning life-cycle process to evaluate the performance of institutions in their e-learning implementation efforts. The model which is strongly underpinned by the participant-oriented evaluation approach uses the extent of incorporation of important interventions (factors) at each phase of the implementation process (life-cycle) to evaluate the institutional e-learning implementation performance. The model which comprises three distinct phases: adoption (decision to use e-learning – involving all stakeholders), implementation (physical construction or installation of the e-learning system), and institutionalization (embedding the e-learning within the institution), highlights factors necessary for strategising e-learning implementation efforts and their relative degree of importance using the AHP model. Using data from nine Technical Institutions across Africa, a BEE model has been developed for measuring e-learning implementation levels of HEIs. A four level Excellence Performance Chart (EPC) was developed and used to perform a gap analysis. The results of the gap analysis was then used to determine the scale-level (SL) points of the factors which is then used to determine the overall e-learning implementation level of the institution. The paper concludes with recommendations for continuous improvement in the identified areas.

Keywords: E-learning; Implementation; Change; AHP; Performance; Gap Analysis

Introduction

Advancements in telecommunications and information technology have over the last two decades caused higher education institutions to rethink their traditional notion of education. Computer networks now enable people in different geographical locations to communicate, stay informed and educate themselves. The affordances created by information and communication technologies, coupled with increasing demands for flexibility and convenience in learning, life-long learning and ubiquity in learning has generated extensive research into how information technology could be effectively integrated with teaching and learning. The implementation of e-learning requires a strategic approach due to the choices that have to be made at each stage of the implementation process. These choices are constrained by resource, technical, pedagogical and individual (instructors and students) factors.

Performance evaluations of institutional e-learning efforts have traditionally focused on the learning experiences of students (Dali, 2008) rather than the entire process of implementation. It is however arguable that the actual learning outcomes for students is highly dependent on the institution's approach to introducing and implementing the e-learning system. A holistic evaluation of the e-learning implementation from how it was adopted to its implementation and integration can provide valuable insights for ensuring effective implementation and harnessing of the strengths of e-learning.

Review of literature

E-Learning Implementation Process

The implementation of e-learning in higher education institutions has been widely reported in literature. These reports often describe the activities that were undertaken, the challenges encountered and surmounted, successes achieved and future directions. Very clearly, they describe the implementation effort as a process and show how

the various activities were managed to facilitate e-learning development. Some of these reports advocate that the implementation of e-learning connotes change in institutional practices, particularly in teaching and learning. Lessons from organisational change and development in the organisational theory literature have shown that changes to traditional organisational practices are often not welcomed and at times fiercely resisted. Evidence from the e-learning literature has shown similar conflicts among top management and stakeholders, especially by the instructors.

Traditionally, HEIs have been developed around the classroom model of instruction. Instructors with varied research experiences and knowledge present information to students. The main pedagogical model here has students passively listening to an expert without much active involvement. The academic curriculum, support structures, etc are all intricately woven around this traditional model of HEIs, making any change in such a rigid system difficult.

There are certain drivers however which necessitates the need for change in the way HEIs traditionally function. Firstly, the increasing number of students enrolled each year places tremendous stress on both teaching and physical infrastructures and resources. This often results in large numbers of qualified students being refused admission. Also, the large student-lecturer ratio coupled with the absence of quality and adequate tutorials often reduces the effectiveness of the learning process. This necessitates the need for a more effective system that adequately caters for the professional ambitions and learning aspirations of students. Secondly, in relation to the first point, there has been an increase in the cost of higher education making traditional rendering of educational services relatively cost ineffective. Thirdly, the widespread adoption of technology enhanced education and the availability of Virtual Learning Environments have caused some traditional universities to over physical barriers to education. Now many universities offer educational services across national boundaries, taking advantage of existing large numbers of potential students. These factors enumerated above represent some of the main drivers for change in HEIs.

The emergence of e-learning proved particularly beneficial even though it was apparently overhyped. This hype may have contributed to the resistance by many instructors in the 1990s especially as there was an unfavourable notion that e-learning would take over traditional classroom learning. Essentially e-learning can be construed as a teaching and learning tool that brings in its wake changes in the way traditional practices within an educational institution are conducted. That notwithstanding, there have been many successful e-learning implementation projects in many HEIs around the world as well as many failures.

There have been various perspectives on the implementation of e-learning in HEIs. Notable among them are the systems perspectives (Cech & Bures, 2004), innovation diffusion perspectives (Singh, 2010) and change perspectives (Schönwald, 2003). Cech & Bures (2004) posited that the steps specifically prepared for e-learning projects are based on the systems approach. They maintained that the systems approach focused on the important elements and relationships and neglects the ones that have little impact on the proposed system. They asserted that while there were numerous methodologies, most of them were built on the generic ADDIE model composed of five stages – Analysis, Design, Development, Implementation and Design. Though suitable for successful implementation of the technology itself, it does not adequately resolve issues of change in the institution as a social system. Singh (2010) argues for the widespread use of e-learning using innovation diffusion strategies which although can get many users involved, the change issues that need to be managed will not be adequately integrated. Schönwald (2003) posited that a change management approach was the best solution for a sustainable e-learning implementation in HEIs.

Although many of these research findings report e-learning implementation as a process, a clearer understanding of the underlying process in relation to the changes believed to occur during the implementation is still conspicuously missing in the literature. Cech & Bures (2004) posited that e-learning as a process encompasses other sub-processes. Studying the nature of the processes involved in e-learning implementation is therefore critical to our understanding of an effective e-learning implementation process. To better understand e-learning implementation from a change perspective, we briefly review some theoretical models from the organisational change and development literature and extant information system (IS) implementation literature

Kwon and Zmud (1987) described a six-phase process of organizational IT implementation. In their model, IT implementation was viewed as a social change process aimed at enhancing the use of IT within targeted user communities. The implementation process included: an **initiation phase** which involves an environmental scanning for potential solutions; an **adoption phase** consisting of the examination of alternative solutions to decide which solution to deploy; an **adaptation phase** that includes a modification of the chosen system to suit the organization's unique processes; an **acceptance phase** where organizational users who will use the system show signs of commitment; a **usage phase** where users are motivated to use the system routinely (also known as routinization); and finally, the **incorporation phase** (also known as infusion, or assimilation) which involves the maximization of benefits across diverse tasks.

The phases described above are sequential, suggesting that effective implementation of a phase will foster an effective implementation succeeding phases.

Viewed from a technological diffusion perspective, IT implementation is defined as an organizational effort directed toward diffusing appropriate information technology within a user community. Based on the Kwon and Zmud's (1987) stage model of IT implementation founded on Lewin's (1952) change model, a variation of their stage model, which incorporates some of the post-adoption behaviours developed by Zmud and Apple (1989), is presented below. The **Initiation stage**, involving an active and/or passive scanning of organizational problems/opportunities and the selection of an IT solution is undertaken. An **Adoption stage** which requires a rational and political negotiation to get organizational backing for implementation of the IT application. Stage three, **Adaptation stage** where the IT application is developed, installed, and maintained. At this stage also, organizational procedures are revised and developed with organizational members trained in the new procedures and the IT application. The **Acceptance stage** involves the inducement of organizational members to commit to the IT application usage. In the **Routinization stage** usage of the IT application is encouraged as a normal activity. At the final stage, **Infusion**, increased organizational effectiveness is obtained by using the IT application in a more comprehensive and integrated manner to support higher level aspects of organizational work.

In the above model, the initiation is associated with Lewin's unfreezing stage; adoption and adaptation are associated with Lewin's change stage; and acceptance, routinization, and infusion are associated with Lewin's refreezing stage.

Source of Model		Phases						
Lewin/Schein (1952)	Unfreezing	Moving				Refreezing		
Kolb/Frohman (1970)	Scouting	Entry	Diagnosis	Planning	Action	Evaluation	Termination	
Kwon and Zmud (1987)	Initiation	Adoption				Adaptation	Acceptance	Use
Cooper and Zmud (1990)	Initiation	Adoption				Adaptation	Acceptance	Routinization
								Infusion

From the above table three generic phases can be distinguished. The levels of division into additional phases as in the Kolb/Frohman (1970) model can be considered as the identification of unique activities or events to be undertaken for the successful performance of any one of the three distinct phases. The generic phase identified through an analysis of the change and IS implementation models are **adoption** (decision to use e-learning-

involving all stakeholders), **implementation (post-adoption)** (physical construction or installation of the e-learning system) and **institutionalization (post-implementation)** (embedding the e-learning within the institution). Any decision to introduce e-learning into a HEI is believed to go through several processes notable among these are the initial decision to go for the specified e-learning (adoption), a construction or installation and configuration of the system for use (implementation), and embedding or routinizing the e-learning within the institution (institutionalization). The change and IS models discussed above however failed to note the possible existence of other processes within the distinct generic processes. This has often led to the complex nature of most e-learning implementations which sometimes ended up in failure. Cech & Bures (2004) contended that the development of the e-learning used in the course curriculum undergoes a unique process of its own within the institution. It is arguable therefore that most of the events/activities identified in each of the generic phases undergo their own processes within and alongside the generic ones. Table 1 shows the generic phases, the events in each phase and some factors that influence the effective outcome of each generic phase. The rest of the paper discusses findings from an empirical investigation of the nature, importance and influence of some of the factors identified to influence the successful outcome of each phase.

Table 1: Generic phases, the events in phase and some factors that influence the effective outcome of the generic phase

Generic Phase	Events	Factors for successful implementation
Adoption	Needs assessment and goal setting Stakeholder buy-in meetings ICT skills assessment and training e-learning readiness assessment e-learning policy development e-learning steering committee e-learning communication events	1. Management support 2. Stakeholder involvement 3. E-learning policy & Goal setting 4. Communication & Advertisement 5. ICT skills training
Post adoption	Developing e-learning framework Physical construction/installation of system e-learning content development e-learning staff training & development Infrastructural development e-learning technical support unit e-learning champions formation	1. Technical support 2. E-learning skills training 3. e-learning champions 4. resource availability 5. Infrastructure
Institutionalization	Establishment of e-learning quality team Integration into institutional policy and practices Integrating e-learning with teaching and learning Establishment of an online support system	1. Perceived management commitment 2. Integration with curriculum 3. Alignment with management and administrative practices 4. Included in policy planning and strategy formulation 5. Online support system

Table 2: Factors and their definition

Stages	Factor	Definition
Adoption	Management support (MS)	A top-down involvement of management through the commitment of resources throughout the project's lifespan.
	Stakeholder involvement (SI)	The inclusion of everyone whose role and responsibility is affected by the e-learning implementation in the decision making process
	E-learning policy and goal	A guiding document and clear target for the e-

Implementation	setting (PG)	learning initiative
	Communication & advertisement (CA)	The provision of relevant information to the stakeholder community aimed at educating, clarifying and gaining commitment.
	e-learning drivers (ED)	An initial assessment and equipment of stakeholders with fundamental knowledge and skills in ICT
	Technical support (TS)	A unit trained and equipped with the necessary resources to support the e-learning development and stakeholders' use of the system.
	E-learning skills training (ST)	Specific knowledge and skills in the management and use of the e-learning system including pedagogical considerations provided to relevant stakeholders
	e-learning champions (EC)	A group of enthusiasts motivated, inspired and self directed in the use of e-learning
Institutionalization	Resource availability (RA)	The availability of the requisite human, technical and financial resources relevant to the e-learning project.
	Infrastructure (IF)	The ready availability of the technological infrastructure necessary for an effective take-up of e-learning.
	Management commitment (MC)	The dedication of management to the overall success of the project.
	Integration with curriculum (IC)	A clear embedding of e-learning into curriculum indicated by a detailed alignment of technology use in teaching and learning
	Alignment with management and administrative practice (AM)	A seamless alignment with the day-to-day running of the institution
	Included in policy planning and strategy formulation (SF)	e-learning statements are fully and clearly integrated into policy and strategic statements and not as isolated statements
	Online support system (OS)	A support system available online 24-hrs a day for resolving stakeholders' problems and needs regarding the use of the e-learning system.

Performance Evaluation

The term Performance Evaluation has been defined variously in the e-learning literature. Used extensively in organisational management to assess employees' work output, achievement and ability (Dali, 2008), Performance Evaluation is a tool that serves the needs of programme evaluation in numerous fields such as education, project management, etc. in this paper we adopt Guskey's (2000) definition of evaluation cited in Hogan (2007) as, "... a systematic process used to determine the merit or worth of a specific programme, curriculum, or strategy in a specific context". Our definition of performance evaluation in the context of e-learning implementation process is, "a systematic process used to determine the extent to which an e-learning implementation meets set standards of acceptable implementation".

There are several classifications of evaluation in the performance evaluation literature. Notable among them are FitzPatrick et al (1983) classification of evaluation into 5 major clusters cited in Attwell (2006): Objective-oriented approach, Management-oriented approach, Consumer-oriented approach, Expertise-oriented approach and participant oriented approach. Attwell, (2006) made some modifications to these classification and added a sixth approach, Learning-oriented approach, from Van der Knapp cited in Attwell (2006). Other specific evaluation approaches have also emerged due to attention given the field by researchers and practitioners. Some of these include CIPP and CIRO (Hogan, 2007). Oliver (2000) also described five types of evaluation: Formative evaluation, Summative evaluation, Illuminative evaluation, Integrative evaluation, and auditive evaluation (evaluation for quality assurance). Compared to FitzPatrick et al's (1983) classifications of evaluation, Oliver's (2000) descriptions can best be considered as broad and general, providing an encompassing description depending on the objective(s) of evaluation. A cursory overview of FitzPatrick et al's (1983) classification is provided in the next paragraph.

The Objective-oriented approach bases on the idea that the purposes, goals, or targets of a project are determined at the start and that the evaluation process should establish whether these have actually been achieved, and if not, why not (Attwell, 2006; Hogan, 2007). The Management-oriented approach serves the needs of decision makers for information by focusing the evaluation products on the needs of managers, policy makers, administrators and practitioners (Attwell, 2006; Hogan, 2007). The Consumer-oriented approach adopts the perspective of the end user of whatever service or product is being provided (Attwell, 2006; Hogan, 2007). Expert-oriented approaches are based on the notion of 'connoisseurship' and criticism and rely heavily on the subjective professional judgement and expert knowledge of the evaluator (Attwell, 2006; Hogan, 2007). The Learner-oriented evaluation approach is aimed at contributing to some form of collective or organisational learning. The models in this approach are based on different theories and types of learning which includes corrective or behavioural learning, cognitive learning and social learning. The outputs and processes of the approach form the inputs of the learning. The Participant-oriented approach takes the needs of project participants as its starting point. The participants in this approach include all stakeholders and potential beneficiaries who may not be direct beneficiaries of the project (Attwell, 2006; Hogan, 2007). Although the intention is not to discuss in detail the various evaluation approaches, in the next paragraph we take a little closer look at the Participant-oriented approach because of its relevance to the study.

Attwell (2006) was of the view that that the Participant-orientated approach usually did not follow a formal plan which was drawn up in advance. The approach rather concentrated on identifying patterns in the data as the evaluation progressed. He argued that different techniques could be used to collect required data and that understanding was generated from observation and bottom-up investigation rather than rational deductive processes. He further opined that the role of the evaluator was therefore to represent multiple realities and values rather than singular perspectives.

The approach is however not without its criticisms as bureaucrats tend to hate it for its lack of 'objectivity', unpredictability of evaluation outputs, difficulty in costing and control, and the potential for the evaluation to degenerate into chaos and lack of focus (Attwell, 2006). Nonetheless, Performance Evaluation has several benefits for its users. Hogan (2007) contended that programme evaluation is utilized by organisations to periodically assess their processes, procedures and outcomes.

Methodology

The AHP model

Analytical Hierarchy Process (AHP) defined by Wikipedia as an approach to decision making that involves structuring multiple choice criteria into a hierarchy, assessing the relative importance of these criteria, comparing alternatives for each criterion, and determining an overall ranking of the alternatives. The AHP model uses pair-wise comparisons and then computes the weighting factors and evaluates. The method uses a reciprocal decision matrix obtained by pairwise comparisons so that the information is given in a linguistic form. In using the AHP, the decision problem is decomposed into a hierarchy of sub-problems and analysed independently. Comparisons are made between using concrete data about the elements involved. The AHP also takes into consideration human judgements in addition to the underlying information. The AHP converts these evaluations to numerical values that can be processed and compared over the entire range of the problem. A numerical weight or priority is derived for each element of the hierarchy, allowing diverse and often incommensurable elements to be compared to one another in a rational and consistent way. This capability distinguishes the AHP from other decision making techniques.

Sampling Method

The data was collected from e-learning participants selected from 9 Technical Training Institutes, 2 Polytechnics and 1 University across West, East and Southern Africa. In all 28 questionnaires were sent to at least two people from each institution. 11 of the participant from 6 institution responded. The choice of a small sample size will not influence the results because we are using AHP to analyse the data.

Results and Analysis

Consistency Ratio

The consistency ratio gives an indication of how consistent the weightings are. A higher value means less consistent and vice versa. Sambasivan and Fei, (2008) indicated that, a consistency ratio of 0.1 or less represent

an acceptable result. Table 3 shows consistency ratios of the various stages of the implementation process which were in the acceptable limits.

Table 3: Consistency Ratio for various stages

Phase	Consistency Ratio
Adoption (AD)	0.022
Post Adoption (PA)	0.057
Institutionalization (IN)	0.027
Overall Implementation	0.046

Priority Weights

The normalised scores were determined for level one and two which were used to rank the factors in order of importance. At level one, adoption with priority weights 0.4905 was found to be the most importance stage of the implementation. This was followed by Post Adoption (with priority weights of 0.3119) and then institutionalization with priority weights of 0.1976.

At level two the normalised score were obtained for the different factors under each stage of the implementation process. The relative order of importance is also determined for each stage. In the adoption stage the order of importance is as follows: MS (0.4847), SI (0.2268) PG (0.1431), CA (0.0880), and ED (0.0566). Under the Post Adoption stage the order of importance is TS (0.1001), ST (0.1453), EC (0.0546) RA (0.4161) IF (0.2838). The third stage of the process, Institutionalization was found to be MC (0.4232), IC (0.2547), AM (0.1413), SF (0.1163), OS (0.0644). Table 4 captures the priority weights as well as the global priority weights.

Table 4: Global priority weights of sub-factors relative to the goal (level zero)

Ranking Success	Factors	Priority weights	Global Priority weights
1	MS	0.4847	0.1677
2	SI	0.2268	0.1112
3	PG	0.1431	0.0446
4	CA	0.0880	0.0430
5	ED	0.0566	0.0278
6	TS	0.1001	0.0312
7	ST	0.1453	0.0453
8	EC	0.0546	0.0170
9	RA	0.4161	0.1298
10	IF	0.2838	0.0885
11	MC	0.4232	0.0836
12	IC	0.2547	0.0503
13	AM	0.1413	0.0279
14	SF	0.1163	0.0230
15	OS	0.0644	0.0127

Discussion of Results

The results of the priority weightings have shown that the most important of the three stages is Adoption. Within this stage, management support and commitment as well as stakeholder involvement have been the two key factors for successful implementation. This is because if the initial idea of e-learning is well accepted by all stakeholders the entire implementation becomes relatively easier. Management ability to effectively develop a suitable policy built on right drivers and more importantly communicate the e-learning idea will ensure that the right foundations are built for the next stage. Though the E-learning driver was the least important factor, it has been observed that a right driver could sustain management interest for the entire process. The concept of change will effectively be diffused in to an institution if the adoption stage is well implemented. Conscious effort should be made by management to own the process, with heads actively involved. From the performance

chart, it can be observed that management could provide initial support and commitment for the adoption stage, a sustained commitment is the greatest tool for a successful implementation.

The second most important stage is the Post Adoption stage. This is the main implementation stage. From the priority weightings, it can be deduced that the availability of resources is the most important factor at this stage. This factor is closely related to management commitment to the process. The readily availability of resources and the needed infrastructure will see to a smooth implementation of the process. More than 50% of respondents have indicated that their process had halted due to unavailability of resources which includes human resources, financial, and time. Provision of a regular adaptive training to an institution is also seen to be vital at this stage. This is because if the approach to training is not suitable to the institution, the process will suffer. The presence of a technical team to provide training and support is necessary to ensure continuity and improvement of the process.

The third most important stage is institutionalization. Though some authors argue it is the most important stage, the results obtained indicate otherwise. The key factor to guarantee a successful implementation is a continuous commitment of management. The ability to align the e-learning process with management and administrative practice can facilitate the institutionalization process. The centre of this stage is the curriculum integration. Therefore content development must be in line with e-learning for proper institutionalization.

It is important to note the interconnectivity of the factors. Factors including management commitment, communications, training runs through the entire process.

Performance Excellence Chart

A performance excellence chart which shows the different level of the selected factors can be drawn for the given results. This can be used to measure an institution's e-learning performance. Based on the results obtained from the analysis of the AHP model, ten of the factors have been chosen to establish a four level performance excellence chart. These are Management Commitment, Stakeholder involvement, Communication, drivers, Technical support, training, e-learning champions, Resource availability Infrastructure, and Curriculum integration. The choice of the ten factors was due to the fact that the remaining five are embedded in one of the selected ten. The result of the chart is shown in figure 2.

Four level performance excellence chart

Drivers	A sense of competition	A system for reaching many students	New trend of Education	Tool for improving quality of teaching and learning
Management Commitment	Approval without Participation	Approval with initial support and commitment	Management provide support but not involved in	Dedicated - showing direction and playing active role
Infrastructure	Unavailable technical infrastructure	Limited technical infrastructure	Available inferior technical infrastructure	Available quality technical infrastructure
Communication	Communicated only to people directly involved	Initial comm but ceases when progress is made.	Regular report of progress internally	Regular visible comm of progress (internal and
Training	Irregular training for only involved people	Regular and not adapted training for involved people	Irregular and adapted training for all	Regular and adapted training for all
Resources	Limited (10 -25%)	Average (25-50 %)	Adequate (50-75 %)	Most Adequate (100 %)
Technical support	An incompetent technical support team	A team for system maintenance	Efficient but Unreliable technical support team	A rapid response technical support team (24/7)
E –learning Champions	Available	Active	Self motivated	Passionate
Curriculum Integration	Less than 10% integration	Below Average (25-50%) integration	Above Average (25-50%) integration	Adequate (50 -100 % integration)
Stakeholder Involvement	Stakeholder Involvement is absent	Involvement of e-learning champions and technical team	Stakeholders involve in some aspect of implementation	Involvement of all relevant stakeholders

Fig 2: A four Level Performance Excellence Diagram

The developed performance chart was used to perform an e-learning gap analysis on one of the institutions. This is captured in the figure 3

Gap Analysis

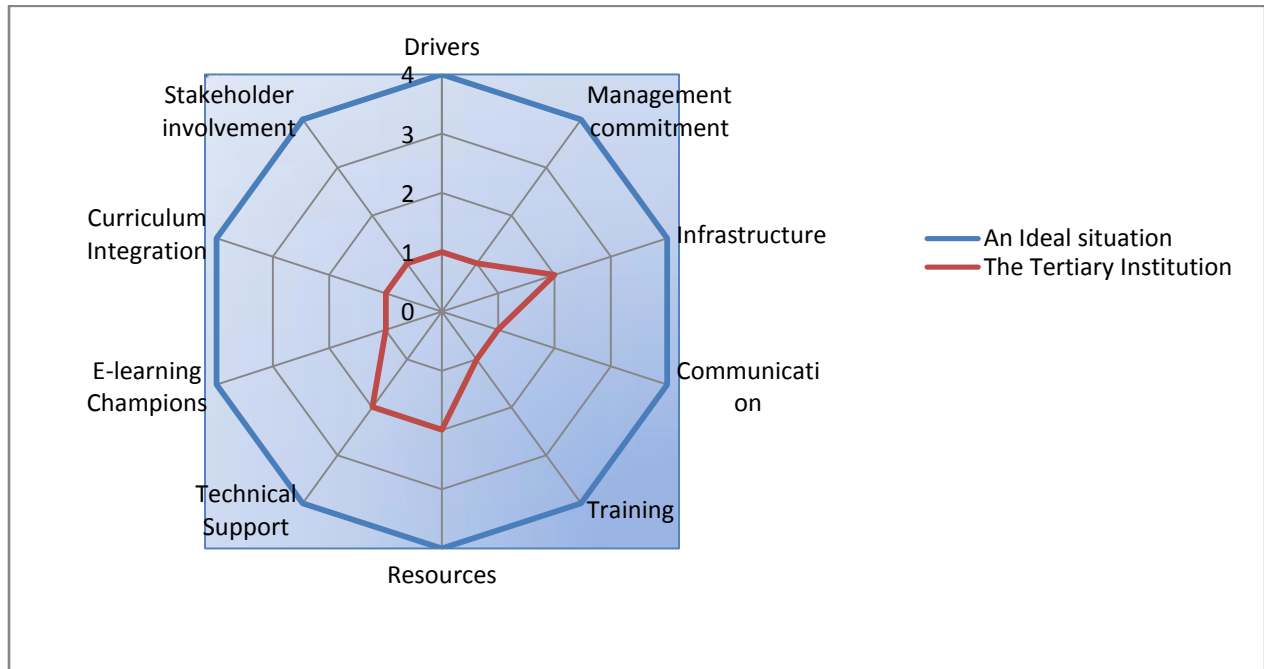


Fig. 3: Gap Analysis for a tertiary

Interpretation of Radar Chart (Gap Analysis)

Three inferences can be drawn from the radar chart;

- The area covered by the institution in question compared to the ideal situation on the chart shows how far the institution is from the ideal situation.
- The skewness of the institution's diagram to a factor shows how well the factor is being catered for.
- The regularity or irregularity of the diagram shows which factors are being neglected.

From the radar diagram above, clearly the tertiary institution in question has got a lot of work to do to ensure a better implementation of the E-learning process. The ideal result is the regular decagon. Comparing the area of the regular decagon (the ideal situation) and the irregular one (the case of the tertiary institution), it can be realised that there is significant difference. In totality, this tertiary institution is scoring 32.5% of the expected performance. May be this is because the chart didn't take into consideration the priority weights of the various factors. That notwithstanding, they are well below societal average.

Estimating E-Learning Implementation Levels

The Authors have developed a table for estimating the overall e-learning implementation success level. This was established by estimating Scale-Level Point (S-L Point) for all the factors. The S-L point is the product of the priority weight and the coded level as recorded on the performance excellence chart. The sum of the S-L points expressed as a fraction of the ideal total S-L point (8.4428) gives the overall e-learning implementation success level.

Table summarizing the S-L Point determination

Factors	Priority Weight (S)	Coded Level (1-4)	S-L Point (S*L)
Drivers	0.0566		
Management Support	0.4847		
Infrastructure	0.2838		
Communication	0.088		
Training	0.1453		
Resources	0.4161		
Technical Support	0.1001		
E-learning Champions	0.0546		
Curriculum Integration	0.2547		
Stakeholder Involvement	0.2268		

The sum of the S-L points can be used to determine the institution's overall e-learning implementation level using the BEE Equation below

$$\varpi = \frac{\sum SL \text{ points}}{8.4428} \times 100\%$$

Conclusion

Clearly, embedding e-learning in a HEI involves paying attention to distinct implementation phases all of which appears to be closely related. For instance, institutionalizing the e-learning within the HEI requires management support and commitment which needs to be prominently featured throughout the implementation process in a sustained manner. The analysis in the paper showed the adoption stage to be the most important. This suggests that the successful implementation of e-learning is heavily dependent on the adoption stage. Also the expected change at each stage can be attributed to the management of the each of the identified factors influencing the stage. The performance excellence diagram has also shown the different levels of the factors for e-learning. Though the gap analysis did not take the relative importance of the factors in to consideration it showed how far away institutional efforts at e-learning implementation were from the ideal levels.

Recommendations

Based on the results of the identified the following recommendations have been made for consideration for e-learning implementation:

- Institutions implementing e-learning should lay emphasis on the adoption phase
- A change management approach must be used throughout the implementation process
- Top management support and commitment should run through the entire process

References

- Attwell, G., (2006), Evaluating e-learning: A Guide to the Evaluation of e-learning, Evaluate Europe Handbook Series Volume 2
- Begičević, N., Divjak, B., & Hunjak, T., (2006), Development of AHP based model for decision making on e-learning implementation, http://scholar.google.com/scholar?q=Development+of+AHP+based+model+for+decision+making+on+e-learning+implementation&hl=en&as_sdt=0&as_vis=1&oi=scholar, Retrieved June 20th 2011.
- Biswas, P., & Ghosh, S. K., (2007), A Novel Approach to Define Performance Metrics for Students' and Teachers' Evaluation, The Electronic Journal of e-learning, Volume 5, Issue 2, pp 87 – 102
- Čech, P., Bureš, V., (2004), E-learning Implementation at University, Proceedings of 3rd European Conference on e-Learning, Paris, France, str.25-34,

- Chiu, H.Y., Chung, S.C., & Chen, A.P., (2007), Modeling e-Learning System Performance Evaluation with Agent-Based Approach,
- Dali, H., (2008), Design and Implementation of e-learning Performance Evaluation System, International Conference on Computer Science and Software Engineering
- Deepwell, F. (2007). Embedding Quality in e-Learning Implementation through Evaluation. *Educational Technology & Society*, 10 (2), 34-43.
- Fetaji B, and Fetaji M., (2009), "e-Learning Indicators: a Multi-Dimensional Model for Planning and Evaluating e-Learning Software Solutions." *Electronic Journal of e-Learning* Volume 7 Issue 2, pp 1 – 28
- Franklin, T., Armstrong, J., Oliver, M., & Petch, J., (2004), Towards an effective framework for the evaluation of e-learning, Downloaded from
- Greco, N., D'Impedovo, D., & Pirlo, G., (2006), Proceedings of the 6th WSEAS International Conference on Distance Learning and Web Engineering, Lisbon, Portugal
- Hogan, R. L., (2007), The Historical Development of Programme Evaluation: Exploring the Past and Future, *Online Journal of Workforce Education and Development*, Volume II, Issue 4
- http://www.google.com.gh/url?sa=t&rct=j&q=towards%20an%20effective%20framework%20for%20the%20evaluation%20of%20e%20learning&source=web&cd=1&sqi=2&ved=0CCwQFjAA&url=http%3A%2F%2Ffranklin-consulting.co.uk%2FLinkedDocuments%2Fframework_for_evaluation.doc&ei=DhxOT4DmJ6PN0QWm6qmeBQ&usq=AFQjCNFGa-Xyeur6JLj80X7yMZVyW4sXzw
- JOSÉ ANTONIO ALONSO (2006), Consistency In The Analytic Hierarchy Process: A New Approach, *International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems*, Vol. 14, No. 4 (2006) 445–459.
- Kocur, D. & Košč, P., (2009), e-learning implementation in higher education, *Acta Electrotechnica et Informatica* Vol. 9, No. 1, 2009, 20-26
- Lefoe, G. & Albury, R. (2006). Environments for change in a Faculty of Arts: The impact of teaching off campus *AACE Journal*, 14(3), 269-285.
- Masaaki Shinohara and Keikichi Osawa (2007) Consistency measure for the whole AHP decision making hierarchy, *ISAHp2007 Proceedings of the 9th International Symposium on the Analytic Hierarchy Process for Multi-criteria Decision Making* August 2-6, 2007 Viña del Mar, Chile [http://www.isahp.org/2007Proceedings/Papers/WorkingSessions/Math Subjects/Consistency measure for the whole AHP Hierarchy.pdf. Assessed on 21/11/11]
- McPherson, M., (2006), Organisational issues for e-learning: Critical success factors as identified by HE practitioners, *International Journal of Educational Management*, Vol 20, No. 7, pp 542 – 558
- Murali Sambasivan and Ng Yun Fei, (2008) Evaluation of critical success factors of implementation of ISO 14001 using analytic hierarchy process (AHP): a case study from Malaysia, *Journal of Cleaner Production* 16 (2008) 1424 – 1433
- Nichols, M., (2007), Institutional Perspectives: The challenges of e-learning diffusion, *British Journal of Educational Technology*, Vol. 39, No. 4, pp 598 - 609
- Sharpe, R., Benfield, G. & Francis, R. (2006). Implementing a university e-learning strategy: levers for change within academic schools. *The Association for Learning Technology Journal*, 14, 2, 135–152
- Singh, G., (2010), Examination of Adoption and Diffusion of eLearning: A Comparative Case Study Using Giddens's Theory of Structuration, *International Journal of Arts and Sciences* 3(14): 351 – 362
- Stiles, M., (2003), Embedding e-learning in a higher educational institution, www.staffs.ac.uk/COSE/cosenew/ati2stilesrev.pdf, Retrieved May 20th 2011

RESPONSE OF COCKERELS TO DIETS CONTAINING DIFFERENT LEVELS OF SHEANUT CAKE

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Abstract

A four-week on-farm-feeding trial was conducted to evaluate the response of 120 Ross 308 cockerel chicks to diets containing sheanut cake (SNC). Three isonitrogenous and isocaloric diets represented as SNC 0%, SNC 5%, and SNC 10% were fed in a completely randomized design (CRD). Measured parameters were body weight, weight gains, and feed intake. Also, feed conversion efficiency and feed cost per kilogram diet were calculated. Hematological parameters were also obtained after the 28-day trial. A reduction in performance was observed with inclusion of SNC into the diets. Weight gain, feed conversion efficiency (FCE) and final body weight reduced significantly ($P > 0.05$) with addition of SNC. However, feed cost per kilogram weight reduced with inclusion of SNC. The highest feed consumption was recorded among birds offered diets containing 10% SNC. The health of the birds was not affected by dietary treatments. It was therefore concluded that though performance of birds was significantly hampered in this experiment, SNC could still serve as a potential replacement for cotton seed cake in cockerels' diet during periods of scarcity.

Keywords: Cockerel; Performance; Blood parameters; Sheanut cake.

Introduction

A major problem facing the poultry industry currently is the high costs of poultry feeds resulting from the soaring costs of conventional feed ingredients (Mmereole, 2008). Feed cost for non-ruminant animals such as pigs and poultry accounts for between 70 and 80% of the total recurrent cost of production (Osuwari *et al.*, 1995). In Ghana and some other low-income, food deficit countries (LIFDC) most poultry farms have shut down due to high costs of poultry feeds (Ekenyem, 2007), thereby escalating the animal protein deficiency crisis already existing.

Alternative feed resources which are cheap, abundant and not in competition with other large scale demands, must be sourced for. In the past decades, studies have been carried out to identify alternative and non-conventional feed resources which are cheap and easily available for poultry production (Aduku, 1993; Esonu *et al.*, 2003). Consistent increase in prices of some available feed ingredients that are protein and energy sources has stimulated huge research interests into numerous underutilized feed resources. Agro-industrial by-products such as SNC could be used to spare these conventional feed ingredients in poultry diets because of their low price and availability.

Sheanut cake is a by-product obtained during the processing of shea (*Butyrospermum parkii*) nuts to produce sheanut butter. The SNC which is made available after extraction is a material that has attracted the attention of scientists and animal nutritionists. Atuahene *et al.* (1997) investigated SNC for its nutritional quality. Chemical analyses of the cake indicated its overall nutritional value to be high. The crude protein, fat, fibre, ash, nitrogen free extract and metabolizable energy contents were 162.4 g kg⁻¹ DM, 134.0 g kg⁻¹ DM, 95.0 g kg⁻¹ DM, 42.0 g kg⁻¹ DM, and 7.12 MJ kg⁻¹ DM, respectively.

This experiment was therefore conducted with the objective to find out the usefulness of SNC in cockerels' diet.

Materials and Methods

The experiment was conducted at K.D. Yeboah Farms in Ashanti Mampong, Ghana. One hundred and eighty, 4-week old cockerels (Ross 308) were used in this study. The recommended medications and vaccines were administered to ensure good health of the experimental birds. At four weeks of age, the birds were weighed and divided into three groups in a completely randomized design. There were three replicates of fifteen birds in each group making a total of 45 birds per treatment. The feed was formulated with SNC to replace cotton seed cake in the diets at 0, 5, and 10% (Table 1). Feed and water were supplied *ad libitum* throughout the experimental

period. Birds were weighed weekly. Growth rate, feed conversion ratio and mortality were monitored. The cost benefit of feeding SNC was calculated at the end of the study. Blood samples were obtained from two birds from each replicate at the end of the experiment. A new sterile syringe was inserted into the wing vein of each selected bird and 2 mls of the blood extracted which was placed inside sterile test tubes containing Ethylene Diamine Tetra Acetic Acid (**EDTA**). Then the blood samples were analyzed for packed cell volume (**PCV**), hemoglobin (**Hb**), white blood cell (**WBC**), red blood cell (**RBC**), mean corpuscular volume (**MCV**) and mean corpuscular hemoglobin concentration (**MCHC**), mean corpuscular hemoglobin (**MCH**) and lymphocytes (**LYM**). Data collected were subjected to analysis of variance and the significant differences between treatment means were determined at 5% confidence level (SAS, 1999). Differences between means were determined by the use of the Duncan's Multiple Range Test (Steel *et al.*, 1997).

Results and Discussion

Treatment effects on growth, hematology and economics of production are presented in Tables 2, 3 and 4 respectively.

Final weight and weight gain declined significantly ($p < 0.05$) with inclusion of SNC. Olorede *et al.* (1997) also reported poor growth rate of broilers fed 15% SNC based diet in a similar experiment. Efficiency of feed utilization decreased with addition of SNC to diets. Regarding daily feed intake (**DFI**), it was clear that compared with control, SNC inclusion at 5 or 10% significantly increased DFI. The poor growth performance of birds fed shea nut meal diet was expected as has been shown in previous studies (Olorede *et al.*, 1999). This could be attributed to the relatively high concentrations of tannins in sheanut (Okai *et al.*, 1995). For instance, broilers fed diet containing the sheanut meal fermented with *A. niger* had an improved growth performance that was 82% of the control birds and feed efficiency in the mentioned study was 86% of the control. The depression in growth performance of birds fed the unfermented sheanut meal was attributed to the effects of residual tannins which make digestion of protein difficult (Annongu *et al.*, 1996; Smulikowska *et al.*, 2001). Tannins combine with proteins, including enzymes in the gastro intestinal tract and thereby negatively inhibit the digestibility of proteins (Jansman *et al.* 1995), thus reducing the chick's growth rate and the efficiency of feed utilization. Iji *et al.*, (2004) also in a similar experiment discovered that high dietary tannins resulted in reduced weight gains and poor feed efficiencies in birds. The experimental treatments did not have any significant effect on health of the birds ($P > 0.05$). In this experiment, all the blood parameters fell within the normal range reported by Pampori (2003). This observation suggests that the health of the birds were not compromised. The cause for the mortalities recorded in this study according to postmortem examination was not clear, since all the organs of the birds were normal.

Table 1: Percentage Composition and Analysis of Experimental Diets.

Ingredients	0% SNC	5% SNC	10% SNC
Maize	55	55	55
Cotton seed meal	15	10	0
Copra cake	13.5	13.5	13.5
Sheanut cake	0	5	10
Fishmeal	4	4	4
Wheat bran	10	10	10
Oyster shell	1.5	1.5	1.5
Vitamin/mineral premix	0.5	0.5	0.5
Salt	0.5	0.5	0.5
Calculated Composition (% DM)			
Crude protein	18.10	17.20	18.21
Crude fiber	4.90	5.05	6.69
Ash	4.55	4.00	4.44
Ether Extract	5.18	4.02	6.20
Calcium	3.10	3.21	3.23
Available phosphorus	0.32	0.29	0.30
Lysine	0.69	0.60	0.63

Methionine	0.27	0.24	0.26
ME (Kcal/kg)	2119	2111	2108
Proximate Composition (% DM), except ME			
Crude protein	17.31	17.90	16.99
Crude fibre	7.74	6.56	5.35
Ash	3.50	5.00	5.09
Ether extract	2.50	2.00	1.00
Moisture	14.00	13.50	13.00
Nitrogen Free extract (NFE)	54.96	55.04	58.76

**Composition of vitamin/mineral premix per kg: Vitamin E, 25mg; Vitamin A, 6250 IU; Vitamin D3, 1250 IU; Vitamin K3, 25mg; Vitamin B1, 25mg; Vitamin B2, 60mg; Vitamin B6, 40mg; Vitamin B12, 2mg; Elemental calcium, 25mg; Elemental phosphorus, 9mg; Elemental magnesium, 300mg; Iron, 400mg; Selenium 1.0mg, Iodine 20mg, Copper 60mg, Magnesium 100mg, cobalt 10mg, Zinc, 150mg; Sodium Chloride, 1.5mg; Choline Chloride, 500mg; Live Lactobaccillus spore, 0.2 million cfu; Niacin, 40mg; Folic Acid, 10mg; d-Biotin, 5mcg.*

Table 2: Effect of Experimental Diets on performance of Birds

Variable	0% SNC	5% SNC	10%SNC	SEM
Mean Initial Body Weight (g/bird)	117.5	117.2	118.7	1.2
Mean Final Body Weight (g/bird)	281.4 ^a	251.8 ^b	257.5 ^b	6.1
Mean Final Weight Gain	163.9 ^a	133.8 ^b	139.5 ^b	6.2
Mean Feed Intake (g/bird/day)	30.9 ^a	36.8 ^b	39.6 ^b	2.0
FCE (Feed/Gain)	0.2 ^a	0.3 ^b	0.2 ^a	0.0
Mortality (%)	0.3	0.3	0.0	0.4

^{ab}: Treatment means with different superscripts within the same row are significantly different at $P < 0.05$

SEM – Standard Error Mean

Table 3: Effect of Experimental Diets on Blood Variables

Parameters	0% SNC	5%SNC	10% SNC	SEM
WBC ($\times 10^3/\mu\text{L}$)	9.1	10.0	9.0	0.9
RBC ($\times 10^6/\mu\text{L}$)	1.8	2.4	1.7	0.2
HGB (g/dL)	9.4	11.3	8.7	0.4
HCT (%)	19.8	25.6	19.4	3.2
MCV (fL)	109.6	110.9	115.5	3.8
MCH (pg)	52.8	44.7	52.2	2.8
MCHC (g/dL)	48.6	40.6	45.2	3.7
LYM (%)	97.6	94.6	98.4	0.4

^{ab}: Treatment means with different superscripts within the same row are significantly different at $P < 0.05$

SEM – Standard Error Mean

Table 4: Costs and Benefits of Feeding Birds with Different Diets.

Parameters	SNC 0%	SNC 5%	SNC 10%
Feed cost/kg (GH¢)	0.9	0.7	0.8
Feed intake (g/bird/day)	30.9	36.8	39.6
No of days on feed	28	28	28
Total cost of feed over the period/bird (GH¢)	0.7	0.7	0.8
Price of bird at 8 weeks (GH¢)	1.0	1.0	1.0
Net revenue/bird (GH¢)	0.3	0.3	0.3

NOTE: US\$ 1.0 = GH¢ 1.5

The feed cost per/kg decreased with inclusion level of 5% SNC (Table 4). Birds fed on 10% SNC diets recorded the highest feed cost as a result of the high intake of this diet. There was 1.4% reduction in feed cost with 5% inclusion of SNC during the experimental period. Feed cost however increased by 10.8% with 10% inclusion of SNC.

Conclusion

Sheanut cake is potentially valuable protein supplement that can be included in diets for cockerels, replacing 10% of cotton seed cake. At this level of inclusion acceptability of the diet containing SNC was not affected. However, weight gain and efficiency of feed utilization were negatively affected. Nevertheless, during periods of scarcity of cotton seed cake, SNC could serve as a potential substitution for cockerels.

Acknowledgements

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Reference

- Aduku, A.O. (1993). Tropical Feed Stuff Analysis. Pluto Publ. Zaria, pp: 28.
- Annongu, A.A., Termeulen, U. Atteh, J.O. and Apata, D.F. (1996). Toxicological assessment of native and industrial fermented shea butter cake in nutrition of broilers. Arch. Gefluegelkd. 60:221–226.
- Atuahene, C.C., Donkoh, A., Asante, F. (1997). Value of sheanut cake as a dietary ingredient for broiler chickens. Animal Feed Science Technology 72: 133-142.
- Ekenyem, B.U. (2007). Effect dietary inclusion of *Ipomea ascarifolia* Leaf meal on the performance of carcass and organ characteristics of grower pigs. Advances in Sci. Technol., 1: 87-91.
- Esonu, B.O., Ihekumere, F.C., Iwuji, T.C., Akanu, N. and Nwugo, O.H. (2003). Evaluation of *Microdesmis puberula* leaf meal as a feed ingredient in broiler starter diets. Nig. J. Anim. Prod., 30: 3-7.
- Iji, P.A., Khumalo, K., Slippers, S. and Gous, R.M. (2004). Intestinal function and body growth of broiler chickens on maize-based diets supplemented with mimosa, tannins and microbial enzyme. J. Sci. Food Agric. 84:1451–1458.
- Jansman, A.J., Verstegen, M.W.A., Huisman, J. and Van den Berg, J.W. (1995). Effects of hulls of faba beans (*Vicia faba* L.) with low or high content of condensed tannins on the apparent ileal and fecal digestibility of nutrients and the excretion of endogenous protein in ileal digesta and feces of pigs. Journal of Animal Science 73: 118-127.
- Mmereole, F.U.C. (2008). Effects of replacing groundnut cake with rubber seed meal on the haematological and serological indices of broilers. In. J. Poult. Sci., 7: 622-624.
- Okai, D.B., Topps, J.H., English, P., Tuah, A.K. and Osafo, E.L.K. (1995). The effects of processed sheanut cake and groundnut skins on the growth performance and organ characteristics of rats. Ghana Journal of Biochemistry, Biotechnology and Molecular Biology 3: 76-82.
- Olorede, B.R., Longe, O.G. and Babantunde, G.M. (1997). Growth performance, organs measurement and economics of production of broiler chickens fed a high shea butter cake diet supplemented with fish meal or groundnut cake. Int. J. Anim. Sci. 14:203–207.
- Olorede, B.R., Longe, O.G. and Babantunde, G.M. (1999). Growth performance, organs measurement and economics of production of broiler chickens fed a high shea butter cake diet supplemented with fish meal or groundnut cake. International Journal of Animal Science, 14: 203-207.
- Osuwari, B.M., Sese, B.T. and Mgbere, O.O. (1995). The effect of whole palm kernel on the performance and production cost-Energy protein ratio. Int. J. Anim. Sci., 10: 115-120.
- Pampori, Z.A. (2003). Field Cum Laboratory Procedures in Animal Health Care. Delhi. Pp 172-173
- Smulikowska, S., Pastuszewska, B., Swiech, E., Ochtabinska, A., Mieczkowska, A., Nguyen, V.C. and Buraczewska, K. (2001). Tannin content affects negatively nutritive value of pea for monogastrics. J. Anim. Feed Sci. 10:511–523.

- Statistical Analysis Systems Institute Inc., (1999). SAS/STAT: User Guide Version and for window. SAS Institute Inc. Cary-NC. USA.
- Steel, R.G.D., Torrie, J.H. and Dickey, D.A. (1997). Principles and Procedures of Statistics. A Biometrical Approach. 3rd Edn. McGraw-Hill, New York.

SOLID WASTE CHARACTERIZATION AND RECYCLING POTENTIAL FOR A HIGHER EDUCATION INSTITUTION: A CASE STUDY OF KOFORIDUA POLYTECHNIC.

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Abstract

Academic institutions of higher learning have the moral and ethical obligation to act responsibly towards the environment; they would be expected to be leaders in the movement for environmental protection and creating value for the waste. The aim of this study was to establish the quality and quantity of daily solid waste generated within the polytechnic community (including residency on campus) through solid waste sampling and characterization of samples. The data captured was then analyzed to evaluate the waste recovery and recycling potential of campus waste. The study revealed that, 1.86 tons of solid waste is generated daily on average basis with per capita generation of 0.37kg. A significant component of the polytechnic waste stream showed a high recycling potential. The percentages by weight of recyclable, potential recyclable and non-recyclable were 46%, 33%, 21% respectively. The paper also highlights the some approach to harness the recycling potential of campus waste and alternatives for waste reduction at source have been recommended as ways for integrated waste management on campus base on the waste hierarchy.

Keywords: waste characterisation, recycling, biogas production.

Introduction

With the ever growing importance of environmental issues in the world, coupled with improved living conditions means a lot more focus has to be placed on appropriate and effective methods of dealing with waste generated by growing population.

Solid waste being a direct consequence of the daily activities of our societies, it is important to understand how their main characteristics evolve quantitatively and qualitatively in time. Solid waste characterization data are important for decision making of an effective solid waste management model mainly in what concerns the collection, transport and treatment of the solid waste. An effective solid waste management must be based on the knowledge of the waste composition of the generating source. Solid waste composition data must be a true reflection of condition of waste components at generating source. Modern waste management practice with its emphasis on using waste reduction, reuse, recycling and composting for diverting waste from waste disposal facilities, relies on information about the composition of the waste stream in order to identify products or materials which should be targeted for diversion. Waste diversion of sanitary landfill increases its useful life and reduces the large demand of space for landfilling. Knowledge of both waste quantities and waste composition is useful for monitoring progress towards achieving waste reduction or waste diversion objectives. With the many benefits that proper waste management brings, establishing a proper waste system is a herculean task.

In Ghana, as in many other African countries the situation of waste management, a major component of environmental sanitation, has over the years been a major headache of successive central government and local authorities. Ghana, with a population of about 23million generates approximately 4.5million metric tons of solid waste a year. (Agyepong, J. S, 2011). Generally waste management in Ghana is the responsibility of the Ministry of Local Government and Rural Development (MLGRD). They take care at the national level; providing policy and technical guidelines. The Environmental Sanitation Policy guides waste management practices in Ghana. Solid waste service providers in Ghana provide services of street sweeping, collection and transportation of waste to final disposal sites. Metropolitan, Municipal and District Assemblies (MMDA's) are the key institutions responsible for waste management service provision at the local and community level. There are private service providers in the waste management sector. This has brought about improved effectiveness, efficiency, integration and accountability.

Waste valorization and waste generation minimization are part of an integrated waste management. Waste characterization helps in efficient treatment of waste. The segregation of solid waste at generating sources has not been habit of Ghanaians as the same for the understudied case study-Koforidua Polytechnic.

In line with an integrated and sustainable management of solid waste provided an opportunity for a solid waste characterization study. Our purpose of characterizing solid waste been sent to dump site identified products or materials which should be targeted for reduction, recycling and composting. The characterizations allowed us

develop a useful and interesting data on the waste stream which needs to be diverted to reduce landfill waste from the campus.

Methodology

There are various methods that could have been used in the collection of data on solid waste. But of these methods the cost effective and methodology that gives a true representation of individual component was direct waste analysis. The methodology employed (direct waste analysis), quantified waste generated within the polytechnic community. The direct waste analysis was used in the data gathering of waste generated at various sources. The solid waste characterisation study consisted of three main stages:

- Solid waste sampling and characterisation
- Estimation of waste generation on daily basis
- Data analysis on waste generator sources
- Recommended approaches to harness the very best from the waste generated on campus in ensuring environmental sustainability and useful lifespan of the polytechnic dumpsite.

Solid Waste Sampling and Characterisation

Solid waste generated was quantified through sampling and collection of solid waste samples from various generator sources in the polytechnic community. In waste characterisation study, sampling stage helps capture representative waste samples. Samples were collected from various point of waste generation. These points of generation were *administration block, outdoor litre bins, bush canteen* and *SRC cafeteria*. These points of generation were selected since they are correct representation of the polytechnic activities. Solid waste samples were analysed for five consecutive days excluding Saturdays and Sundays. Trial sampling was conducted at each source before main sampling. This trial sampling aided for data collection and for the identification of the solid waste categories to be sorted into. The collected samples were sorted into waste categories and weighed. The waste categories used in the study were: *Papers and Cardboards, Glass and Metals, Rubbers and Plastics, Organic* and *Other waste not categorised*. Waste characterisation data are influenced by periods within a season and population of persons within the area. The data gathered during this study was within the period of April to May of the second semester 2010/2011 academic year. The possible sources of error in the study were; not all waste generated were dumped into assigned bins. Also the weighing scale used had an accuracy of $\pm 0.002\text{kg}$.

Table 1.0: Waste Categories or Composition of Waste Streams.

Waste streams					
Paper & Cardboards	Organic waste	Glass and Metals	Rubbers and Plastics	and	Other waste
Office papers	Food leftovers	Aluminium packaging	Plastic packaging		Sand, Textile
Newspapers	Kitchen waste	Ferrous metals packaging	Polythene products		Wood
Magazines	Garden waste	Glass packaging	Rubber packaging	Sachet	Batteries
Tissue papers Glossy papers					Leather Electrical and Electronic
Other cardboard					Any waste that does not fall in the other categories.

Estimation of Waste Generation Rate

Solid waste generation rate per persons was estimated base on the total of average weight of waste streams collected during the period of characterisation and population of persons. The sum of average weight of each waste streams (*Papers and Cardboards, Glass and Metals, Rubbers and Plastics, Organic* and *Other waste not categorised*) aided in the estimation of daily waste generation. The waste generation potential of the polytechnic was dependant on several factors. The most important was the population size. This factor influenced the generation of several categories of waste, including organic wastes, plastics and rubbers packaging products. Season also contributed to rate of solid waste generation.

$$W_R = \frac{A_{wd}}{N_s}$$

W_R is waste generation rate in $\text{kgp}^{-1}\text{d}^{-1}$ (kilogram per person-day)

A_{wd} is the average total waste generated per day

N_s is the number of people on campus

Each category or compositions of waste stream were also recorded in a Microsoft office spreadsheet. The percentage composition of each category of waste stream was calculated using the equation:

$$P_s = \left(\frac{M_l}{M_T} \right) * 100$$

Where:

P_s is the percentage of composition in waste stream

M_l is the category amount in kg

M_T is the total amount of waste streams in kg.

Results & Discussions

From the waste composition table by weight and percentage (%) of waste sources (Table 2.0), total amount of waste generated by weight was 600kg (i.e. total waste generated at administration block, bush canteen, SRC cafeteria and outdoor litter bins. The waste composition studies carried out indicated that, waste generation rate of $118.72\text{person}^{-1}\text{day}^{-1}$. The estimated number of persons based on the polytechnic's population was 5054.

Calculation of the generation rate is shown below:

$$W_R = \frac{A_{wd}}{N_s}$$

W_R is waste generation rate in $\text{kgp}^{-1}\text{d}^{-1}$ (kilogram per person-day)

A_{wd} is the total amount of waste generated per day

N_s is the number of persons on campus = 5054 persons

$$\text{Waste generation rate per day } W_R = \frac{600\text{kg}}{5054\text{persons /day}}$$

$$W_R = 0.118718\text{kg/person} \approx 118.72\text{person}^{-1}\text{day}^{-1}.$$

	Administration Block		Bush Canteen		SRC Cafeteria		Outdoor Litter bins	
Waste Categories	Weight (kg)	Percentage %	Weight (kg)	Percentage %	Weight (kg)	Percentage %	Weight (kg)	Percentage %
Papers and Cardboards	29.41	42.99	20.2	7.68	4.49	9.27	39.57	17.97
Glass and Metals	4.22	6.17	7.05	2.68	7.32	15.12	29.68	13.48
Rubbers and Plastics	7.07	10.33	41.21	15.67	5.2	10.74	85.92	39.02

<i>Other waste not categorised</i>	3.32	4.85	12.15	4.62	3.42	7.06	9.31	4.23
<i>Organic</i>	24.39	35.65	182.38	69.35	27.98	57.8	55.71	25.3
TOTAL FROM SOURCE	68.41	100	262.99	100	48.41	100	220.19	100
TOTAL WASTE GENERATED 600kg								

Table 2.0: Weight and percentage (%) composition of solid waste generated at the administration block, Bush Canteen, SRC Cafeteria and Outdoor litter bins.

Waste generated from sources.

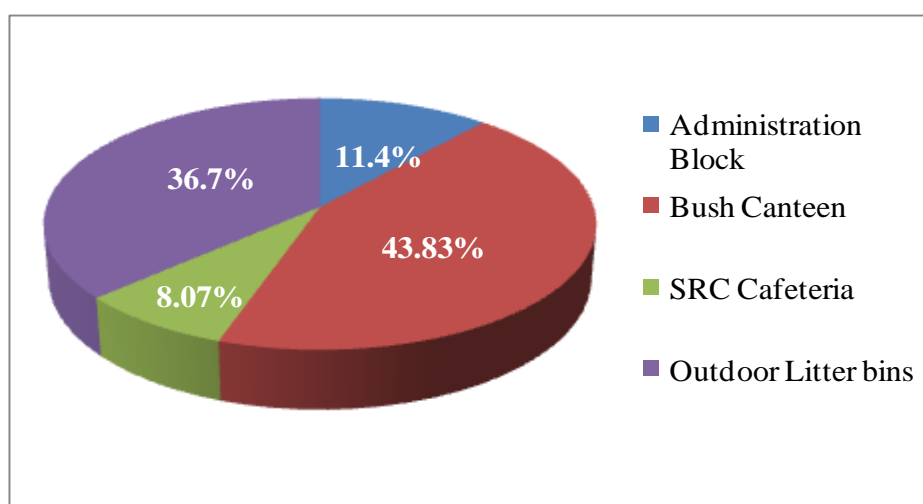


Figure 1.0: Percentage contribution of waste by weight from generation sources

Figure 1.0 illustrates the percentage contribution from generation sources by weight contributing to the daily total waste generated. From the figure above bush canteen contributed 43.83% by weight being highest of the total waste generated on campus. The second highest contributor or generation source was outdoor litre bins being 36.7%. Least among the sources was SRC cafeteria being 8.07%. Percentage contribution varies from sources due to activities and number of persons per time. These basic factors contributed to the variation in percentages of waste generation sources. The table below shows the weight equivalence in kg of waste generated from studied sources.

Table 3.0: Waste sources composition by percentage and weight.

Generation Sources	Composition (kg)	Composition (%)
Administration Block	68.41	11.4
Bush Canteen	262.99	43.83
SRC Cafeteria	48.41	8.07
Outdoor Litter bins	220.19	36.70
Total	600	100

Administration Block

Table 4.0: Administration Block waste categories by weight (kg) and percentage (%).

Waste Categories	Composition (kg)	Composition (%)
Papers & Cardboards	29.41	42.99
Glass & Metals	4.22	6.17
Rubbers & Plastics	7.07	10.33
Other waste not Categorised	3.32	4.85
Organic	24.39	35.65
Total	68.41	100

Waste generated at administration was mainly papers and cardboards. This waste category predominance in this area clearly shows the administrative activities occurring at the administration block. This data is a true reflection of activities occurring at the area. Papers and cardboards constitute 42.99% of solid waste generated at this location. The organic category of solid waste was due to a restaurant facility operating within the administration. The organic category forms the second largest constituent of 35.65%. The components of solid waste organic category were food leftovers, fruit and vegetable peels, bones, etc. Rubbers and plastics category has components of bottled plastic water packing, food packaging, drinks and bottled drinks and beverages of plastic packaging. Glass and metals components were mainly can drinks and bottle drinks. The other waste not categorised forms 4.85% of the solid waste generated been the least among the waste categories from the administration block.

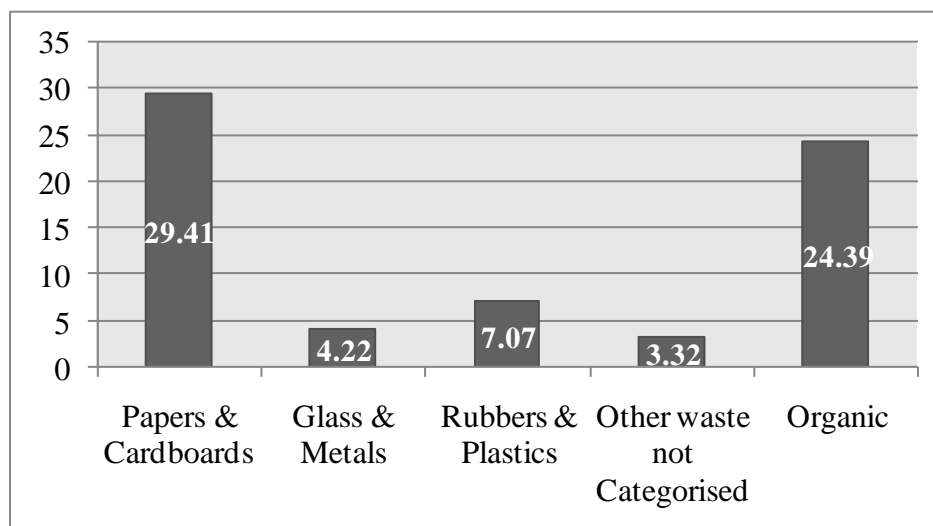


Figure 2.0: Composition of solid waste by weight generated at the Administration Block.

Bush Canteen

Waste categories	Composition (kg)	Composition (%)
Papers & Cardboards	20.2	7.68
Glass & Metals	7.05	2.68
Rubbers & Plastics	41.21	15.67
Other waste not Categorised	12.15	4.62
Organic	182.38	69.35
Total	262.99	100

Table 5.0: Bush Canteen waste categories composition by weight (kg) and percentage (%).

The bush canteen is the major generator of solid waste on campus. The amount of solid waste generated at this source is about 262.99kg. The bush canteen contributes about 43.83% of the total waste generated on campus. The activity at this source is usually food and drinks selling to persons. It has a high patronage due to availability. From Table 5.0, the waste category forming the main constituent is organic depicting the real activity occurring at this source. The organic component of solid waste generated at the bush canteen forms about 69.35% of the total solid waste generated at this source. With lifestyles on campus, students consume rubber and plastic packaging products being also the second largest category of solid waste generated at the bush canteen. Glass and metals form the least category due to price of glass and metal packaging products. With this, they are consumed less at sources with high students' patronage. Glass and metals have composition by weight of 7.05kg and by percentage of 2.68% of the total waste generated at the bush canteen. For rubbers and plastics waste generated at bush canteen, the major component is sachet water packaging.

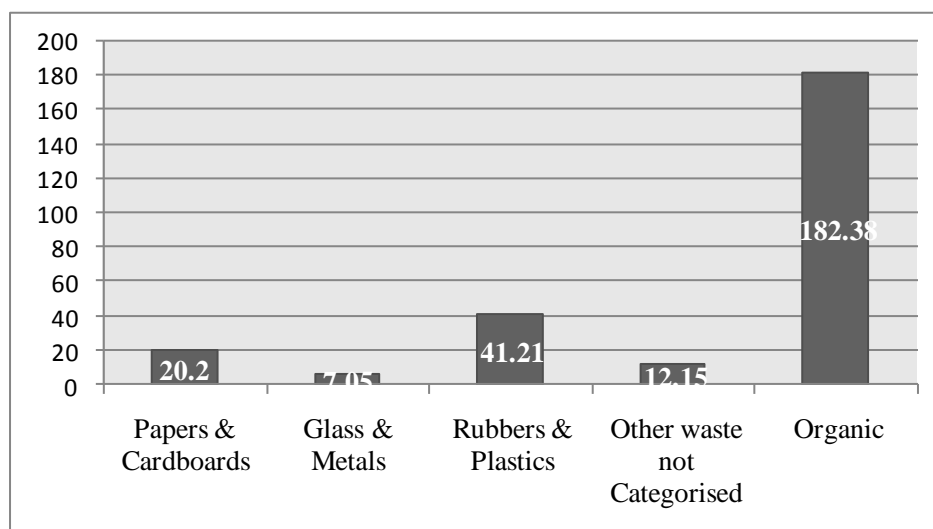


Figure 3.0: Composition of solid waste by weight generated at Bush canteen.

SRC Cafeteria

The SRC cafeteria facility provides catering services to both the students and other populace on campus. The services provided by this facility is quite expensive compared to that of the bush canteen. With this the bush canteen enjoys high patronage than SRC cafeteria. The SRC cafeteria contributes 8.07% of the total waste generated daily on campus. Table 4.0 shows the composition of solid waste by weight generated at SRC cafeteria.

Waste categories	Composition (kg)	Composition (%)
Papers & Cardboards	4.49	9.27
Glass & Metals	7.32	15.12
Rubbers & Plastics	5.2	10.74
Other waste not Categorised	3.42	7.06
Organic	27.98	57.8
Total	48.41	100

Table 4.0: Composition of solid waste by weight generated at SRC Cafeteria.

Table 3.0 shows that organic waste forms the major component of also their waste produced, being 27.98kg by weight and 57.8% percentage. The major component being organic also demonstrates the main activity of catering services occurring at this source. Glass and metals form the second highest component of 7.32kg by weight and 15.12% by percentage. Glass and metals forms the second highest percentage as it is highly consumed by people using the cafeteria. Cans and bottle packaged products were consumed more at SRC cafeteria compared to bush canteen. Class and lifestyle of people attending the SRC cafeteria enjoy food with

bottled and canned beverages or drinks. For rubbers and plastic waste produced at the cafeteria are mainly plastic bottle water and food packaging rubbers compared to bush canteen.

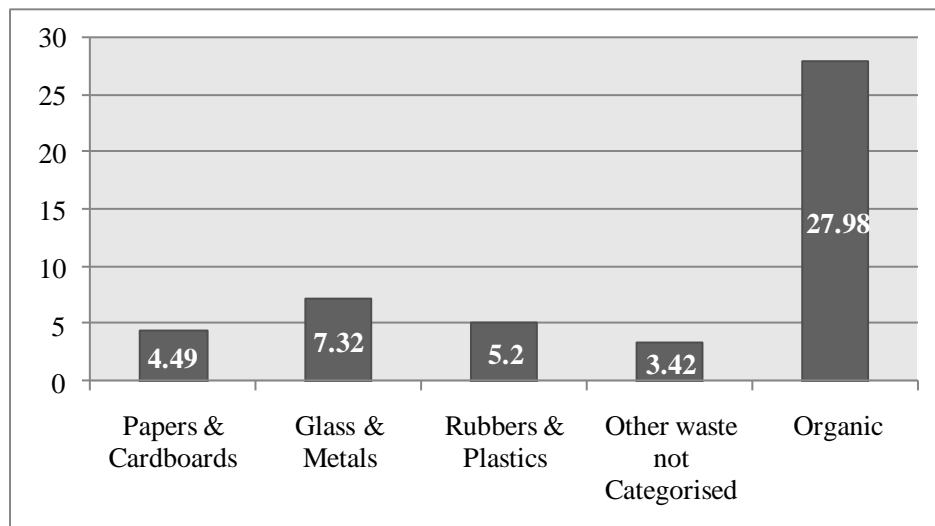


Figure 4.0: Composition of solid waste by weight generated at SRC Cafeteria.

Outdoor Litter Bins.

Outdoor litter bins are receptacles placed on various points on campus. They are no difficult to be sited. Outdoor litter bins on campus have prevented littering of waste on campus. Outdoor litter bins contribute second highest generator of waste on total basis of solid waste generated daily on campus. Outdoor litter bins contribute 220.19kg with 36.70% equivalent percentage out of 600kg of solid waste generated daily on campus. Summary of waste composition of outdoor litter bins is shown in Table 5.0 and Figure 5.0.

Table 5:0 Composition of solid waste by weight from Outdoor litter bins.

Waste categories	Composition (kg)	Composition (%)
Papers & Cardboards	39.57	17.97
Glass & Metals	29.68	13.48
Rubbers & Plastics	85.92	39.02
Other Waste not categorized	9.31	4.23
Organic	55.71	25.3
Total	220.19	100

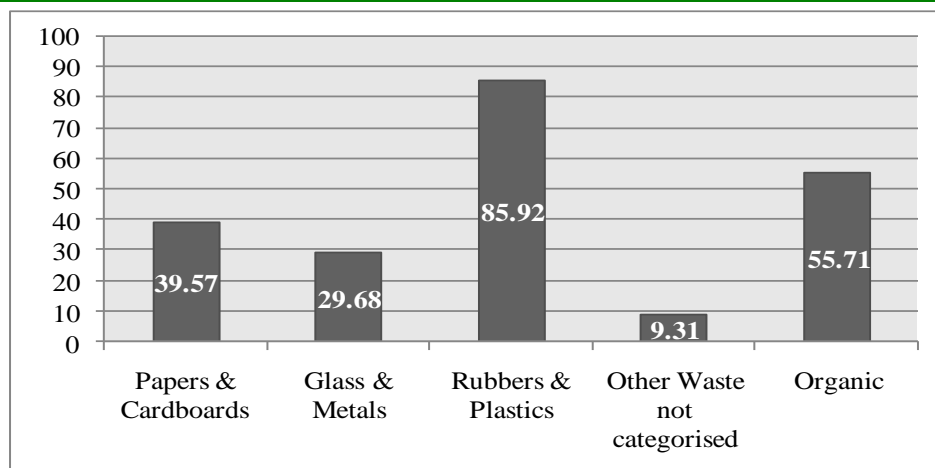


Figure 5.0: Composition of solid waste by weight from Outdoor litter bins.

Total composition by categories of waste generated from sources

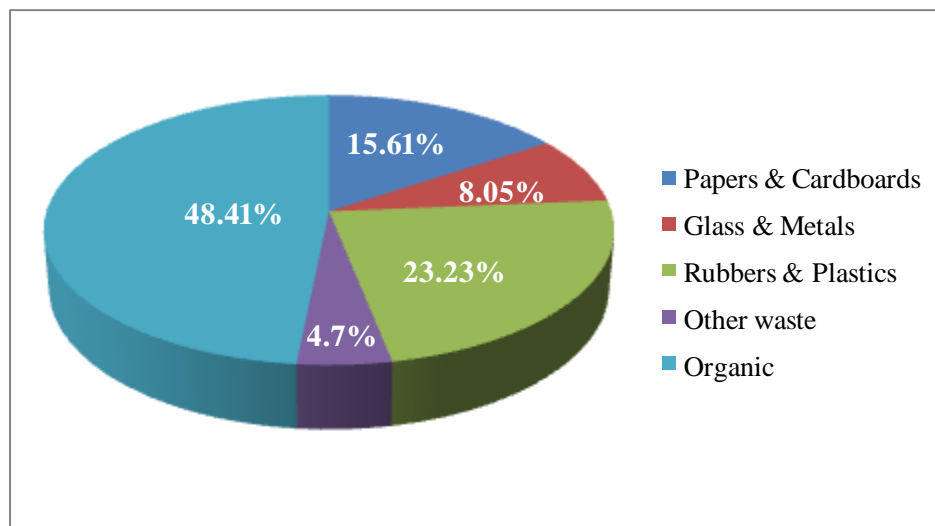


Figure 6.0: Waste composition by categories from generation sources.

From figure 6.0 above, the highest composition by categories of solid waste generated was organic, which was 48.41%. The predominance of organic waste in the total waste generated can be attributed to various activities on campus. The increased number of food vendors on campus can attribute to the high percentage of organic waste in the total waste stream. Various catering activities occur on campus with cafeteria locations of bush canteen (collection of food vendors), Administration Block, SRC cafeteria. Garden waste (leaves and grasses) also contributed to the high percentage of organic waste. Of the organic produced 73% were food leftovers and 27% comprising of kitchen waste and garden waste.

Rubbers and plastics were the second highest of the composition with 23.23%. This percentage of rubbers and plastic was due to packaging. Polythene bags and sachet water packaging was the major component in the waste stream of rubbers and plastics. They form a significant percentage of rubbers and plastics composition. Food packaging and plastic cups were also potential component in the rubbers and plastics waste stream. Table 6.0 below shows the total composition of waste by various categories in weight (kg).

Waste category	Total composition (kg)
Papers & Cardboards	93.67
Glass & Metals	48.27
Rubbers & Plastics	139.4
Other waste not categorized	28.2
Organic	290.46
Total	600

Table 6.0: Total weight of each category of solid waste generated.

Recycling Potential

The recycling potential was estimated by sub grouping of waste categories under each waste source. The sub grouping was done by grouping the components of the categories into recyclable, potential recyclable and non recyclable. Recyclable materials within the waste generated were waste that can be exploited for many benefits within the polytechnic campus. Materials reuse was also considered in the grouping of recyclable products.

Also potential recyclables were materials that can be recycled but not within the school, this can be done externally. The non recyclable materials were materials that cannot be recycled whether internally or externally. Targeting of materials for recycling increases diversion rate of materials ending up in dumpsites. Effective recycling is based on segregation at source. Hence the recycling potential of waste categories like papers and cardboards can increase if not mingled with other waste like organic and high water content materials. Table 7.0 and figure 7.0 summarise the recycling potential of the solid waste of each waste category generated in the polytechnic community.

Table 7.0: Recycling Potential of Waste Categories

Waste category	Total weight (kg)	Composition (%) in total waste	Recyclable (kg)	Potential Recyclable (kg)	Non recyclable (kg)
Papers & Cardboards	93.67	15.61	12.06	58.94	22.67
Glass & Metals	48.27	8.05	41.52	6.75	0
Rubbers & plastics	139.4	23.23	31.12	108.28	0
Other waste not categorised	28.2	4.7	3.51	8.66	16.03
Organic	290.46	48.41	268.68	21.78	0
Total	600	100	356.89	204.41	38.7

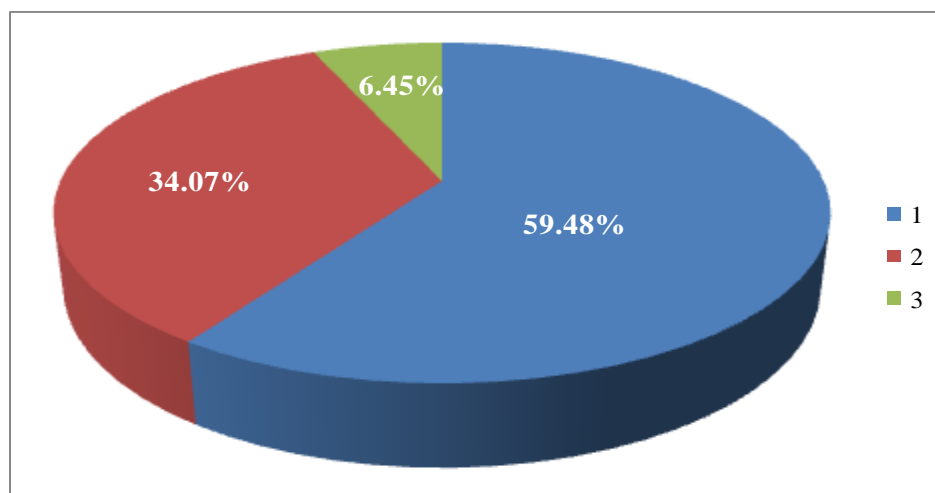


Fig 7.0: Recycling potential of Solid waste

1. Recyclable
2. Potential recyclable
3. Non Recyclable

From the diagram above 59.48% the total waste generated (600kg) on campus are recyclable. 34.07% and 6.45% are potential and non recyclable components respectively. Only 6.45% of the waste generated should end

up at the dumpsite. From figure 7.0 above 561.3kg of solid waste generated daily on campus are diverted from the dumpsite. With a diversion of 93.55% of solid waste will increase the useful life span of the polytechnic dumpsite.

Recommended Waste Management Practices.

In line with the waste management hierarchy, reduction, reuse and recycle are more favoured option of waste management. With this intent that production of waste should be minimised and that recycling should occur wherever possible. The targeted material that can be managed and diverted from dumpsite is the organic component. The organic component forms 47% of the total waste generated. Food leftovers and kitchen waste are the main components of the organic waste generated. Food leftovers constitute 73% of the organic waste. This shows a great potential of energy recovery from organic waste through biogas systems. This will be able to supplement the energy service of cooking for the hospitality department. Also the other 27% of organic waste comprising of kitchen waste and garden waste can be composted enrich land used for agricultural activities on campus.

There is a great potential of recovery and recycling options of solid waste management in the polytechnic. Recovery and recycling targets to divert waste call for segregation of waste at the source, through providing separate waste containers for different waste types. Wastes generated at sources were not segregated there by making recoverable or reuse of materials unfit.

Conclusion

The degree of consciousness that the society has on educational institutions requires educational institutions to act sustainably to the environment. This research is aim at serving to prompt for integrated waste management on campus base on the waste hierarchy. A huge percentage of recoverable can be achieved if waste was segregated at source.

References

- Agyepong, J.S., Barriers to Private Sector Participation in sustainable waste management–*Experiences of private operators and waste service providers in Ghana, 2011.*
- Carolina, A.V., Sara, O.B., Elizabeth, R.B., 2008. Solid waste characterization and recycling potential for a university campus. Elsevier waste management 28 (2008) S21-26.
- Malakahma, A., et al., Solid Waste Characterization and Recycling Potential for University Technology PETRONAS Academic Buildings, American Journal of Environmental Sciences 6 (5): 422-427, 2010
- Mbuligwe, S.E., 2002. Institutional solid waste management practices in developing countries: a case study of three academia institutions in Tanzania. Resources, Conservation and Recycling 35 (3), 131–146.
- Sanitation country profile Ghana (2004). <http://www.un.org/esa/agenda21/natlinfo/countr/ghana/SanitationGHANA04F.pdf>
- Seyoum, K., Studies on municipal solid waste management of Addis Ababa University, July 2007.

DEVELOPMENT OF AUTOMATED DYEING MACHINE (*BOAFO*) FOR SMALL SCALE DYERS, BATIK, TIE AND DYE IN GHANA.

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Abstract

Hand craft dyeing processes has been with traditional batik makers, tie dye producers for centuries coupled with indigenous techniques without any major technological advancement in their dyeing processes. These indigenous techniques most of the time result in varied dyeing defects. This project seeks to develop an automated dyeing machine (*Boafo*) for small scale dyers, batik, tie and dye in Ghana. The experimental approach was used in execution and testing of the machine. Findings revealed that the machine (*Boafo*) offers minimum handling of chemicals and fabric by operator. This speeds up production rate of a given time and maintains calendaring lustre of fabric even after dyeing process, thus improve performance in the dyeing methods adopted by local craft, small scale industries and institutions working in the domain of dyeing textile fabrics.

Key words: Dyeing; Dyeing process; Fabrics, Dyeing machine

Introduction

Textile has been with man from the prehistoric times to this era .The quest for man to clothe himself, look different, identify himself, protect himself from the element of the weather, and paramountly, to cover his nakedness has accounted for the constant production of textile products from fibre, yarn, fabric to garment. The constant development of man based on sophisticated whims and caprices has accounted for the search and development of varied colouration techniques. Symbolic colours were employed to suit the need of the people in the domain of hunting for disguise, representation of thought in cloth and flags, magical purposes, for representation of beauty and exhibition of class and status. This constant requirement for dyed textile fabrics propelled a lot of people to enter into the business of colouring fabrics by the 'hand dyeing' methods. The hand dyeing methods grew from just a hobby to a skilled occupation which attracted a lot of patronage from interested locals.

Gillow and sentence (1999) opines that during renaissance in Europe the art of dyeing became a skilled occupation, which brought about rapid development in the dyeing industry. Foulds (1990) also has it that the art of colouring textiles is very old, and that history can be traced from at least 4000years, starting in India and progressively spreading through Persia to Phoenicia and Egypt. Ingamells (1993) also states that the origin of dyeing is uncertain, but it is believed that the coloured fabric found in the ancient tombs of Egypt were in existence before 2500bc.

In Ghana there has also been conscious effort to develop the small scale dyeing industry as a source of creating small to medium scale employment through many youth and women empowerment programmes. For example National Board for Small Scale Industry in providing support systems for the youth in augmenting the National youth employment policies, motivating and providing funds to some recruited personnel in the dyeing and printing industry to promote the growth of textiles. Already in Ghana, the small scale local dyeing industry is made up of a cluster of enterprises struggling to survive by serving local markets and developing local skill.

There have been numerous developments of local skills in the hand craft dyeing techniques in the domain of design improvement, developing and improving the fastness of dyes, development of basic tools. But there are major setbacks in achieving repeatability of shade, handling of chemicals posing health hazards to dyers, uneconomical usage of water and slow rate of production.

In this paper an attempt has been made to develop a simple machine for dyeing textile fabrics that will facilitate and speed up production rate, minimal handling of chemical, level dyeing and achieving repeatability of shade for small scale dyers, batik tie and dye producers.

Materials and Methods

The materials adopted for the construction of the dyeing machine are common and available on the market making it possible for similar constructions and development. The main determinant for the selection of the material for construction is the reaction of dyeing chemicals during the dyeing process considering the dwell time for dyeing. This structure has been designed to curb the current challenges of achieving repeatability of shade, handling of chemical posing health hazards to dyers, uneconomical use of water and slow rate of production. The main vat or trough is made of Perspex a material that has no chemical reaction with the dye bath. Underneath is a metallic stand that supports the vat and presents it at the waist level to an average human length of 30 inches from the ground. To achieve level dyeing and shade, the researchers introduced rollers in the vat to constantly roll and agitate fabrics to prevent folds and overlaps during dyeing. Another area of concern to the researchers was the minimal handling of chemicals by the operator to reduce health hazards, for this the a motorized system was introduced to automatically power the system electronically and roll the fabric to replace the human power for agitation and submersion processes and also discharging of residue dye bath. The position of the rollers at the base of the vat was lower to the barest to allow the system to work at short liquor ratio using small quantity of water to dye large quantity of fabric.

Fabrication Processes

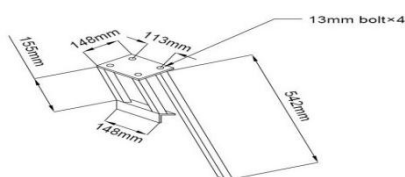


Fig 1 seat for the motor

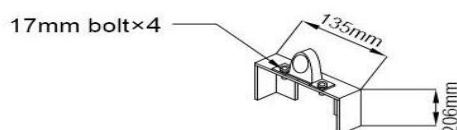


Fig 2 bearing for the revolving shaft

Table 1 General Parts of machine as indicated in fig 3.

ITEM	DESCRIPTION	QTY	ITEM	DESCRIPTION	QTY
1	SQUARE ROLLER	1	6	ROLLER STAND	2
2	STAND	1	7	BEARING BOLT	4
3	BEARING HOUSING	2	8	ROLLER STAND BOLT	8
4	ROLLER	1	9	MOTOR STAND	1
5	HOUSING				

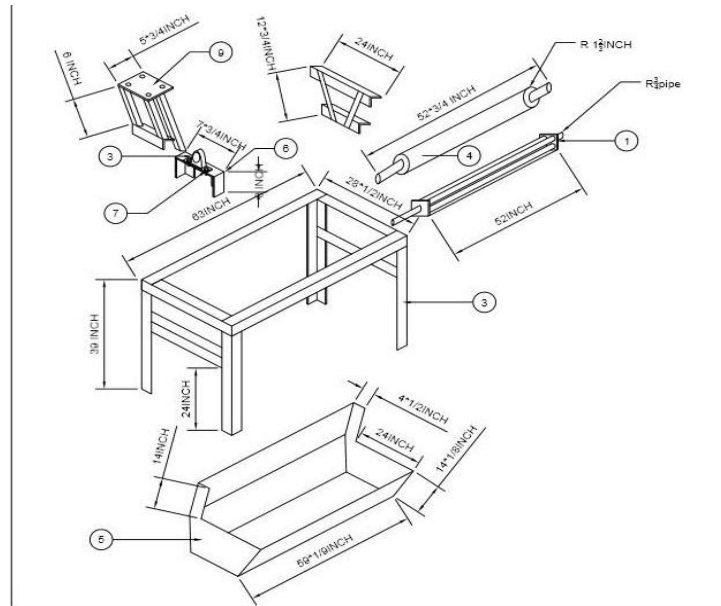


Fig 3 general parts of the machine with dimension

ITEM	DESCRIPTION	QTY	ITEM	DESCRIPTION	QTY
1	SQUARE ROLLER	1	6	ROLLER STAND	2
2	STAND	4	7	BEARING BOLT	4
3	BEARING HOUSING	2	8	ROLLER STAND BOLT	8
4	ROLLER	1	9	MOTOR STAND	1
5	HOUSING	1	10	DISCHARGE PIPE	1

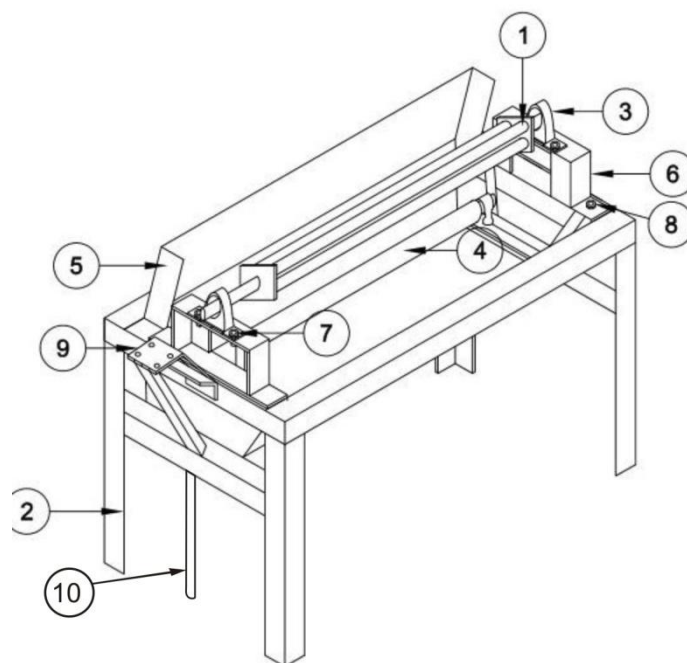


Fig 4 Assembled *Boafo* dyeing machine with labelled parts

Operating the Dyeing Machine

The machine operates on mainly electricity. It is also automated so it has a motorized system that controls the movement of the rollers. The horse power (speed) of the motor attached to the winch is 0.34hp making it possible for the fabric being dyed to gradually pick the dye molecules and gradually diffuse into the interstices of the fibre (fibre shaft). The fabric is processed in an open width orientation in order to prevent folds and creases that might lead to patch dyeing and strike defect.

The vat or trough that contains the dyebath has been designed and constructed in such a way that the discharge of residue dye is easy and convenient. The base of the trough or vat is slanted to one side to enable a complete disposal through the discharge pipe.

The maximum capacity of length of fabric to be dyed is twelve (12) yards by one (1 ^{1/3}) yards width wise; the size of mercerised cotton fabric. The fabric to be dyed is wound around the rollers by the operator, the loose ends that is the starting point and ending are stitched together to provide a continuous loop of fabric around the roller. This will allow a cyclic movement of fabric over and over again till level dyeing is achieved.

The fabric to be dyed is passed through a 'clear water' by turning on the motorized system to wet the fabric and open up its molecular structure making it receptive for dyeing.

The machine is turned on for the dyeing process to begin, the average time for the process is 10 minutes reducing the handcraft manual dyeing method of 30 minutes, saving 20 minutes.

The machine also works with open width format avoiding the constant turning and agitation by human, thereby reducing the handling of chemicals that cause health hazards to operators.

Again the machine operates with short liquor ratio making it possible to save water, in that with the dyeing procedure of this machine there is not complete emersion of the whole quantity of fabric in the dye bath as in the case of exhaust dyeing. It works with the modus operandi of pad dyeing.

Testing the Dyeing Machine or its Efficiency

Sample of mercerized cotton was used in the testing of the machine because that is the raw material for most of the local batik, tie dye producers. The sample material was four (4) yards. The dye class used was vat dye due to its wide usage by the local dyers. Most of the apparatus used were basic tools used by the local dyer for it to have direct developmental implications on their work.

The basic recipe used was;

One (1) yard of fabric: one (1) spoonful caustic soda: Two (2) spoonful hydrosulphite: three (3) litres of water.

Four table spoons full of orange vat dye were fetched into a container with water for dye liquor preparation. Four (4) tablespoonful of caustic soda and eight (8) spoonful of sodium hydrosulphite respectively were added to the dye liquor solution based on the basic recipe being used. The mixture was stirred until an even consistency was achieved. The fabric was then wrapped around the rollers of the machine and the two ends of the fabric were stitched together to form a batch. Twelve litres of water was then poured into the vat and the machine switched on to wet the fabric, after few revolutions the fabric was lifted from the water. The dye liquor was poured into the vat and stirred, the fabric was lowered into the dye bath and the machine was switched on again. The dyeing went on for ten (10) minutes and the machine was put off (during the dyeing, the hand was used to stretch the fabric whenever the fabric folded up, in order to prevent creases). The stitched ends of the fabric were unstitched after a successful dyeing process and the fabric dried.

Several observations made in relation to the set objectives were that the new automated dyeing machine dyes fabrics much faster, thus speeding up production rate. A piece of four (4) yards when taken through exhaust

dyeing(normal local dyeing technique)could take thirty (30) minutes was reduced by *Boafo* to ten (10) minutes due to the open width format adopted for dyeing.

It was also noted that *Boafo* does not exert any kind of stress or processing tension on the fabric which would have suffered rugged agitation and turn around manipulation in the dye bath by the exhaust dyeing (normal local dyeing technique) operator. This set back is eliminated due to the revolving nature of the roller thereby reducing creases and folds. Invariably the mercerized lustrous effect associated with the fabric is maintained and improved by the addition of colour.

It was also observed that *Boafo* was economical in the use of water thereby reducing drastically the use of water in the dyeing process. The average operational water to be used for (normal local dyeing technique) would be in the ratio of four (4) yards of fabric: twenty eight (28) litres of water this is based on principle that with exhaust dyeing there is complete immersion of the textile fabric under the dye bath to prevent patchy dyeing as a result of irregular exposure of the fabric as compared to four (4) yards of fabric: Twelve (12) litres of water.

It was also observed that *Boafo* solved a major problem associated with the local dyeing industries minimizing the issues of chemical accidents, because it was noted that the local dyeing operators paid little or no attention to Personal Protection Equipments (PPE). The machine encourages minimal handling of chemicals. After mixing of the dye liquor the operator does not play any role except occasionally straightening slight fabric folds until dyeing is complete. The health issues of using your hands to agitate and turn fabrics in the dye bath is eliminated completely, direct inhalation of dye through this act is also avoided.

Lastly, the automated winch machine was fabricated to dye five(5) yards of fabric but after the test dyeing, it was realized that the machine could handle six yards and above without having any effect on the fabric and also could be used to dye lighter fabrics in rope form.

Implications for Development

Awedoba, (2007) emphasizes that development takes into accounts many other aspects of life operating in synergy with the economic and the political. These include environmental and health issues, education, access to information, appropriate technology and science as well as the perceived broader cultural goals and objectives of life and existence such as the arts and aesthetics; these are each relevant to the developmental aspiration of a people.

The *Boafo dyeing machine* has major relevant implications for developments; it approaches diverse developmental issue in the desire of small scale and medium scale batik tie and dye producers in Ghana.

Growth of the textile industry (small and medium scale enterprise)

The *boafo* addresses a developmental concern in the domain of growing the collapsing textile industry. It tends to approach the growth from the low to middle drive, thereby empowering the local industry through mechanization to be able stand the challenges of hand production in this 21st Century. The *boafo* tends to bring the local small scale dyer almost at par with some industries operating with order basis due to the current challenges facing the major giants in textile production in Ghana. The *boafo* will serve as a stop gap in' small scale production to salvage the local textile industry.

Quality Control

The *boafo* also solves a wide range of quality control issues which are evident with most small scale batik tie and dye operators, ranging from problems associated with repeatability of shades, patchy dyeing, retaining of lustre. Observations made which can help develop the industry were that finished products from *boafo* were free from patches which is undesirable, and also retained the calendared luster which serves as a tool in marketing textile products.

Speeding up Production Time

It was also noted that the rate of production (yardage wise) increases and (time wise) reduces. This means that the operator will be producing more, making more money with a shorter time thereby creating more wealth.

Minimal Handling of Chemical (Health)

Boafo guarantees the operator minimal handling of chemicals where in the case of typical hand craft dyeing chemical forms about eighty (80%) of accidents in the industry. Invariably the health related issues are minimized thereby cutting down the company budget on health and channelling all resources towards production. Again the cost of acquiring PPE's will be drastically reduced.

Conservation of Water/Chemicals

Water for dyeing process should be as neutral as possible on the pH scale; the closest possible source is the treated water from our pipes. This is because water with metallic oxides may alter shades of colour during the dyeing process. Treated water is expensive so reducing usage by a margin of sixteen litre (16lit.) in dyeing four (4) yards is significant, this will absolutely save the company in domain of water bills.

Conclusions

On the strength of the testing and findings, the conclusion drawn was that the *Boafo* machine was capable of promoting the growth of the small and medium scale dyeing industries, in the domain of preventing patchy dyeing, achieving repeatability of shades, speeding up production, achieving minimal handling of chemical and conservation of water and chemicals. .

References

- Awedoba, A.K (2007) *Culture and Development in Africa*. Accra, Historical society of Ghana publishers.
- Foulds, J (1990) *Small Scale Textiles,Dyeing and Printing*. United Kingdom Intermediate Technology Publication.
- Gillow, J & Sentance, B (1999). *World Textiles, A visual Guide to Traditional Technique*. U.K Thames and Hudson ltd.
- Ingamells, W (1993). *Colour for Textiles, A Users Handbook*, England. Society of Dyers andColourists publishers,

DESIGN, CONSTRUCTION AND TESTING OF A SOLAR WATER HEATER USING AVAILABLE LOCAL MATERIALS

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Abstract

Schools, Health centers, Restaurants and hotels in Ghana use hot water for various purposes. Solar water heater is one of the simplest solar applications. In rural areas where electricity is not available, woodfuel is used as a source of fuel to produce hot water for domestic use. However, Ghana is endowed with solar energy and harnessing this resource through passive solar heating can meet hot water needs while reducing the over dependence on woodfuel. Additionally, developing the capacity to produce solar water heaters using local materials in Ghana makes it possible to distribute this technology more widely in the country. A single glaze thermosyphon solar water heater was designed and fabricated using available local materials. It consists of a flat-plate collector panel of 0.52m² area and a 100 liter hot water storage tank. The average temperature of the heated water measured were 26°C in the mornings and 38°C in the afternoons which were below the expected range of 40°C to 60°C.

Keywords: Ghana; Thermosyphon; Solar Energy; flat-plate collector

Introduction

Ghana's current primary indigenous energy utilisation shows a high degree of dependence on wood fuels (90-95%), the remaining being derived from hydro energy sources (5-10%) and a small portion from solar energy sources (1%) (Ghana Energy Commission, 2006). Although, the nation is endowed with a lot of renewable energy resources, virtually most of it remains untapped significantly. The development of the renewable energy resources, including solar, is therefore a key policy objective of the government (Tse, 2000).

Ghana receives good amounts of solar energy (particularly in the Northern Regions) with an average annual radiation of 16-29 MJ/m², indicating that conditions are ideal for the exploitation of the resource (Jyoti *et al*, 2004). Solar power from photovoltaics involves the conversion of solar energy to electricity in photovoltaic cells. In Ghana technologies demonstrated to harness the solar energy potential of the country includes solar crop dryer (SCD), solar water pumps (SWP), solar refrigeration, solar lighting and solar water heaters (SWHS).

Solar heating systems are generally composed of solar thermal collectors, a fluid system to move the heat from the collector to its point of usage, and a reservoir of tank for heat storage and subsequent use (Ministry of Energy, 2010). Solar water heaters are divided into two kinds of systems, namely passive solar system and active solar system (Ghana Energy Commission, 2011). A passive system operates using only the natural conversion system and allows cold water to flow in from the bottom and hot water to flow out of the top of the system.

Alternatively, active solar water heaters are more efficient than passive solar water heaters and require more equipment like sensors, pumps and controllers. An active system comes in two types: direct and indirect systems. Direct systems heat water in the collectors directly; however indirect systems instead, use another fluid such as freon, distilled water or propylene glycol to heat the water through a heat exchanger arrangement, where the heat of the fluid is transferred to the water. A number of solar water heater designs have been developed and constructed and tested, these includes the Differential Controller Operated Systems, Photovoltaic Operated Systems, Drain Back Systems, Drain Down System, Integrated Collector Storage (ICS) System and the Thermosyphon System (Duffie *et al*, 1991).

Given the available solar energy resource, and the need to conserve the depleting conventional energy resources (fossil fuel, wood, etc); there is the need to disseminate solar water heating systems in both the rural and urban areas of the country. To make the systems more affordable, for rural households with low income earnings, it is proposed to design and build a simple and cost-effective solar water heater using locally available materials. In the approach to help in this regard, the paper looked at the design, construction, installation and the performance testing of a prototype of a solar powered water heater that can provide 100 litres of hot water daily at the temperature range of 40°C – 60°C.

Materials and Methods

Material Selection

In deciding on the material for the construction of the solar water heater, it was necessary to consider the latitude and solar irradiation values for the location. The location which is Koforidua Polytechnic Campus has latitude and longitude values of 06°03'N and 00°17'W respectively. Values of beam radiation (G_{bt}), Diffuse radiation, (G_{dt}) and Total radiation on tilted surface (G_t) were adapted from table 1.

Table 1: Monthly solar radiation on the tilted collector surface for the location [8]

Months	Beam radiation on tilted surface (G_{bt})	Diffuse radiation on tilted surface (G_{dt})	Total radiation on tilted surface (G_t)
January	288.042	429.2297	717.272
February	260.776	370.6983	631.474
March	477.560	438.9849	916.544
April	455.338	292.6566	747.994
May	422.137	341.4327	763.570
June	57.878	497.5162	555.394
July	52.831	321.9222	374.753
August	77.940	351.1879	429.128
September	149.962	468.2505	618.212
October	175.303	487.751	663.064
November	394.296	292.652	686.952
December	313.680	302.4118	616.092

A typical thermosiphon solar water heater consists of two basic units, the collector and an insulated storage tank. The collector constructed consists of the cover plate, absorber plate and the insulator. The material selection was based on cost and availability of material in the local market. Table 2 gives an account of the various materials selected for the components of the water heater constructed.

Table 1 Materials selected

Components	Materials
Absorber plate	Aluminium
Glazing	Ordinary plain glass
Collector tubing	Copper pipes
Leading pipes	PVC pipes
Frame	Wood
Insulation	Styrofoam and Sawdust
Storage tanks	Plastic

In a thermosyphon solar water heater arrangement, cold water from mains fills the cold water tank and enters the collector from the bottom. With the serpentine configuration oriented in the horizontal direction, the water is heated as it rises through the copper tubes with the incidence solar radiation being absorbed by the tubes. The water in the serpentine tube in the collector is heated as it moves through the tubes and stored in the hot water storage tank ready to be used. Figure 1 depicts a representation of the flow diagram of the design.

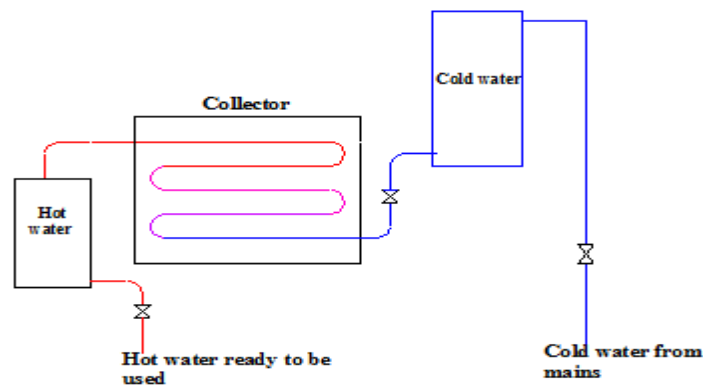


Figure 1: Representation of the flow diagram of design

Design Specification

Collector type: Flat plate
 Storage tank capacity: 100 litres
 Absorber tube diameter: 126mm
 Cold water temperature: $23^{\circ}\text{C} = 301\text{K}$
 Hot water temperature: $43^{\circ}\text{C} = 313\text{K}$
 Ambient temperature(T_a): $32^{\circ}\text{C} = 305\text{K}$
 Density of water: 1000 kg/m^3
 Specific heat capacity of water: 4200J/kg K
 Absorber plate to cover plate spacing: 0.05m
 Mean temperature of plate: $70^{\circ}\text{C} = 343\text{K}$
 Number of glass covers: 1

Design Calculations

For the energy balance for the plate design it was assumed that absorbed plate radiation is equal to the useful energy gain plus the thermal losses and for a unit area of collector surface the energy derived is expressed quantitatively as

$$G(\tau\sigma) = q_u + q_{total}$$

where G is the rate of incidence of solar radiation on a unit surface of an incline collector

τ Is the solar transmissivity of the collector cover.

σ Is the absorptivity of the blackened absorbing surface of the absorbing tubes.

q_u Is useful energy transfer to the water per unit area of the collector

q_{total} Is rate of thermal losses from the absorbing surface. (These include losses to the atmosphere and surroundings by re-radiation and convection and through the back insulation, per unit area of collector surface)

The energy loss at the top of the collector consists of the radiative and convective heat loss between the absorber plate and the cover plate and between the cover and the ambient. For a collector tilt angle between 0° and 70° , the top loss coefficient is calculated from the formula

$$U_t = \left\{ \frac{N}{\frac{C}{T_{pm}} \left[\frac{T_{pm} - T_a}{N + f} \right]^2} + \frac{1}{h_w} \right\}^{-1} + \frac{\sigma (T_{pm} + T_a) (T_{pm}^2 + T_a^2)}{(\epsilon_p + 0.00591 N h_w)^{-1} + \frac{2N + f - 1 + 0.133 \epsilon_p}{\epsilon_g} - N} \dots (1) [1]$$

where

ϵ_p = Emissivity of the collector plate (0.88)

$f = 520(1 + 0.089h_w - 0.116h_w \epsilon_p) (1 + 0.07866N)$

β = collector tilt angle in degrees

ϵ_g = Emissivity of the glass (0.95)

h_w = wind heat transfer coefficient

Velocity of wind(V_w): 2.42m/s

Stefan Boltzman constant: $5.67 \times 10^{-8} \text{ w/m}^2 \text{ k}^4$

N = Number of glass covers

T_{pm} = Mean temperature of plate

T_a = Ambient temperature

$C = 520(1 - 5.1 \times 10^{-5} \beta^2) \text{ for } 0 < \beta^\circ < 70^\circ$

$$e = 0.430 \left(1 - \frac{100}{T_{pm}} \right)$$

The collector was tilted at an angle of 15° to the south allowing maximum solar radiation to be captured. For the temperature variation computation, the steady state equation of the temperature distribution along the length of the pipe was used, this is stated as

$$U(x, t) = \frac{1}{i} (t_{out} - t_{in})x + t_{in} \dots (2) [1]$$

Where i is the length of the tube

t_{out} is the outlet temperature

t_{in} is the inlet temperature

x is the distance in metres

The Useful energy output was calculated from the formula

$$Q_u = A_c F_R [S - U_L (T_i - T_a)] \dots (3) [1]$$

Where A_c = Collector Area

F_R = Heat removal factor

U_L = Overall heat loss coefficient

T_i = Inlet fluid temperature

T_a = Ambient temperature

The bottom losses was calculated from the formula

$$q_{bot} = \frac{Ka}{La} + \frac{Kb}{Lb} + \frac{Kc}{Kc} \dots (4) [1]$$

Where,

Ka = thermal conductivity of the Styrofoam

La = Thickness of Styrofoam

Kb = Thermal conductivity of sawdust

Lb = thickness of sawdust

Kc = thermal conductivity of wood cover

Lc = thickness of wood cover

The collector efficiency was determined from the relation

$$\eta = \frac{Q_u}{A_c G_T} \dots (5)[1]$$

Where

η = efficiency

Q_u = Useful energy output

A_c = Collector area

G_T = Incident total radiation

Other parameters were determined using relevant relations from [1] and the results have been presented in table 3 [1]

Table 3: Results of design parameters

Parameter	Design calculated results
Top Losses	8.2908 W/m ² K
Bottom losses	6.18 W/m ² K
Total losses	14.4708 W/m ² K
Useful energy (q_u)	305.943 W/m ²
Collector Efficiency, η	65%
Area of collector	0.5217 m ²
Heat transferred to water(q_w)	6W/m ²
Frictional losses in pipes	1.3165×10^{-3} m
Head losses	29.0×10^{-4} m
Collector angle	15.0°
h_w	4.79W/m ² °C
f	0.08957
C	513.873
Q_{load}	1441kJ

Results and Discussion

3.1 Designed temperature variation along the length of the absorber tube

The graph depicts the designed temperature rise of the absorbers tubes along its length. The absorber tube by design was set to achieving maximum and minimum temperatures of 28°C and 43°C respectively, achieving a maximum temperature around midday. Generally it was expected that the temperature of the water be increased gradually as it moves along the length of the tube. The designed result of the temperature variation along the length of the absorber tube is presented in figure 2.

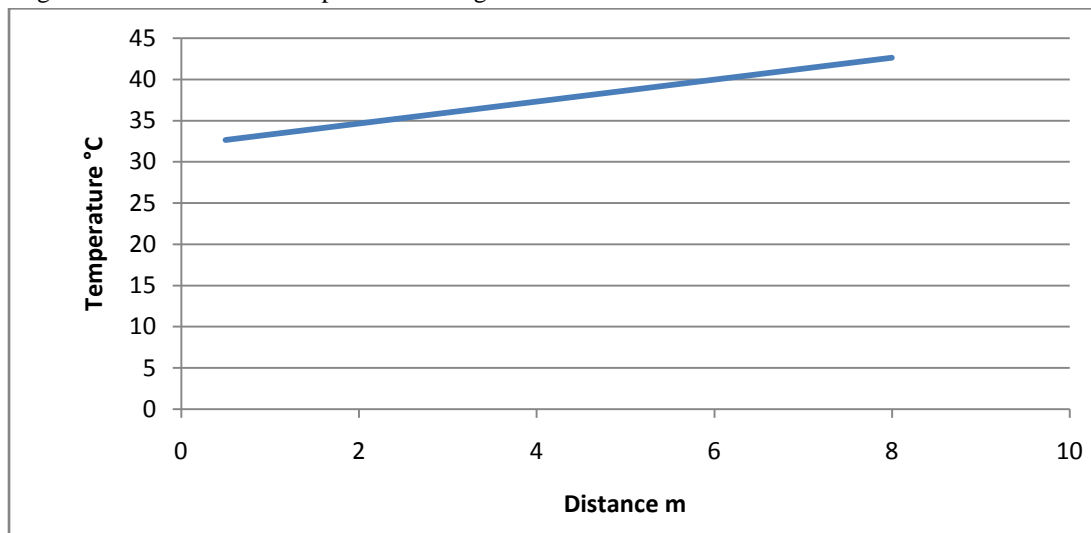


Figure 2: Temperature variation along the length of the absorber tube

Performance Testing of the Constructed Solar Heating Unit

Testing of the solar heating unit constructed was done in the months of July, August and September. In this, figures 3, 4 and 5 shows continuous variation of temperature at time 8 am, 12 noon and 4 pm for the various days in the months under study. The average temperatures recorded for the times 8 am, 12 noon and 4 pm for the entire study period were 26 °C, 38°C and 32°C respectively. Consequently the variation in temperature for

the various study times could be attributed to varying atmospheric condition during the period of the study. Higher temperatures were recorded during time 12 noon on sunny days while moderate and low temperatures were recorded at 4pm and 8 am respectively. Even though the designed temperatures of 43°C maximum and 28°C minimum were not realized, some degree of heating was achieved. If the solar water heater designed is improved, significant temperature close to the designed could be attained. Increasing the efficiency of the installed solar water heater to provide hot water using local raw material by improving the design and construction would ultimately lead to the over dependence of fossil and woodfuel. Harnessing the sun's energy to produce hot water and reducing the reliance on fossils and woodfuel would ensure proper forest management and mitigate climate change.

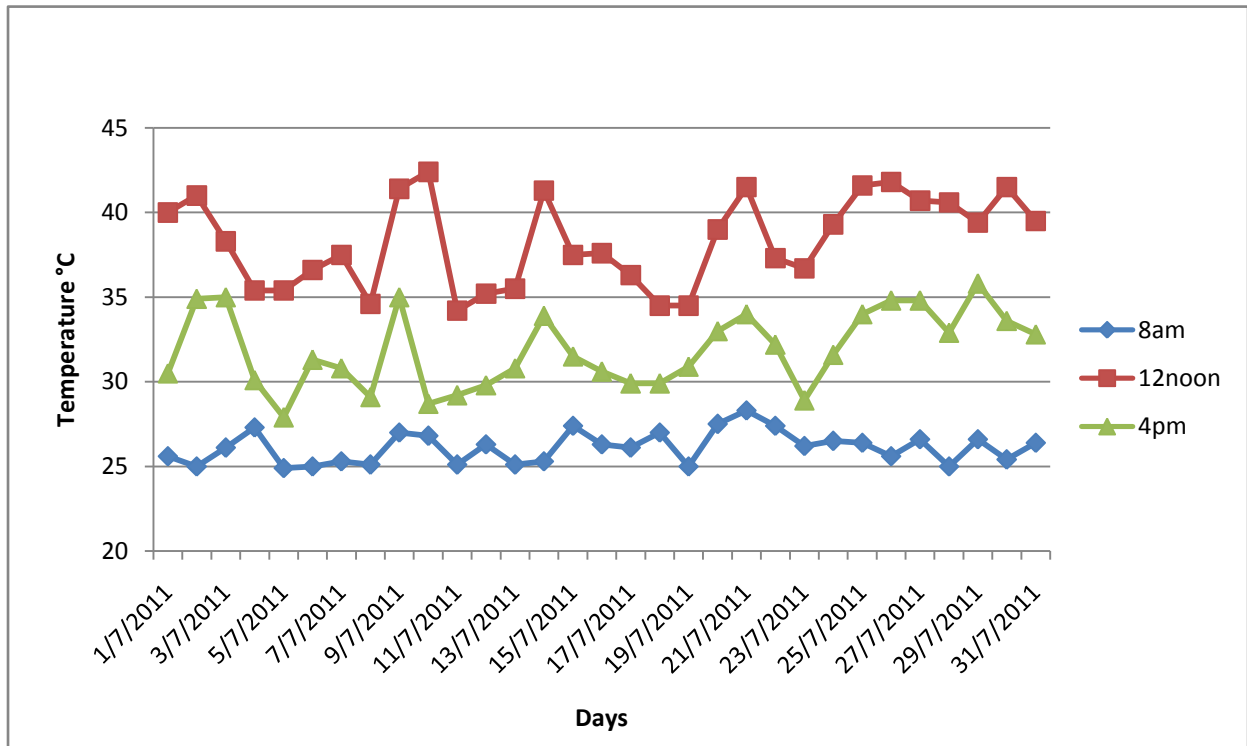


Figure 3: Performance evaluation of Solar Water Heater in the month of July

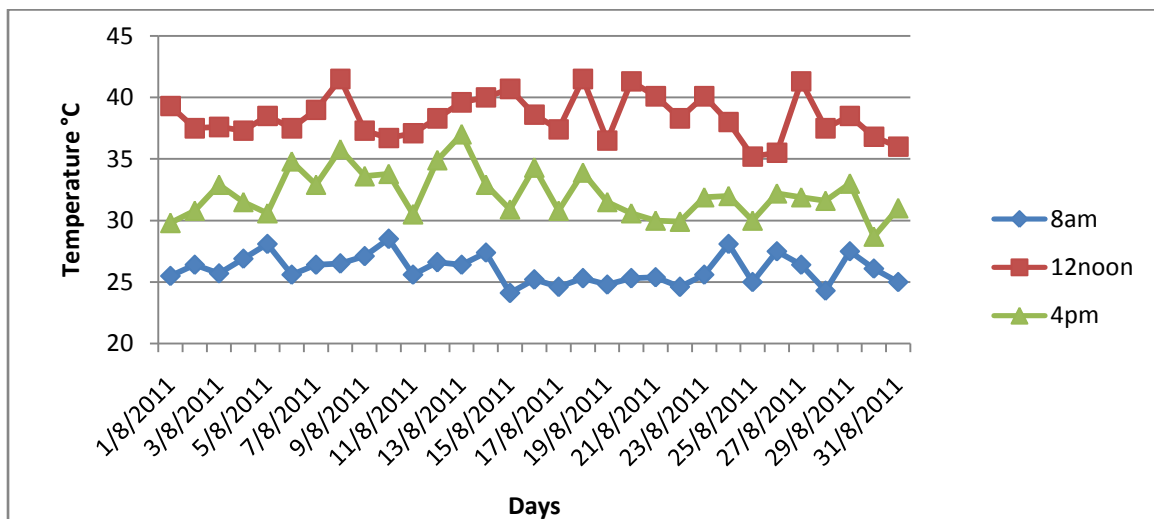


Figure 4: Performance evaluation of Solar Water Heater in the month of August

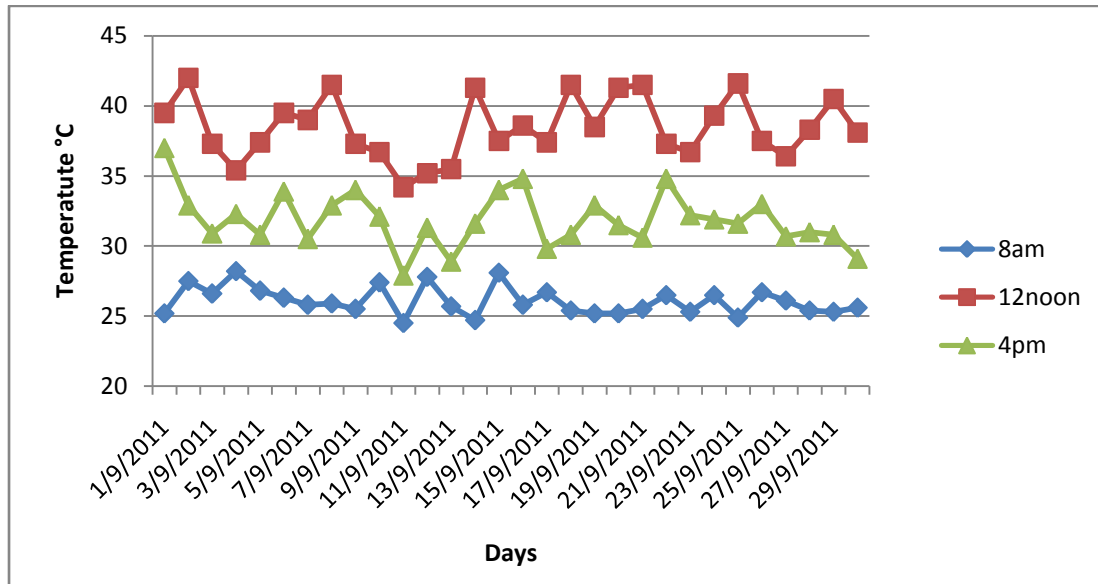


Figure 5: Performance evaluation of Solar Water Heater in the month of September

Conclusion and Recommendation

In conclusion the assumed temperatures used in the calculations and the actual results obtained from testing the constructed design indicated was not consistent. The temperatures differences between the assumed values and the values obtained after testing of the constructed design could be attributed to the ungrooved contact between the absorber plate and the copper pipes, the shining surface of the absorber plate, the insulation material used, type of sealant used between glazing and the wood as well as between the adjacent woods . It is therefore recommended that further studies be carried out in order to improve on the efficiency of the system.

Acknowledgement

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References

- Duffie JA., William AB., (1991) Solar Engineering of Thermal Processes (Second Edition)
- Energy Commission (EC). Strategic national energy plan (2006-2020) and Ghana energy policy. Accra, Ghana: Main version; 2006.
- Energy Commission, Energy Supply and Demand Outlook for Ghana 2011.
- <http://new.energycom.gov.gh/downloads/2011Energy%20Outlook.pdf> [assessed 26.02.2012]
- Jyoti, PP., Joygen, VF., (2002) Implementation of Renewable Energy Technologies, Barriers and Opportunities. UNEP Collaborating Centre on Energy and Environment, Risø National Laboratory Denmark.
- Ministry of Energy (MoE), National Energy Policy (NEP) 2010.
- http://ghanaoilwatch.org/images/laws/national_energy_policy.pdf [assessed 02.01.2012]
- Tse, M., (2000), Commercialization of Renewable Energy Technologies in Ghana. Barriers and Opportunities, pp 1-17
- Jacob Fish and H.C. William Anderson Introduction to Solar Technology
- Akuffo, F.O., and Jackson, E. A. (1998) "Simulation studies on a compact solar water heater in the tropics." *Solar & Wind Technology* 5: 229-239

QUALITY ASSURANCE PRACTICES IN POLYTECHNIC INSTITUTIONS IN GHANA: THE CASE OF KOFORIDUA POLYTECHNIC

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Abstract

To consistently and efficiently assure quality standards in Higher Education (HE), Higher Education Institutions (HEIs) have put in place internal mechanisms and policies. Quality Assurance Agencies have also been set up by many countries to coordinate the proper development of HEIs. This study sought to examine the quality assurance practices of Koforidua Polytechnic (KP). Using the student life cycle framework (Chambers and Paul, 2008), the author followed students from admission stage through being taught and assessed and to graduation, looking at the quality checks at each stage. The findings suggest that KP has taken steps to assure quality in its operations. These steps are geared towards meeting the standards set by the quality assurance bodies and also to fulfil the polytechnic's mission. Despite these efforts, KP has not been successful in establishing a quality culture and challenges remain. The author has made some recommendations.

Keywords: Quality, Quality Assurance; Quality Assurance Practices; Higher Education; Koforidua Polytechnic

Introduction

Higher Education Institutions (HEIS) have over the years played pivotal roles in the socio-economic development of nations. In order to guarantee the sensitivity of HE to national situations and offer value-for-money education, there is the need to consistently and efficiently assure high standards in the provisions of the institutions that deliver HE (anon, 2008). To achieve this, a number of HEIS have put in place internal mechanisms and policies to ensure quality standards. Quality assurance agencies have been set up by various countries to coordinate the proper development of such institutions.

Statement of the Problem

In Ghana, Apart From Standards Put In Place By The Quality Assurance Bodies To Ensure Quality HE, Each Institution Has Its Own Internal Policies And Mechanisms For Ensuring That It Is Fulfilling Its Own Purposes. . In Spite Of The Policies And Mechanisms Put In Place By Koforidua Polytechnic (KP) To Ensure Quality In Its Operations, Quality Culture Is Not Embedded And Challenges Remain.

Purpose of the Study

The main purpose of this study is to examine the internal quality assurance practices of KP. The study focuses on significant portions of the student lifecycle framework (chambers & paull, 2008). Students are followed from admissions stage through being taught and assessed and to graduation, looking at the quality checks at each stage. In the literature it appears there is no empirical research on quality assurance practices in polytechnics in Ghana, particularly Koforidua Polytechnic and the contribution of this paper is to fill this knowledge gap.

Research Questions

The research questions to be addressed in this study are:

- i. What is the quality assurance model of Ghana?
- ii. What are the internal quality assurance practices of KP?
- iii. What quality assurance challenges do the polytechnic face?
- iv. What is the way forward for the Polytechnic?

Quality and Quality Assurance

The term quality' migrated or was imported from its more familiar industrial and commercial settings of the 1980s into the domain of HE and also to other professional and public service settings (Newton, 2002). Defining quality in HE is a challenging task since quality is a rather vague and controversial concept. In the literature there is no single definition of the term which is absolutely agreed or universally accepted. Tammaro (2005) observed that quality is a value judgement, differently interpreted by different stakeholders, such as governments, employers, students, administrators, lecturers, etc. Like 'beauty' quality is subjective, a matter of personal judgement (Doherty, 2008). Although it is difficult to define quality especially in HE, Mishra (2007) argued that the term has a few central ideas around which the whole concept revolves; quality as absolute, quality as relative, quality as a process, and quality as culture. He noted that educational institutions are particularly concerned with quality as a culture, though other ideas of quality have their respective places.

Harvey (1997) identified five broad approaches to quality identifiable in relation to HE. These are quality as exceptional, quality as perfection, quality as fitness for purpose, quality as value for money, and quality as transformation. Most of these definitions however do not seem to apply to HE. For example the dimension of quality as perfection cannot be applicable since HE does not aim to produce defect-free graduates (Watty, 2003). The author agrees with Lomas (2001) that fitness for purpose and transformation are more appropriate definitions of quality in HE.

HEIs, as opposed to manufacturing industries, are service organisations because of their characteristics (Tan et al, 2010). The definition of service quality just like the term 'quality' has no overall agreement in the literature. There have been so many definitions. The most common ones define service quality as the extent to which service meets customers' needs or expectation (Lewis & Mitchell, 1990). Rana (2008) identified so many service quality measurement models, but service quality authors do not agree on the use of these models. Most of the models are industry models such as SERVQUAL (Parasuraman et al, 1988), SERVPERF (Cronin & Taylor, 1992) and Evaluated Performance Model (Teas, 1993), which are not easily applicable to HE. Moreover, most of the service quality models focus on students as customers of HE but focusing on the student as the customer is questionable since it is difficult to define customers in HE. Quinn et al (2009) argued that while students are perhaps the most obvious customers, many other stakeholders also function as customers of HE. Parents, research sponsors, government, employers, faculty/staff, and the general society can all be described as customers of HE at one point or the other, adding to the complexity. Helmes and Key (1994) pointed out that the student can be classified as raw material, customer, or even as employees in HE. Quinn et al (2009) stressed that the difficulty of defining customers of HE is a major barrier to quality improvement efforts.

Many definitions of quality assurance are identified in the literature but generally refers to a planned and systematic review process of an institution or programme to determine whether or not acceptable standards of education, scholarship and infrastructure are being met, maintained and enhanced (CHEA, 2003). Quality assurance has become globally important especially in HE and more attention is being paid to it than ever before. According to Tagoe (2008) the purposes of quality assurance and accreditation in HE are to ensure good quality education is being offered, to equip students to manage their own learning and development throughout their lives, to provide students with knowledge and skills that are relevant to the current job market locally, nationally and internationally and to ensure that internationally recognized academic standards are achieved.

Types of Quality Assurance Practices

In HEIs, quality assurance can be either external or internal processes. Anon (2008) referred to External Quality Assurance as a situation whereby there is a review by an external agency (e.g. a national quality assurance agency) or body (e.g. a professional body) which evaluates the operations of a university (institutional) or its programmes to find out the level of compliance within the set standards. External Quality Assurance is carried out through the instrumentality of accreditation and involves a self-study, peer reviews and reporting system. Parri (2006) noted that External Quality Assurance is necessary in order to prove that the goals set by the institution will be achieved.

Internal Quality Assurance on the other hand, refers to the internal policies and mechanisms of a HEI or programme which ensures that it is fulfilling its purposes as well as the standard set that apply to HE in general or to the profession or discipline in particular (Parri, 2006). It aims at institutional development and assessment of internal accountability. According to El-Khawas (1998), in Internal Quality Assurance, HEIs provide evidence of how they are carrying out their mission, how well they are performing and what they are doing to assess their effectiveness and identify where improvement is needed and what they are doing to make these improvements.

Anon (2008) explained various internal activities that ensure that certain agreed standards of performance are met in HEIs. These include the external examination system, self assessment, the practice of mentoring, student-lecturer assessment and student admissions. The external examination system is one where student examinations are assessed within curriculum content and general professional or global standards. External Examiners (senior academic staff) assess examination scripts and project work of students. In some cases, institutions also carry out external examinations. Anon (2008, p.8) observed that with increase in student numbers, external examiners are not able to cope with assessing all students' scripts and projects. Also, some HEIs are unable to fund the external examination system as the numbers of academic programmes and the required external examiners have increased significantly.

There is also the self assessment system whereby an institution carries out an internal appraisal of its programmes to find out the level of achievements of its internally set objectives and standards. Two levels have been identified in the literature; programme and institutional levels (Anon, 2008). The self assessment system advises the administration of the level of permeation of quality in the operations and activities of the institution.

Mentoring is another form of internal quality assurance, a practice in which a young academic person is mentored by a professor or senior academic colleague with the objective of improving the capacity of the young academic on how to teach and conduct research. In this case senior academic colleague serves as a role model to the mentored. It may also be at the institutional level where a new university or HEI may elect to be monitored by an older and more experienced university or HEI in development and operation of its structures.

There is also the practice of student-lecturer assessment. Although this is not popular among lecturers in HEIs, it has been used in many institutions to give students a say in the quality curriculum delivery and as a means to limit possible excesses of lecturers.

The student admission process which aims at admitting best quality students in a programme is an important basic determinant of programme or institutional quality. In most countries, student admission is conducted by individual universities using their own internal systems. Some countries even conduct a general qualifying examination annually for all students wishing to be admitted into HEIs in the year. The results are used to determine the students who are eventually admitted as freshmen. This process largely settles the question of probity in the admission process. In Ghana there is no general qualifying examination to admit students into HEIs. HEIs have their internal policies for admissions but are guided by NAB standards.

Quality Assurance Models

From the literature there seems to be three prominent approaches of quality assurance in HEIs. These are the Command and Control Model, the Self-regulation Model, and the Market Regulation Model. Jamieson (2010) observed that the Command and Control Model is an attempt by the state to control HEIs. In this case the state has prescriptive rules and/or standards to ensure quality in HE. HEIs are sanctioned for failure to observe these rules and/or standards. An example of this model is how US state universities are regulated. In the Self-regulation Model, HEIs are autonomous. They design their own curricula and award their own degrees. HEIs are ruled by professionals and it is trusted that these professionals will do the right things. In the Market Regulation Model there is a relationship between market competition and HEIs. Market competition for HE causes consumers (students) to make informed choices. The best HEIs flourish and the worst fails.

Jamieson's (2010) observation is in line with Clark's (1983) classic triangle of coordination which suggests three principal modes for coordinating or controlling behaviour in academic institutions: state regulation,

professional self-regulation which was termed “the academic oligarchy” and market forces. Clark’s model (1983) is used to determine how HEIs are steered and how influential each force is in relation to the steering of these systems. Michael (2001) agreed with Clark when he observed that the state, the academe, and the market are the primary forces influencing quality in HE, a view supported by Becket and Brookes (2008).

Ghana seems to employ all the three models but the state seems to play a more influential role through the NAB in ensuring quality HE than the academe and market forces.

Methodology

The research design is tailored to the purpose of the study, which is to examine the quality assurance practices of KP. The study is a descriptive qualitative research. There are many different approaches to the qualitative research method and this study uses the approach of case–studies, a focus on one or a few examples of a social phenomenon (Babbie, 2004 p.293). Case studies make it possible to give a certain level of overview and make the differences between HEIs visible.

Document content analysis, semi-structured interviews and direct observations were employed to collect data for the study. Documents that were analysed include the National Board for Professional and Technician Examinations (NABPTEX) Act (Act 492) of 1994, the National Accreditation Board (NAB) Act (Act 744) of 2007, the NABPTEX Student Guide for HND Examinations, administrative documents of KP among others. According to Babbie (2004 p. 263) an interview is a data collection method that consists of an encounter where one person (interviewer) questions another person (the respondent). In this study, semi-structured interviews were held in order to ascertain the acceptable standards of Ghana’s HE system and the quality assurance practices of KP.

Purposive sampling technique was used to select the sample size which comprises the Heads of the Quality Assurance Unit, the Examination Department, and the Admissions Department, all of KP. An official each of the quality assurance bodies (NAB and NABPTEX) were also interviewed. The questions revolved around the research questions. Purposive sampling instead of other sampling techniques was employed because the author believed, based on prior information, that the selected personnel were people who could provide the data needed for the study. The major disadvantage of this approach is that the author’s judgement may be in error; may not be correct in estimating the representativeness of the sample or their expertise regarding the information needed.

The author, having worked at KP for more than ten years and participated in quality assurance issues, also used his personal experience and direct observation to gather data for the study.

The study has some limitations. Firstly, the author is a former Vice Rector of the polytechnic and therefore the responses of the interviewees in the polytechnic may be influenced by their acquaintance with him. Secondly, in choosing the author’s own organisation as a case study, there is the possibility of personal biases and values which can potentially impact on the research questions and process. The author however, remained objective.

The analysis is guided by the student lifecycle framework of Chambers and Paull (2008) (see figure 1). The framework follows students in HEIs from the pre-application stage to the marketing stage. The framework has not been utilized as a whole; this will be beyond the space and time constraints of the study.

The adapted framework (see figure 2) focuses on significant portions of the lifecycle, i.e., Student Admissions, Teaching and Learning Processes, Graduation and Employment, looking at the quality checks at each stage and relating them to the accepted standards of the quality assurance bodies.

Findings

Ghana's Quality Assurance Model

Ghana employs a multiplicity of quality assurance models, which is the Command and Control Model, the Professional Self-Regulatory Model and the Market Model (Clark, 1983) but the Command and Control Model seems to play a more influential role. HEIs in Ghana are regulated by a number of regulatory bodies to ensure quality. These include the National Board for Professional and Technician Examinations (NABPTEX), the National Accreditation Board (NAB), the National Council for Tertiary Education (NCTE) and the Council for Technical and Vocational Education and Training (COTVET).

NABPTEX formulates and administer schemes of examinations for non-university tertiary institutions, both public and private, accredited by NAB. NABPTEX responsibilities include: 1) setting standards for assessment of skill competencies in non-university tertiary institutions, professional bodies and private tertiary institutions; 2) moderating examination questions for all HND programmes in Polytechnics in Ghana and other non-university tertiary institutions; and 3) conducting examinations and awarding national certificates and diplomas based on the results of the examination (NABPTEX Act, Act 492, 1994). Thus, NABPTEX is in charge of polytechnic examinations and the issuance of certificates.

The responsibilities of NAB include: 1) accrediting both public and private tertiary institutions as regards the contents and standards of their programmes; 2) determining the programmes and requirements for the proper operation of an institution and the maintenance of acceptable levels of academic or professional standards in the institution in consultation with that institution; and 3) determining the equivalences of diplomas, certificates and other qualifications awarded by institutions in the country or elsewhere (NAB Act, Act 744, 2007). NAB ensures quality polytechnic education by granting accreditation to the polytechnics to operate. The methodology the NAB uses is the 'threshold' model which seeks to identify the inputs (or threshold standards) required before offering accreditation to programmes/institutions. NAB monitors the courses and their contents, polytechnic structures, faculty suitability and infrastructure. NAB also coordinates with industry to be part of the assessment teams in the polytechnics to ensure quality and goal congruence with the objectives and mandate of the polytechnics.

The NCTE serves as the coordinator of tertiary institutions in terms of budget, finance and salary negotiation, development of norms and standards to ensure transparency and accountability to the state. Its primary objective is to advise the Minister of Education on all matters relating to tertiary education (NCTE Act, Act 454, 1993).

The COTVET is in charge of technical and vocational training and education (TVET) in the country (COTVET Act, 2006). The mandate of COTVET is to promote TVET and coordinate with the polytechnics such that products of COTVET institutions get access to polytechnic education to ensure continuous practical training.

Internal Quality Assurance Practices of KP

Student Admissions

The Polytechnic has an admission brochure that contains the programmes of study and the admissions requirements for each programme. The admissions requirements conform to the standards set by NAB. The Polytechnic has an Admissions Committee made up of members of the various faculties and is a sub-committee of the Academic Board. Its main function is to ensure that only students who meet minimum requirements of the various programmes are admitted into the Polytechnic. According to the Head of Department (HOD) for admissions, the Admissions Committee meets regularly especially during the admissions period to select qualified applicants. He pointed out that his department organises entrance examinations to screen mature applicants before they are admitted into the Polytechnic. To ensure that only qualified students are admitted into the polytechnic, the Quality Assurance Unit collaborates with the Internal Audit Department to conduct a Post Admission Audit. According to the Heads of the Quality Assurance Unit and the Admissions Department, the

post admission audit has helped to improve quality in the admission process by ensuring that only qualified applicants are admitted.

Teaching and Learning Processes

Adequate facilities/equipments are necessary for effective teaching and learning. Unfortunately, it was observed that the KP does not have adequate classrooms, library, laboratories, internet and audio-visual technology for teaching and learning as required by NAB. According to the Head of the Quality Assurance Unit, her outfit always monitors and brings to the attention of management some of these lapses so that appropriate actions could be taken. The Unit makes sure that the available resources are efficiently utilised. It was observed that in some departments, for example in the Accountancy Department, total student load per week is between 20-25 contact hours, far above the NAB standard which is between 15 and 21 contact hours for full time students. The Polytechnic has put in place appointments and promotions policies that ensure that only applicants that meet the necessary requirements are employed or promoted. Newly recruited staff goes through formal interview before they are appointed or promoted. For lectureship it is required that only applicants with Masters Degree or its equivalent and with adequate research training are employed. Recruited lecturers serve six months probation before they are confirmed.

To ensure quality teaching, students assess lecturers at the end of every semester. The assessment is based on items such as the provision of course outlines with references, adequate coverage of course content, the use of appropriate teaching methods, and lecturer appearance among others. This exercise is used to select the best teacher of the year.

The Polytechnic employs a self assessment system to assure quality. It has instituted Academic Review Committees (Programme Advisory Committees) for all programmes. The review committees are made up of external experts from academia and industry who visit the Polytechnic once every year. For each programme, a review committee conducts an appraisal to ascertain the level of achievement of its internally set objectives and standards. This is distinct from the required pre-accreditation self-assessment exercise which is externally mandated by NAB. This self-assessment exercise covers areas such as facilities and equipment, teaching and non-teaching staff, student and staff relationship, curriculum content, teaching methodologies and conduct of examinations among others. Recommendations of the Advisory Committees are submitted to the management of the Polytechnic for actions to be taken on them.

For KP to meet its own quality standards and the standards of NAB and NABPTEX, it has a published Examination Guide, which together with the NABPTEX Examination Guide regulates examination activities in the polytechnic. These are available to all students. The polytechnic employs the external examination system. Examination questions are submitted to NABPTEX for moderation by external examiners, which is to ensure that questions meet required standards. As pointed out by the HOD for examinations, invigilators, supervisors, examination officers and security personnel are given orientation on the roles expected of them during the conduct of examination; this is done every semester. She indicated that before and during examination, rules and regulations governing examinations are circulated for the information of students. Examination cards are used to regulate the sitting arrangement of students to prevent any form of examination malpractice. Students' cards are inspected during the examination to prevent impersonation. Also, strict invigilation is done to prevent any form of examination malpractice. An Examination Malpractice Committee, a sub-committee of the Academic Board sits at the end of each semester and students caught engaged in any form of examination malpractice are sanctioned to serve as a deterrent to others. This ranges from cancellation of papers to rustication for a stated period. KP has instituted an Examination Results Audit Committee whose objective is to vet marked examination scripts in all subject areas to ensure that they have been correctly marked and recorded. Marked scripts of final year students including dissertations are also vetted by external moderators appointed by NABPTEX. Students who satisfy all general requirements of NABPTEX and the polytechnic are awarded certificates after completion of their studies. According to the official of NABPTEX, notwithstanding previous conferment of award, NABPTEX in consultation with the Polytechnic may at any time, cancel an award with

retrospective effect if it becomes known that a candidate had gained admission with false qualification; had impersonated someone else; or had been guilty of examination malpractice.

Graduation and Employment

Like any higher education institution, KP has the responsibility to keep track of the performance of its graduates to ascertain their employability and also find out whether the Polytechnic's programmes have impacted positively on the individual, their place of work and the country. There is also the need to find out from employers the performance of the polytechnic's graduates on the labour market. According to the official from NAB, this is a requirement of Board. The study however, found out that the polytechnic has not formally carried out any tracer study to determine the performance of its graduates on the job market and the influence of its programmes in meeting the human resource needs of the society. Thus there are no quality checks on graduate performance and employment.

Discussions

From the above, it is obvious that efforts have been made by KP to assure quality in its operations. Apart from efforts made to meet the standards set by the Quality Assurance Agencies, KP has taken innovative initiatives to improve upon internal quality, notably the establishment of the Quality Assurance Unit, the Admissions Committee, the Post Admissions Audit, the Academic Review Committee (Programme Advisory Committee) and the Examination Results Audit Committee. These innovations are major achievements of KP quality assurance system. However, there are some difficulties or challenges which must be addressed by KP. Data gathered reveals that enrolment in the Polytechnic has moved from 33 students in 1997 to 5,151 students in 2011, leading to enrolment explosion. The enrolment however, is not matching with the infrastructure (library, classroom space, laboratories etc.), faculty strength and resources, administration and management systems. This has gradually degraded the quality of teaching, learning and research functions of the polytechnic. It has manifested in unacceptable student-lecturer ratio particularly in the Business School at KP which is about 52:1, far above the NAB quality standard of 18:1. It has also led to excessive teaching load of some lecturers. It was observed that some lecturers were teaching more than twenty (20) hours per week, far above the NAB standard of 9-12 contact hours per week, leaving little room for research.

Quality teaching and learning largely depend on the availability of highly qualified faculty members. However it was revealed that some faculty members of the Polytechnic do not have the minimum qualification required for appointment. Some of them do not have adequate research and industrial training before engagement as required by the NAB. In some instances some Heads of department (HODs) are too young and inexperienced to handle the enormous demands of managing the issues and problems of leadership. The NAB requires that HODs should be senior lecturers but in the study it was realised that none of the HODs in the polytechnic is a senior lecturer, this will in no doubt affect the quality of their leadership. The general inadequacy of resources and the difficulty of attracting and retaining high calibre staff accounts in part for this situation.

For quality teaching and learning, curriculum review from time to time is very important. One of the purposes of quality assurance is to provide students with knowledge and skills that are relevant to the current job market (Tagoe, 2008). The NAB requires that syllabuses and general curriculum be adequate and appropriate and be reviewed at least every five years. Unfortunately, the Polytechnic has no policy on curriculum review and for the past seven (7) years it has not reviewed the curriculum of some courses. Curriculum review, as we know, could lead to review of knowledge in existing courses, additional courses and merger of existing courses. The delay of the curriculum review means that new materials that could make courses more relevant and up-to-date are not likely to be incorporated. This brings into question the relevance and quality of the courses offered.

The Polytechnic does not have a comprehensive staff development plan to replace staff, upgrade staff and improve competence of staff as required by the NAB. There is also no proper succession plan with regards to academic leadership. This will affect quality service and should be addressed by the polytechnic.

Although the activities of the Programme Advisory Committees have led to some quality improvements in the various programmes of study, data highlighted that the Polytechnic does not implement most of the recommendations of the Committees. The author suggests that the Polytechnic be committed to the recommendations of the Committees if it really wants to assure internal quality.

It was revealed that quality assurance has not been fully embraced by some staff members, who view the Quality Assurance Unit with suspicion. They perceive quality assurance as fault finding and therefore unwilling to accept the Unit. Some see its role as interference and a 'policeman'.

Despite efforts to improve the examination system in KP, there are difficulties. For example, there are long delays in the release of examination results. Students sometimes get the results of the first semester examination just before the start of the second semester examination. The situation is due to late submission of examination marks by lecturers and the bureaucratic procedures involved before results are released. The Polytechnic does not normally meet the deadlines set by NABPTEX, causing delays in graduating students.

NABPTEX is not able to cope with the large student numbers and has resorted to verifying scripts of only final year students, confirming the observation made by Anon (2008) that with increase in student numbers, external examiners are not able to cope with assessing all the students' scripts and projects in HEIs. This has a negative effect on quality.

Examination malpractice is still a major challenge facing the polytechnic. The general ineffective monitoring and control of various levels of student assessments, non-detrimental nature of punishments for engaging in examination malpractice and students inability to prepare for examinations have significantly contributed to the high rate of examination malpractice. This goes a long way to affect the quality of certificates awarded by KP.

In the Planning Department where the Quality Assurance Unit is located, it was observed that there are only seven personnel. Apart from the HOD who holds a Masters degree, the rest holds Bachelor degree or Higher National Diploma (HND) and have little experience on quality assurance issues. The Unit is also not adequately resourced and the personnel are not well motivated. This situation affects the efficiency and effectiveness of the Unit. The generally low salary levels and poor conditions of service in the Polytechnic do not motivate workers to give out their best.

Reflecting on the activities of NAB and NABPTEX, the two quality assurance bodies have not been adequately resourced to fulfil their roles properly. For example, the delay experienced by candidates waiting for the results of their examination from NABPTEX does not suggest an improvement in the overall quality of the system nor its responsiveness to students needs. The Board is hampered by inadequate human and financial resources.

Conclusions and Recommendations

Ghana employs a multiplicity of quality assurance models but the Command and Control Model seems to be more influential. . There are structures in place to address quality in HE primarily through NAB and NABPTEX. These two bodies have standard requirements that they expect HEIs to meet. The methodology the NAB uses is the 'threshold' model which seeks to identify the inputs (or threshold standards) required before offering accreditation to programmes/institutions. The quality assurance practices of KP are geared towards meeting the standards set by the quality assurance bodies and also to fulfil its own mission. Despite these efforts KP has not been fully successful in establishing a quality culture; challenges remain. Hence the author suggests a study on developing a framework for embedding quality culture in KP. Meanwhile, the following are recommended:

- The external quality assurance bodies, i.e. NAB and NABPTEX should support HEIs including KP to develop internal quality culture. The NAB should move from the threshold standard model (which serves to identify under resourcing) to a more performance improvement model. The NAB can assist by ensuring that institutional processes of quality assurance in KP are strengthened. NAB for example can encourage and share good practice by the promotion of graduate tracer studies, employer involvement

and feedback from students. It should be possible for NAB and NABPTEx to combine being a 'policeman' i.e. making sure institutions follow the quality standards and that of supporting HEIs to improve quality.

- The polytechnic should have a Strategic Plan for quality assurance, support it for execution and assess all major activities against quality standards. This will gradually transform KP culture into quality culture which will further transform into quality education, quality curriculum, quality human resources, quality graduates, quality research and quality infrastructure (Wahab, p.304).
- There should be a balance between a centrally located quality assurance unit and what goes on in the departments. Quality assurance desks could be set up in the various departments to run the system and to report to the head of the Quality Assurance Unit.
- As part of KP's strategic plan, an appropriate balance must be maintained between student numbers and physical infrastructure and faculty capacity. This will address problems associated with the student/lecturer ratio and excess teaching load. Lecturers will also have more time for research, a very important function of HEIs.
- Moreover, the Polytechnic's policy that a Masters degree is required for appointment to a lectureship should be strictly enforced. Any faculty member appointed without a Masters degree should be made to enrol on a Masters degree programme within three years of appointment. Failure to complete the degree should result in termination of employment.
- A comprehensive staff development plan should be developed by KP as part of the polytechnic strategic plan to replace staff, upgrade staff and improve competence of staff. Top management should be committed to the plan.
- Since the salaries and conditions of service of polytechnic staff are generally poor, KP should be more entrepreneurial by identifying other sources that will generate internal income to supplement what staffs receive from government.
- On the issue of succession planning, all faculty members should be involved in committee work at the departmental and polytechnic levels, to identify those with leadership potential. Such potential could be enhanced through participation in leadership development workshops and other formal programmes.
- KP should be committed to the activities of the Programme Advisory Committees by implementing their recommendations. This is necessary so that their activities will not become mere academic exercises.
- The Polytechnic must come out with a policy on curriculum review. For instance the curriculum could be reviewed every five years. This should be done in collaboration with industry and NABPTREX to make courses relevant and up-to-date.
- For quality examination, KP should put in place measures that will ensure that lecturers and departments meet the deadlines of NABPTEx. These should be strictly enforced.
- The polytechnic should be committed to severely punishing candidates who involve themselves in examination malpractices to serve as deterrent to others.
- The Quality Assurance Unit of KP should be given adequate resources to work with. The competences of the staff should be upgraded through regular training and workshops to reflect contemporary issues in quality assurance.

References

- Anon., (2008). *Quality Assurance Practices in Higher Education in Africa* [online] Available at: http://african.aau.org/userfiles/file/Quality_Assurance_Practices_in_Higher_Education_in_Africa.pdf [Accessed 25 January 2011].
- Babbie, E. (2004). *The Practice of Social Research*. Belmont, USA, Wadsworth/ Thomson Learning
- Becket, N. & Brookes, M. (2008). Quality Management Practice in Higher Education-What Quality Are Actually Enhancing? *Journal of Hospitality, Leisure, Sport & Tourism Education*, 7(1), pp.40-54
- Chambers, D. & Paull, A.(2008).Landscape Study of Student Lifecycle Relationship Management
- CHEA, (2003) Statement of mutual responsibilities for student learning outcomes: Accreditations and programmes. US: Institute for Research and study Accreditation and Quality Assurance Council of Higher Education. Washington, D.C.[Online] Available at: http://www.chea.org/pdf/stmntstudent_Learning_outcomes_9-03.pdf (Accessed 26th March 2011)
- Clark, B.R. (1983). *The Higher Education System: Academic Organisation in Cross- national Perspective*. Berkeley, CA: University of California Press.
- Cronin, J.J.& Taylor, S.A. (1992). Measuring Service Quality: A Re-examination and Extension', *Journal of Marketing* 56(3) pp.55-68
- Doherty, G. D. (2008). On Quality in Education. *Quality Assurance in Education* 16(3) pp. 225-226.
- Government of Ghana, Act 492, 1994, *National Board for Professional and Technician Examination Act, 1994*. Accra: Ghana Publishing Corporation.
- Government of Ghana, Act 744, 2007, *National Accreditation Board Act, 2007*. Accra: Ghana Publishing Corporation.
- Harvey, L.(1997). External Quality Monitoring in Market Place. *Tertiary Education and Management*. 3(1) pp. 25-35
- Helms, S. & Key, C.H.(1994). Are Students More than Customers in the Classroom? *Quality Progress*, 27,pp 97–99.
- Jamieson, I.(2008). *Research and Quality Assurance in Higher Education*. University of Bath. Unpublished
- Lomas, L.(2004).Embedding Quality: the Challenges of Higher Education. *Quality Assurance in Education* 12(4) pp. 157--165
- Lewis, B. R. & Mitchell, V.W. (1990). Defining and Measuring the Quality of Customer Service, *Marketing Intelligence and Planning*, 8(6) pp. 11-17
- Michael, S.O. (2001). *The Management of Higher Education: Challenges Before Higher Education Leaders in the Twenty-First Century*, The First International Conference on Moldovan Higher Education, Chisinau, Moldova
- Mishra, S.(2007) *Quality Assurance in Higher Education: An Introduction*. Revised edition. National Printing Press, Bangalore: India.[online]. Available at: http://www.co/org/site_collection_Docoments/PUB_QAHE_Intro.pdf [Accessed 25th January2011]
- Newton, J.(2002). Views from Below: Academics Coping with Quality. *Quality in Higher Education*, 8(1) pp.39-61
- Parasuraman, A., Zeithaml, V.A. & Berry, L.L. (1988). SERVQUAL: A Multiple-item Scale for Measuring Consumer Perceptions of Service Quality' *Journal of Retailing*, 64(1) pp.12-40
- Parri, J. (2006). Quality in Higher Education. *VADYBA/MANAGEMENT*, 2006 m Nr. 2(11) pp 107-111.
- Quinn, A., Lomey, G., Larsen, P. & Johnson, D.M.(2009). Service Quality in Higher Education. *Total Quality Management and Business Excellence* 20(2) pp.139-152
- Rana, S. (2009). *Measuring Service Quality in Higher Industry* [Online] Available at SSRN: <http://ssrn.com/abstract=1502646>[Accessed 15th June 2011]
- Tagoe, C. N. B.(2008). *Academic Quality Assurance and Accreditation. Regional and Inter-Regional Issues and Implication*. A paper presented at the international Workshop on Quality and Evidences: Issues in Education Abroad June 19th-21st University of West Indies.

- Tammam, A. M. (2005). *Report on Quality Assurance models in LIS programmes*. [Online] Available at: <http://www.ifla.org/VII/S23/index.htm> (Accessed 23rd March 2011)
- Tan, B.I., Wong, C.H., Lam, C.H., Ooi, K.B. & Ng, F.C.Y. (2010). Assessing the Link Between Service Quality Dimensions and Knowledge Sharing: Student Perspective. *African Journal of Business Management*. 4(6) pp.1014-1022
- Teas, R.K. (1993). Expectations, Performance, Evaluation, and Consumers' Perceptions of Quality. *Journal of Marketing*, 57(4) pp. 18-34
- Wahab, F. (2010). *A framework for Embedding International Quality Culture in Higher Educational Institutes of Pakistan*. A paper presented at the 3rd International Conference on Assessing Quality in Higher Education 6th – 8th December 2010 Lahore-Pakistan. [Online] Available at: <http://www.icaqhe2010.org/papers%20published%20in%203rd%20CAQHE%202010/19.-Fazal%20Wahab.pdf>
- Watty, K. (2006) Want to know about Quality in Higher Education? Ask an Academic, *Quality in Higher Education*, 12 (3) pp. 291-301.

APPENDICES



Figure 1: Student Lifecycle Model

Source: Chambers, D. and Paull, A., (2008) Landscape Study of Student Lifecycle Relationship Management

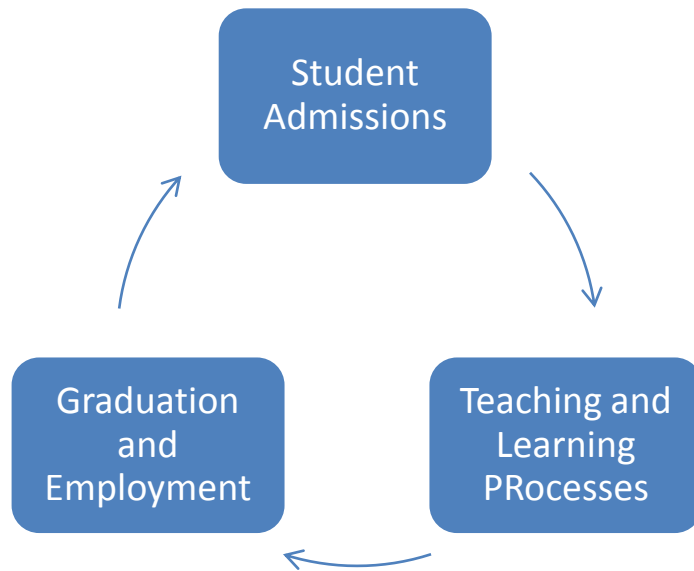


Figure 2: Student Lifecycle Model (Adapted from Chambers and Paull, 2008)

HAND PAPERMAKING WITH WASTE FABRICS AND PAPER MULBERRY BARK

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Abstract

This experimental papermaking project focused on investigating the possibility of turning waste fabrics into useful art paper when combined with paper mulberry fibre. This involved collecting fabrics pieces from dressmakers in Kumasi, harvesting some paper mulberry plants (*Broussonetia papyrifera*) from the Abofuor forest reserves on the Kumasi-Techiman highway, processing both materials into pulp, couching the wet pulp into sheets, and drying the wet sheets flat in sunlight to obtain papers of different colours and texture. Testing their usefulness involved writing on them with pen, and drawing pictures in colour pencil, watercolour, pastel, poster colour, oil and acrylic paints. It was found that linen-with-cotton and paper mulberry sheets can be stitched into books to serve as writing and sketch pads. Watercolour worked well on the linen, cotton, nylon, polyester, wool, and acetate fabric papers; colour pencil and pastel worked well on cotton and paper mulberry, and linen-with-cotton and paper mulberry sheets while oil and acrylic worked well on linen-with-cotton and paper mulberry sheets. Linen, cotton, nylon, polyester, wool, acetate with paper mulberry, and linen-with-cotton and paper mulberry sheets are good supports for poster colours. Although this project is time consuming and labour intensive, it provides ample opportunity for skills development in critical observation, environmental awareness, sorting, cutting, pulping, couching, drying, pressing, sewing, drawing, colouring and book binding while also promoting creative waste management, a positive attitude to recycling and re-use of discarded materials, and drawing attention to the paper mulberry plant as raw material for pulp and paper making in Ghana.

Keywords: Recycling; Waste Fabrics; Paper Mulberry; Art Paper; Writing Pad.

Introduction

In the days of old, the generation of waste was such that it got naturally recycled through biodegrading. Different types of waste, each with its own environmental impacts, have come into existence with the advent of the industrial revolution, giving rise to the new definition of waste “as any product or substance that has no further use or value for the person or organisation that owns it, and which is, or will be, discarded” (Caulfield, 2009). It is worth noting however, that what may be discarded as waste by one party may have value to another. The amount of waste generated, and its actual or potential negative effects on the environment, are matters of concern to governments and communities at large. This concern led to this creative art project which focused on the following objectives: 1) Identifying waste fabrics that could produce art paper when combined with paper mulberry bark; 2) Processing the identified materials into art paper; 3) Testing the suitability of different drawing and painting mediums on the produced papers; 4) Creating miniature books from the produced papers and testing their suitability as writing pads.

Fabric Waste Recycling

Recycling implies taking materials from products that one has finished using and trying to make new products out of them. It involves processing used materials into products to prevent waste of potentially useful materials (Aggarwal, 2010). According to Barry (2000), textile recycling is one of the oldest forms of recycling, having started in 1813 when Benjamin Law of West Riding area of Yorkshire pioneered the process of “pulling”, a process which involved breaking down woollen textiles into their constituent fibres so that they could be re-spun into fresh thread. Barry indicates that while the textile industry has a long history of being careful with its resources, a large proportion of unnecessary waste is still produced each year, much of which is either incinerated or disposed of in landfills. Caulfield (2009) reports that the three main reasons why it is necessary to recycle waste are: 1) waste disposal in landfills can harm the environment and human health; the requirement of landfill space is reduced when waste is recycled; and, the costs for landfill disposal which is continuously increasing is also reduced when waste is recycled. 2) Textile waste in landfill contributes to the formation of leachate, the liquid that is produced from the decomposition of waste within the landfill as it decomposes, which has the potential to contaminate ground water. 3) Incinerating textile waste in large quantities emits organic

substances such as acidic gases and dust particles, which are all harmful to humans and animal alike, into the environment.

Textile waste, according to Caulfield (2009), consists of pre-consumer and post-consumer waste; pre-consumer waste includes all the waste manufacturers generate during the processing of fibres into fabrics and all floor cuttings that garment manufacturers generate whereas post-consumer textile waste consists of all types of garments or household textiles that consumers no longer need or use and are therefore disposed of. One reason Caulfield cites for the increase in textile waste is consumer reaction to changes in fashion, both in clothing and household interior designs. Seasonal changes in fashion mean that clothes become outdated quickly, encouraging replacement and disposal of clothes, which allows manufacturers to increasingly develop clothing in response to this “throwaway society” the world has gradually become.

The Paper Mulberry Plant in Handmade Papermaking

The paper mulberry plant, which is native to Japan and Taiwan (Bosu, Apetergor and Refera, 2009), was introduced into Ghana in 1969 with the objective of providing a supply base for a pulp and paper mill in Kumasi (Darkwa, 1996). Darkwa explains that seedlings of both male and female species of this very fast-growing plant were planted in the Afram headwaters and at Abofuor in the Ashanti Region. The paper mulberry plant is described as an exotic invasive plant which can quickly colonise vast areas (Morgan and Overholt, 2004) and although it played a very important part in shaping world history, it has unfortunately now become better known as an unwelcome weed of natural areas worldwide. McMinn (2004) says the plant bears fruits that birds relish and disperse very widely. It is also distributed by floodwaters which wash away cuttings to establish new growths kilometers away.



Different species of paper mulberry plant

According to Barrett (1983), the cooking process of paper mulberry for hand papermaking by the Japanese consists of boiling the inner fibre in an alkali solution such as soda ash or caustic soda to dissolve the lignin, wax and gums in the mulberry fibre. After cooking, the fibres are rinsed and cleaned with water to ensure that the fibre is free of the cooking solution. After a thorough cleaning and rinsing, the cooked fibre is beaten into pulp with a mallet on a hard surface for papermaking by the Japanese. The property that makes the paper mulberry plant fit to be used for papermaking is the high cellulose content that the inner bark of the plant has.

Equipment for Hand Papermaking

Smith (1995) indicates that equipment and materials for making handmade papers range from equipment and materials that are very expensive to equipment and materials that can be scrounged free from the environment. Equipment and materials can also be improvised to save cost. Smith (1995) and Hiebert (1998) recommend the following as basic things that could help to execute hand papermaking projects: Beaters, pulp, vats, sizing, moulds and deckles, felts, presses, dryers and colours. The use of these equipment and materials however, depends on the individual's choice between expensive and in-expensive equipment and materials that are available for use.

According to Hiebert (1998), the following are the basic process involved in hand papermaking: First, raw material is obtained (papermaking fibre) by harvesting plant material or purchasing fibre from a papermaking supplier. Once the fibre is obtained it is processed; the processing varies from fibre to fibre but most plant fibres require cooking. All processed and cooked fibres are beaten into pulp, using methods such as hand beating, a blender, or beating in a Hollander beater. After beating, the pulp is mixed with water in a vat. A mould and deckle is then dipped in and out of the vat of pulp, allowing the pulp to settle on the screened surface of the mould as the water drains through the holes in the screen. With this the deckle is removed and the mould is tilted to let the excess water drain off. The wet sheet on the mould is then transferred onto a felt or blanket. Multiple sheets of paper one on top of the other, can be couched together each separated by a layer of felt or blanket. The couched sheets are pressed to remove water from the wet sheets. The pressed sheets are dried using a box fan or sunshine. Hiebert stresses that the method of drying handmade papers has some effect on the texture of the dried papers.

Methodology

The quasi-experimental research method (Leedy & Ormrod, 2005) was used to identify waste fabrics which have enough cellulose content to combine effectively with the paper mulberry fibre to produce useful sheets of art paper. This art studio based research was modelled after Barrett's (1983) description of the Japanese process of hand papermaking. Paper generated during preliminary tests using waste fabric and paper mulberry fibre in 50:50, 60:40 and 70:30 proportions were all good but because the study was a project based on recycling waste fabric, we decided to work with the 70% fabric and 30% fibre ratio to produce the papers and to find out how the sheets would react to ink, watercolour, pastel, colour pencil, poster colour, oil and acrylic paints.

Production Procedure

The researchers collected lots of waste fabrics from the floors of dressmakers and also old clothes that were not being used anymore from friends and family members. The collected waste fabrics were then sorted out according to their types, which resulted in identifying six different categories of fabrics: linen, cotton, polyester, nylon, wool and acetate. The different sizes of fabric in the six groups were cut into tiny pieces and placed in plain plastic bags and labeled to facilitate easy identification. Harvesting of the paper mulberry plant involved assisted visits to the Abofuor forest on the Kumasi-Techiman highway to identify the plants, harvest enough for the project and cut them up for easy transporting to the project site. Processing of the paper mulberry fibre began with the peeling off of both the outer and inner barks from the paper mulberry stalks. After this, one pound of the mulberry fibres were weighed and placed in a large saucepan to which 160 grammes of caustic soda and 18 litres of water were added before cooking it for two hours on open fire.

According to Farnsworth (1989), if by pulling on a piece of cooked mulberry bark it separates with a slight tug, the bark is done, and the longer the cooking time the easier the fibres pull apart. In line with this assertions, a piece of the fibre was tested by pulling it apart after two hours of cooking but the fibre did not pull off easily so another 160 grammes of caustic soda was added to the cooking fibres and left to cook for another one hour. After three hours of cooking, another pulling test was done and this time, the pulling was done with ease, so the fire was put out with water and the fibres were removed from the cooking pan. The outer barks of the fibres were then removed to obtain the inner bark. The inner bark of the mulberry plant was also cut into smaller pieces. An electric blender filled with 1.5 litres of water was used for the pulping by combining the cut pieces of fabrics individually with the cut pieces of the cooked mulberry bark in a ratio of 70% fabric: 30% mulberry fibre.

In identifying the fabrics that could make useful handmade papers, a combination of linen and mulberry inner bark pulp was poured into 25 litres of water in a plastic pan, and then the mixture was vigorously stirred with the hand to obtain an even consistency after which a mould and deckle was used to scoop some of the pulp onto the mould. The pulp on the mould was then couched on a felt placed on a flat wooden board, and while the sheet was still wet, it was removed from the felt and held up to see if the pulp would fall apart or not. This was modelled after a procedure demonstrated at a workshop on hand papermaking that the researchers participated in from 15th July to 10th August, 2010 at the Textiles Department of the Faculty of Art, KNUST, Kumasi. The Facilitator of this workshop had made participants aware that pulps that are likely to produce good quality

handmade paper are those which can be held up after couching when the sheet is still wet without it falling apart. The remaining five pulps were all taken through the same process. All the six wet sheets did not fall apart when they were removed from the felt and held up suggesting that all six wet sheets had the potential of producing good quality handmade papers.

Because all six wet sheets exhibited good potentials to form good quality papers, dried sheets were produced out of each of the six pulps of fabrics in different combinations with paper mulberry bark to see their outcome. This was done by starting with the same procedure used for the identification of the fabrics but this time after couching two wet sheets, a felt was placed on the wet sheets, and another two wet sheets couched on the felt. This was repeated until a good number of sheets were couched and a flat wooden board was placed on the couched sheets and pressed with G-clamps. The pressed sheets were then removed from the felt and placed onto flat metal plates where a brush was used to remove air bubbles that were created by the sheets on the metal plates. After this the sheets were dried in sunshine but as Hiebert (1998) indicates, in humid conditions, handmade sheets can be dried using a box fan. After drying the sheets, colour pencil, watercolour, pastel, poster colour, oil and acrylic paints were used to test the suitability of the dried papers for art work. Some of the dried papers were also stitched into miniature books that were also tested with pen and ink for their feasibility as writing pads.

Results and Discussion

One characteristic feature observed from all the dried sheets of the different types of waste fabric was that the sides that were fixed onto the metal drying plate had a smooth texture while the part that faced the sun had a rough texture. This happened because the surfaces of the metal plates were very smooth and so the sides of the sheets that got in contact with the plates assumed the smoothness of the plates. Consequently, every sheet provided two surface textures to choose from. This corroborates Hiebert's (1998) statement that the methods of drying handmade papers eventually affect the texture of the dried sheets. It was also observed that the dried sheets from the linen and paper mulberry sample were not very crisp but rather felt a little bit mushy and soft to the touch. This creamy-white coloured paper could bend easily when held from one end in mid air. The surface did not appear fibrous but rather looked a little rough. This paper (Plate 1) was found to be porous and absorbed water quickly.

Papers made from cotton and paper mulberry fibre produced very thin and crisp sheets while the thick sheets were non-crisp and hard. The paper felt firm and solid to the touch. See illustration in Plate 2. Dried papers from nylon and paper mulberry were found to be very soft and fluffy and the fibre content flaked off easily. The sheets also looked fibrous and the fibre content was inconsistent throughout the paper, some places appeared thicker than others. There were so many loose fibres all over the surface of the paper. The nylon fibre content gave the paper a shiny look (Plate 3).

Dried papers from polyester and paper mulberry (Plate 4) were very soft with fibre strands of the polyester fabric visibly showing. There was also a loose binding between the individual fibres of the sheet with fibres coming off at the slightest pressure. Dried papers from wool and paper mulberry fibre (Plate 5) produced very thick, soft and non-crispy sheets which looked like a blanket. There were loose fibres on the surface of the paper. Dried papers from acetate and paper mulberry fibre (Plate 6) were very soft and somewhat fluffy. Dried papers from a combination of linen, cotton and mulberry fibre (Plate 7) were strong and hard. This shows that the different types of paper produced from the six types of fabric exhibited different qualities and capacity for art work because of the variations in fabric content for each of the papers.



Plate 1: Linen sheets



Plate 2: Cotton sheets



Plate 3: Nylon sheets



Plate 4: Polyester sheets



Plate 5: Woollen sheets



Plate 6: Acetate sheets



Plate 7: Linen and Cotton sheets

Reaction of Linen and Mulberry Papers to Drawing and Painting Mediums (Plates 8 – 12)

Colour Pencils (Plate 8): Hard scratches of the colour pencils on the linen sheet made the surface fibre content to peel off. The pencil made deep impressions on the paper for the colours to stand out well. Where the colour pencil impressions were not deep, the colour appeared pale.

Watercolour (Plate 9): The watercolour dried very fast upon application on the linen sheet. This made colour control difficult. The watercolour bled on and through the sheet to an extent that the painted work could be seen on the reverse side of the sheet. The appearance of the colour on the finished work looked mouldy and did not look very fresh. The paper surface also wrinkled a little after the drying of the paint and the forms in the painting were not well defined due to the bleeding.

Pastel (Plate 10): The application of pastel on the linen sheet resulted in peeling off of the fibre content on the surface of the sheet. The peeling off did not allow good control over the pastel sticks which resulted in the invisibility of the features of the pineapple. In addition, the sheet with the pastel work felt softer than before.

Oil and Acrylic paint (Plate 11): Both oil and acrylic paints bled through the reverse of the linen sheet only slightly. The freshness and warmth of both colours were very outstanding and that made the colour on the final work look appealing and interesting despite the bleeding. The colours were more distinct from each other and more defined at the edges.

Poster Colour (Plate 12): The poster colour dried very fast on the linen sheet upon application as the colour bled through the reverse side of the sheet. All the same the final work appeared well. The paper felt harder than before the painting was done.



Plate 8: Colour pencil



Plate 9: Watercolour



Plate 10: Pastel



Plate 11: Oil and Acrylic paint

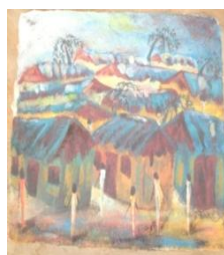


Plate 12: Poster colour

Reaction of Cotton and Mulberry Papers to Drawing and Painting Mediums (Plates 13 – 18)

Colour Pencils (Plate 13): Colour pencils worked excellently on the cotton sheets. There was no removal of fibre content from the surface of the sheet even when the pencils were scratched hard on the surface of the sheet; the finished work also appeared good. The colours were outstanding and had a glossy appearance.

Watercolour (Plate 14): When watercolour was applied on the cotton it dried slowly. It made the colours run into each other to create accidental effects on the sheet. There was a feeling of freshness shown with the watercolour in the finished work. The transparent quality of watercolour was also seen in the work. There was no bleeding of the colours.

Pastel (Plate 15): The pastel sticks created excellent effects on the roughly textured side of the cotton sheet. The fibres on the surface of the paper did not peel off during the application of the pastel on it. The sheet accepted the pastel very well and allowed the individual colours to stand out as vivid as possible. The finished work appeared like real objects that could be picked from the sheet.

Oil Paint (Plate 16): The cotton sheet reacted well with the oil paint: the structure of the work was well defined without any bleeding of the paint. However, there was a slight seeping of the oil solvent through the paper to the back. There was no fading of the colours after the work dried.

Acrylic (Plate 17): The acrylic paint worked well on the cotton sheet: the structure of the work came out well with a slight bleeding of the paint through the back of the sheet. The edges of the work were well defined and the acrylic demonstrated no fading. The colours were solid on the paper.

Poster Colour (Plate 18): The colours in the work were distinct from each other with a well defined work. The poster colour did not show any bleeding and fading effects on the paper.



Plate 13: Colour pencil



Plate 14: Watercolour



Plate 15: Pastel



Plate 16: Oil



Plate 17: Acrylic

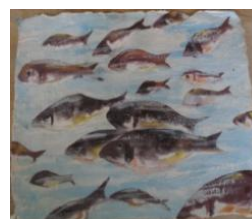


Plate 18: Poster colour

Reaction of Nylon and Mulberry Papers to Drawing and Painting Mediums (Plates 19 – 23)

Colour Pencils (Plate 19): The movement of the colour pencils on the nylon sheet made the fibre content peel off hence its unsuitability for colour pencil work.

Watercolour (Plate 20): Although fibres of the nylon paper peeled off very easily, gentle brush strokes with watercolour exhibited very good effects. Looking at the work critically, there were small spaces within the painted area which did not take the watercolour paint: these accidental effects made the work unique. The bleeding of the paint on and through the sheet did not make the work to be well defined. The sheet also absorbed the paint very fast when it was applied.

Pastel (Plate 21): The pastel sticks made the fibre content of the nylon sheet to flake. Pastel control was quite difficult as any little pressure applied on the pastel removed the fibres from the surface of the fabric.

Oil and Acrylic Paint (Plate 22): The combination of the two colours on the nylon sheet appeared very strongly in a well-defined composition but with a slight bleeding at the reverse side of the sheet.

Poster Colour (Plate 23): The gentle application of the poster colour on the nylon sheet produced a well defined work which did not bleed.



Plate 19: Colour pencil



Plate 20: Watercolour



Plate 21: Pastel



Plate 22: Oil and Acrylics



Plate 23: Postercolour

Reaction of Polyester and Mulberry Papers to Drawing and Painting Mediums (Plates 24 – 28)

Colour Pencils (Plate 24): Just like the nylon sheet, the fibre content of the polyester sheet also flaked off when the colour pencils were applied on it.

Watercolour (Plate 25): The watercolour paint applied on the polyester sheet dried quickly as it bled to the back of the sheet. This made paint control difficult but the final work looked well defined with bright colours.

Pastel (Plate 26): The pastel sticks made the fibre content of the polyester sheet to flake off. This made it difficult to control their application.

Oil and Acrylic Paint (Plate 27): The oil and acrylic paint bled through the polyester sheet, but created a well defined painting on the sheet. The sheet felt flabby after the painting.

Poster Colour (Plate 28): The combined polyester and mulberry sheet received the poster paint well without any problem; however the dried poster colour felt very hard on the polyester sheet.



Plate 24: Colour pencil



Plate 25: Watercolour



Plate 26: Paste



Plate 27: Oil and Acrylics



Plate 28: Poster colour

Reaction of Wool and Mulberry Papers to Drawing and Painting Mediums (Plates 29 – 33)

Colour Pencils (Plate 29): The use of colour pencils on the surface of the woollen sheet made the fibre content of the sheet peel off.

Watercolour (Plate 30): There was no fluidity in the watercolour work on the woollen sheet and the transparency effect of watercolour was completely lost in the work. The colours also looked dull on the paper due to the colour of the wool.

Pastel (Plate 31): The application of pastel strokes on the woollen sheet made the fibre content of the woollen sheet peel off. This made it uncomfortable to work with the pastel sticks on the sheet.

Oil and Acrylic Paint (Plate 32): The application of the oil and acrylic paint on the woollen paper worked well to bring out the features of the work. The two painting mediums worked well on the paper.

Poster Colour (Plate 33): The poster paint dried very fast after its application on the woollen sheet but there was no bleeding of the paint on the reverse side of the sheet. The poster paint on the woollen sheet was very hard when felt.



Plate 29: Colour pencil

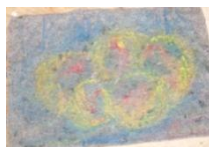


Plate 30: Watercolour



Plate 31: Pastel



Plate 32: Oil and Acrylics



Plate 33: Poster colour

Reaction of Acetate and Mulberry Papers to Drawing and Painting Mediums (Plates 34 – 39)

Colour Pencils (Plate 34): The application of colour pencils on the acetate sheet made the surface fibres to flake off. The colour therefore did not appear well on the surface of the paper.

Watercolour (Plate 35): The watercolour paint on the acetate sheet showed similar qualities as that of the watercolour on the nylon sheet. The sheet absorbed the paint quickly when it was applied. The paint's inability to take certain portions within the work also created excellent accidental effects.

Pastel (Plate 36): The pastel strokes made the acetate sheet flake off. It was therefore difficult to control the pastel on the paper. Due to this, the pastel appeared faint and invisible on the paper.

Oil Paint (Plate 37): In applying the oil paint on the acetate sheet, the fibre content of the acetate sheet clogged to the ferrule part of the painting brush which made the painting difficult. Although there were loose fibres on the surface of the paper, the paper supported the oil paint well; this was evident from the work.

Acrylic Paint (Plate 38): The application of the acrylic paint was done without any fibre removal from the acetate sheet and the finished work looked fine and smooth. The paint was bright and vivid on the paper. The colours were distinct as well and there was no evidence of fading of the work.

Poster Colour (Plate 39): Poster colour application on the acetate sheet was successful without any problem. The dried poster paint on the sheet was hard when felt. The poster was well supported by the paper. The colours looked natural and fresh on the paper. There was no evidence of pale or fading effect on the work.



Plate 34: Colour pencil



Plate 35: Watercolour



Plate 36: Pastel



Plate 37: Oil



Plate 38: Acrylics



Plate 39: Poster colour

Reaction of Linen, Cotton and Mulberry Papers to Drawing and Painting Mediums (Plates 40 – 44)

Colour Pencils (Plate 40): Working with colour pencils on the mixture of linen, cotton and mulberry sheet was excellent. The strong and hard nature of the sheet made the pencil strokes to appear well.

Watercolour (Plate 41): The application of watercolour on the sheet dried very fast, with the colour bleeding through to the reverse side of the sheet. The finished work looked defined but had a pale appearance. The paper looked a little wrinkled after the paint had dried.

Pastel (Plate 42): The pastel also worked excellently on the sheet, with the final work appearing very well. The fibres on the surface of the paper did not peel off during the application of the pastel on it. The sheet accepted the pastel very well and allowed the individual colours to stand out.

Oil and Acrylic Paint (Plate 43): These paints worked well on the sheet, with the finished work appearing bright and fresh. The media did not bleed through the paper but the oil solvent bled through at the points of high concentration.

Poster Colour (Plate 44): The poster colour application on the mixture of linen, cotton and mulberry sheet was successful and excellent. The paper felt harder than it was before it was used for the painting. The colours were distinct from each other and the work had well defined edges. The poster colour also did not show any fading effect on the paper.

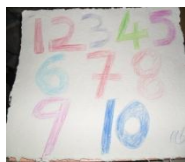


Plate 40: Colour pencil



Plate 41: Watercolour



Plate 42: Pastel



Plate 43: Oil and Acrylics



Plate 44: Poster colour

The testing with the identified drawing and painting mediums on the produced handmade papers showed clearly that Colour pencil did not work well on linen, nylon, polyester, wool and acetate sheets because the fibres of the sheets did not bond together strongly. With the nature of application of the coloured pencils, the loose fibres of the sheets could not stand the pressure. Cotton and the mixture of linen, cotton and paper mulberry worked excellently with the colour pencils because of the strong bonding nature of the fibres of the sheets. The bleeding and fast drying of the watercolour that was recorded on linen, nylon, polyester, wool, and acetate was due to the porous nature of the sheets. The mixture of linen, cotton and paper mulberry sheets also recorded bleeding and fast drying although the fibres of the sheet looked compact. This could be that there is a degree of porosity with the sheet due to the linen fibre content. This means that in order to work comfortably with watercolour on linen, nylon, polyester, wool, acetate, and the mixture of linen, cotton and mulberry sheets, the painting must be done quickly and fast. Only cotton combined with the mulberry sheet, recorded no bleeding and slow drying of the watercolour paint. This means that, the compact nature of the fibres of the sheet made the watercolour to dry slowly which resulted in the easy control of the paint on the sheet.

Like the colour pencils, pastel did not work well on linen, nylon, polyester, wool and acetate because of the inability of the fibres of the sheets to bond together strongly. Again, cotton and the mixture of linen, cotton and paper mulberry sheets worked excellently with the pastel sticks because of the firm bondage of the fibres of the sheets. This means that pastel sticks can be suitably used on handmade sheets from cotton waste combined with paper mulberry and the mixture of linen, cotton and paper mulberry sheets. With regard to the seven sheets tested with the oil and acrylic paints, all of them appeared well although the different sheets exhibited different qualities in reaction to the two paints. This means that all the seven sheets can support oil and acrylic paints well. This suggests that linen, cotton, nylon, polyester, wool, acetate and the mixture of linen, cotton and paper mulberry sheets can support poster paint very effectively although linen recorded some bleeding.

Suitability of Handmade Papers in Book Form

Linen and Mulberry Papers: The sheets were comfortably sewn into a book but the mushy nature of the linen sheets made writing on them feel foamy. This nature of the paper caused the writing to look blurred and faint. Because of the soft nature of the sheets, the paper made no flipping sound when the pages were flipped. See Plate 45 for finished sample.

Cotton and Mulberry Papers: With the crispy nature of the thin sheets produced from the cotton fabrics and mulberry, it was very easy sewing a book out of the sheets and writing on the sheets also felt like writing on machine made papers. The writing was very legible on the paper. The book was easy to open because the sheets could be easily flipped. Flipping sounds were made when the sheets were flipped. See Plate 46 for sample of book.

Nylon and Mulberry Papers: Sewing a miniature book out of the nylon sheets was not comfortable because the fibres peeled off when holes were punched in. In addition, because of the fluffy and soft nature of the sheets, they tore apart when sewing was done. Writing in the book made the fibres flake. The entire book felt soft to the touch and the touch could be compared with a soft carpet. The pages made no flipping sound upon flipping. The writing was not very legible in the book and it appeared faint. The pages also remained in position when flipped. See Plate 47 for finished book.

Polyester and Mulberry Papers: The polyester sheets were sewn into a miniature book without any problem, but the fibre content of the sheets flaked off when the sheets were written on. The writing was not legible and it appeared faint on the paper. No flipping sound was heard when the sheets were flipped and the sheets did not return to their position when flipped. See Plate 48 for sample of book.

Wool and Mulberry Papers: Making a miniature book out of the woollen sheet was not very suitable. The soft and non-crispy nature of the sheet coupled with the loose bonding of the fibres made the sewing thread to tear through the sheets. Writing on the sheets also made the fibre content peel off. The writing was not legible on the sheets it appeared faint and blur. The book was a bit thick when felt and the pages made no flipping sound when flipped. See Plate 49 for sample of book.

Acetate and Mulberry Papers: The fibre content of the sheets was flaking off as the book was being sewn. Writing on the sheets also made the fibre content peel off. The writing appeared faint, dull and blur on the sheets. The entire book was soft to the touch and it could be likened to a soft carpet. See Plate 50 for sample of book.

Linen, Cotton and Mulberry Papers: The strong nature of the sheets produced from the mixture of linen, cotton and mulberry fibre made it easy sewing a miniature book out of it. Writing on the sheets was comfortable and suitable. The writing was very legible on the sheets. The flipping sound made by the sheets when they were flipped was low as compared to that of the combined cotton and mulberry sheets. See Plate 51 for finished book.

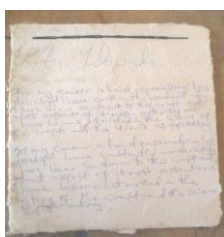


Plate 45

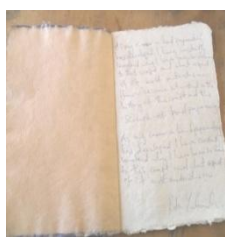


Plate 46



Plate 47



Plate 48



Plate 49



Plate 50

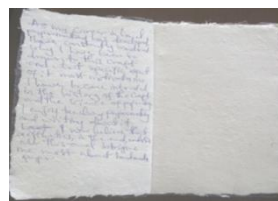


Plate 51

Considering the suitability of these handmade papers being used as miniature books, the combined cotton waste and paper mulberry and the mixture of linen, cotton and paper mulberry sheets worked excellently because of the strong bondage of the fibres of the sheet. Linen worked partially because, although the sheets could be written on, the foamy nature of the sheets made it very uncomfortable to use. The nylon, polyester, wool and acetate sheets did not work as writing pads because of the fluffy nature of the sheets. It can be concluded that

paper derived from the combination of cotton and paper mulberry and the mixture of linen, cotton and paper mulberry can produce useful sheets of papers that can be used as writing pads.

As the findings of the study indicate, the large volumes of fabric waste generated by both the large textiles manufacturing industry and small-scale garment makers in this country can be collected and reused to ease pressure on landfills, gutters, open drains, markets, open spaces and other places where waste accumulates and also to protect the environment and human health. This can help reduce the formation of leachate that emanates from decomposed waste within landfills, which has the potential to contaminate ground water in this country. The project also points to the fact that recycling textile waste into useful products such as art paper is an appropriate method of protecting and preserving the environment because ecologically, recycling conserves natural resources like water, trees and other minerals.

Recycling of textile waste, if organised and done properly, can generate a livelihood for the many unskilled workers and unemployed youth in Ghana and other countries; and when citizens begin to perceive waste materials such as waste fabric as potential recyclable materials, they can propagate the concept of “waste is money” to support income generation and proper use of leisure hours in this country. This can also encourage both the young and old to take up environmental issues seriously and take pragmatic steps to help save our environment. Recycling may also be considered as an economically beneficial venture in Ghana and other developing nations because it provides significant employment opportunities to a large informal sector. Incorporating recycling of waste materials in teacher training college programmes could expose newly-qualified teachers to the importance of saving the local environment to enable them to serve as change agents who would motivate their students to develop positive attitudes towards the environment. Teachers could even initiate recycling clubs in schools, colleges and universities to engage more people in learning and adopting creative ways of problem-solving through recycling as they develop skills of identifying, sorting, cutting, pulping, cooking, couching, blending, stitching, drawing, painting and writing through recycling of waste fabrics.

The whole exercise of processing fabric waste into useful art papers can help reduce educational costs as Visual Arts could use these papers for class activities and use conventional art papers which are all imported and therefore expensive for examination purposes. This way, teachers can give copious assignments to encourage creativity among their students and also encourage entrepreneurship based on recycling. This would create jobs and wealth for many of the unemployed youths and also promote the “I-can-do-it” attitude in Ghanaians. This could offer opportunities for occupational and art therapy for people in various health situations.

Summary

The descriptions above indicate the variety of papers that can be obtained from the waste fabrics and the paper mulberry bark. This indicates that the nature of each type of fabric has some effects on the sheets they generate. It is evident here that Colour pencils are unsuitable tools for artwork on linen, nylon, polyester, wool and acetate sheets mainly because the fibres of the sheets did not bond together strongly and can therefore not withstand the kind of pressure required in using Colour pencils for art activities. It was realized that sheets derived from Cotton as well as sheets from the combination of linen, cotton and paper mulberry worked perfectly with Colour pencils because of the strong bonding between the fibres.

Bleeding and fast drying occurred with watercolour work on linen, nylon, polyester, wool, and acetate sheets due to the porous nature of these sheets. Similarly, the mixture of linen, cotton and paper mulberry sheets also recorded bleeding and fast drying although the fibres of the sheets looked compact. This is probably due to porosity in the linen fibre content in the sheet, implying that watercolour painting exercises on linen, polyester, wool, acetate, and the mixture of linen, cotton and paper mulberry sheets must be done quickly and accurately within a short time. The only type of sheet that recorded no bleeding and also encountered slow drying of watercolour painting was the Cotton combined with paper mulberry sample. It is clear that the compact nature of the fibres in the sheet slowed down the drying of watercolour, making it easy to control the painting and drying process on the sheet.

Like the Colour pencils, Pastel did not work well on linen, nylon, polyester, wool and acetate because of the inability of the fibres of the sheets to bond together strongly. However, Cotton and the mixture of linen, cotton and paper mulberry sheets worked excellently with the Pastel sticks because of the firm bondage of the fibres of the sheets. This makes Pastel a suitable medium for art activities on sheets derived from Cotton fabric waste combined with paper mulberry fibre, and the combined linen, cotton and paper mulberry sheets. With regard to oil and acrylic paints on all seven types of sheets, all went well although the different sheets exhibited different qualities in reaction to the two paints. This means that all the seven sheets can support oil and acrylic paint work. The tests also indicate that linen, cotton, nylon, polyester, wool, acetate and the mixture of linen, cotton and paper mulberry sheets can support Poster paint work very effectively although linen recorded some bleeding.

Further testing of the different sheets as writing materials showed that differences exist in the way each type of paper made from the different fabrics and paper mulberry fibre reacted to their use in book form. Considering the suitability of these handmade papers as material for books, the study showed that the Cotton waste and paper mulberry, and the combined Linen, cotton and paper mulberry worked excellently because of the strong bondage of the fibres of the sheets. Linen worked partially well; although the sheets could take some writing, its foamy nature made it very uncomfortable to write well on them. The nylon, polyester, wool and acetate sheets did not work as writing pads because of the fluffy nature of the sheets. The implication is that papers derived from the combination of cotton and paper mulberry, and the mixture of linen, cotton and paper mulberry can produce useful sheets of papers suitable for use as writing pads.

Conclusion

This research proves that linen, cotton, polyester, nylon, wool and acetate waste fabric contents when combined with the inner bark of the mulberry fibre in hand papermaking can produce useful papers that can support different drawing and painting mediums in various ways. Paper mulberry grows widely in Ghana and can be found almost everywhere in Ashanti Region. In view of this, the authors suggest that the Government of Ghana should take steps to establish a pulp and paper mill in Kumasi where waste fabrics and paper mulberry which is in abundance in the country can be used for manufacturing papers for local use as well as for export. In recycling waste fabric, Ghana can also use mulberry fibre to produce calligraphy papers, envelopes, decorative papers, business cards, notebooks, and papers for art work like the Japanese and thereby cut down on the spending of scarce foreign exchange on imports of these paper products.

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References

- Aggarwal, R. (2010). *Recycle and reuse of textiles*. Retrieved September 27, 2010, from http://www.techno-preneur.net/information-desk/sciencetech_magazine/2010/april10/Reuse-Textiles.
- Barrett, T. (1983). *Japanese papermaking: Traditions, tools, and techniques*. New York: John Weatherhill, Inc.
- Barry, L. (2000). *Textiles*. Retrieved July 09, 2010, from http://www.wasteonline.org.uk/resources/Wasteguide/mn_wastetypes_textiles.html.
- Bosu, P., Apetergor, M., Refera, A. (2009). *Invasive plants and forest Ecosystems: Ecology and Management of Tropical Africa's Forest Invaders*. London and New York: CRC Press-Taylor and Francis Group.
- Caulfield, K. (2009). *Sources of textile waste in Australia*. Retrieved September 07, 2010,

From <http://www.ttna.com.au/TEXTILE%20WASTE%20PAPER%20March%20>.

- Darkwa, N. A. (1996). *Paper imports and consumption patterns in Ghana*. *Ghana Journal of Forestry*. 3, 55-60.
- Farnsworth, D. S. (1989). *A guide to Japanese papermaking: Making Japanese paper in the Western world*. Oakland, California: Magnolia Incorporated.
- Hiebert, H. (1998). *Papermaking with plants*. Pownal, Vermont: Story Books.
- Leedy, P.D. & Ormrod, J.E. (2005). *Practical Research: Planning and Design* (8th edition). Upper Saddle River, NJ: Pearson Education.
- McMinn, D. (2004). *Paper mulberry: A worse weed than camphor laurel*. Retrieved May, 23, 2010, from <http://www.davidmcminn.com/ngc/pages/papermul.htm>.
- Morgan, E.C. & Overholt, W.A. (2004). *Wildland weeds: Paper mulberry, (Broussonetia papyrifera)*. Retrieved September 23, 2010, from ENY-702, <http://edis.ifas.ufl.edu/in498>.
- Smith, G. Z. (1995). *Teaching hand papermaking: A classroom guide*. Cedar Rapids: Zpaperpress.

THE EFFECT OF CONFLICTS AMONG EXECUTIVES OF IDENTIFIABLE STUDENTS GROUPS ON THE PERFORMANCE OF EXECUTIVES AND ACHIEVEMENT OF GOALS. A CASE STUDY OF KOFORIDUA POLYTECHNIC

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Abstract

Conflict is a pivotal variable influencing team decision and performance. The objective of this research work is to assess the causes of conflict among identifiable student groups in Koforidua Polytechnic, determine how to address team conflict and to improve the ability of the executives of the various students groups to manage and to build teams that could deal effectively with both healthy and unhealthy conflicts. This research work reviewed literature on intra-group conflict and studied how the different types of conflicts affect team decision quality and achievement of goals. The main tools for data collection were questionnaires and interview. A survey on all the group executives in the institution was conducted and found that the roles of all the groups were properly defined. The common causes of conflict included mismanagement of funds, disloyalty of some members, undermining each other as well as usurping each other's role. It was also found that both task conflict and relationship conflict were negatively affecting team members' decision and performance. Most of these conflicts were unresolved because the executives had no training in conflict resolution as a result were not aware of the symptoms of conflict and the resolution strategies that were available to them so these conflicts were ignored consciously or unconsciously for the fear that they will assume responsibility for the resolution. The study also showed that conflicts could be minimized if the various executives were given training on the symptoms, causes and prevention of conflict before they assume their positions.

Key words: Conflict; Performance; Personality clash; Undefined roles; Usurping role

Introduction

Conflicts start when an individual perceives that someone is negatively affecting or about to affect, something they care about. It occurs as a series of episodes between those involved, with each episode shaping how the conflicts are subsequently perceived and managed. Although conflicts is popularly thought of as involving a win-lose struggle, many conflicts in the work place occur between individuals and small groups who share similar goals but disagree over the means by which they can be achieved. Personal agendas may drive member participation, and members push their own ideas regarding task definition and resolution.

Although conflict is a normal part of life, learning how to resolve conflict effectively can be a daunting task, particularly in groups. Addressing conflict should be viewed as an important element in achieving group effectiveness and enhancing productivity. Many groups, however, suffer chronic patterns of unresolved conflict that are costly and often symptomatic of serious group dysfunction. According to Dana 1999, Slaikev and Hasson 1998, some experts believe that unresolved conflict represents the largest reducible cost in many businesses, yet it remains largely unrecognized without a clear picture of the real costs associated with conflict, the priority for developing healthy resolution strategies is likely to remain low.

Early conflict and groups theorists have focused on the negative effects of team conflict (Brown, 1983; Hackman & Morris, 1975; Pondy, 1967; Wall & Callister, 1995). Conflict has been suggested to interfere with team performance and reduce satisfaction because

it produces tension, antagonism, and distracts team members from performing the task. Empirical evidence has supported the negative relationship between conflict and team productivity and satisfaction (Gladstein, 1984; Saavedra, Earley, & Van Dyne, 1993;

Wall & Nolan, 1986). Deutsch (1973), Coser (1956), and Walton (1969) recognized that low levels of conflict could be beneficial. When in conflict, people confront issues, learn to take different perspectives, and need to be creative (Levine, Resnick, &

Higgins, 1993; Nemeth, 1986; Tjosvold, 1997). When conflict is absent, teams might not realize that inefficiencies exist. Indeed, research by Schulz-Hardt, Mayer, and Frey (2002) showed that teams made better decisions when pre-discussion preferences were in disagreement rather than agreement.

Problem Statement

Each person has different talents, there is much to be gained by people working together, and accomplishing together what none could do alone. But because each person also has different needs and views, there will always be some conflict in living and working with others. By understanding more of what goes on in conversations, we can become better team problem solvers and conflict navigators. Learning to listen to others more deeply can increase our confidence that we will be able to engage in a dialogue of genuine 'give and take', and be able to help generate problem solutions that meet more of everyone's needs.

Unresolved conflict can create serious and quite varied consequences. For example, small group conflicts often create project delays that can result in missed market opportunities. The development of effective work groups and teams can fail as a consequence of disputes between members. How conflicts get resolved is the critical factor in any relationship. In fact, it is the most critical factor in determining whether a relationship will be healthy or unhealthy, mutually satisfying or unsatisfying, friendly or unfriendly, deep or shallow, intimate or cold. Conflict is an ever-present process in human relations. Potential for conflict exist wherever human contact exists.

It is upon these facts that the Professional Studies Department of Koforidua Polytechnic is conducting the research on conflict among executives of identifiable student's group on the achievement of goals in the polytechnic and how to manage the conflicts effectively. This type of research has not been conducted in the institution before now.

General Objective

The objective of this research work is to understand the causes of conflict among identifiable student groups in Koforidua Polytechnic, determine how to address team conflict using specific tools, skills, and processes; and to improve the ability of the executives to manage and to build teams that can deal effectively with both healthy and unhealthy conflict.

Specific Objectives

- To identify the types of conflicts that exist among the executives of the various groups in the institutions.
- To assess the causes of conflict among the groups.
- To examine the extent to which conflicts affect the achievement of goals.
- To organize interventions on how to manage conflicts effectively among the groups.

Research Questions

The study seeks to answer the following questions:

1. What are the types of conflict that exist among the executives of the various students groups in the institution?
2. What are the causes of these conflicts?
3. How do these conflicts affect the achievement of goals in the various groups?
4. To what extent are conflicts important to the achievement of goals to the group?

Significance of the Study

The significance of this study is to assist in helping the identifiable groups to effectively manage conflict to be able to achieve their stated goals. This study will help the institution, policy makers, respondent and reader to be mindful of the existence of conflicts among groups in the polytechnic, the importance of conflicts, and how to manage conflicts effectively in and among the executive.

Methodology

Research design

The study used the descriptive survey design. This involves gathering data with the aid of survey instruments which was based on a description of the phenomenon under study, that is, conflicts among executives of identifiable student groups on the achievement of goals at Koforidua polytechnic. Two Hundred and Fourteen (214) respondents were drawn from all the executives of the identifiable groups in the polytechnic, using purposive and simple random sampling methods. Out of the total population size, 150 were sampled for the study. 10% of respondents were interviewed and 90% given questionnaires relating to conflict and its management to complete. The data collected from respondent were carefully checked and edited. The data analysis of the study was aided by the use of the bar chart and frequency tables. The data was subjected to frequency counts.

Population

The focus of this research was on the identifiable students groups in Koforidua Polytechnic There are Eight (8) subject associations, ten religious groups, four main regional groups in this population, three political groups and the Students' Representative Counsel (SRC). The members of all these executive groups total Two Hundred and fourteen (214).

Sample Size

Data was collected purposively from the three Schools and all the departments within the schools. These are School of Business and Management Studies (SBMS), School of Applied Science and Technology (SAST) and School of Engineering (SOE). The reasons for purposively using these selected school is that they are the ones the polytechnic has and they have the subject groupings and other groups and have executives for the groups. Out of the ten (10) religious groups five executive groups were selected using the Lottery Method. All the four regional group executives identified were used for the study and the SRC. The total sample is One Hundred and Fifty (150) executives. Each individual member of the various group executives were then selected using the simple random sampling method using a table of random numbers. This was done to give everybody in the identifiable student executive groups an equal chance to be selected.

Findings

Demography

The demographic characteristics of respondents revealed that 8% of the respondents in the executive groups are male. This implies that the ladies do not go in for positions in the institution.

Task related conflict

According to Eva Rykr (2010), there are many reasons for conflict within a team or between teams. One way to simplify the source of the conflict is to examine whether the conflict is task-based or if it stems from a relational issue. This separation is often helpful because, generally speaking, task-based conflict is productive while relationship-based conflict is destructive to the desired outcome. Often, though, conflict is complex and does not have a single source that can be pinpointed and identified as one or the other.

This research found out that 70% of the executives have issues base on the task they set themselves. Some of these issues were poor planning, incompatible interests, disagreement about strategy, and lack of focus, and the setting of unclear objectives. According to the respondents these have led to serious disagreements among some of the executive members leading to gossip, passive or aggressive behavior, hostility, finger pointing, hoarding information that should be shared, and complaining to the extent of verbal abuse in some cases.

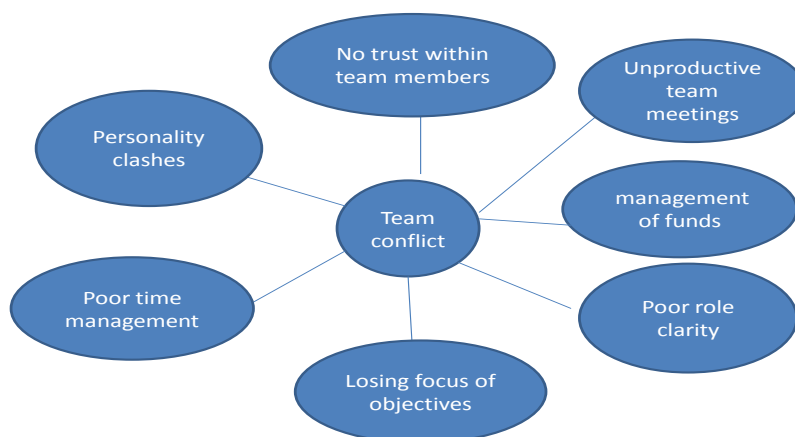
Some of these causes of conflict can be constructive as long as it is managed and dealt with directly and quickly. By respecting differences between people, being able to resolve conflict when it does happen, and also working to prevent it. The key is to remain open to other people's ideas, beliefs, and assumptions. When team members learn to see issues from the other side, it opens up new ways of thinking, which can lead to new and innovative solutions, and healthy team performance.

This finding confirms the interview with some of the executives that left the institution in the year 2011 which led to some of the executive members resigning from their position.

Financial mismanagement

According to 80% of the respondent, mismanagement of funds by some of the executive members most of the time lead to argument and name calling among the executives. Some of the executive stated, “When we all agree on how much to be spent on a programme, and reduced amount is given for the programme, other executive members will think you have used part of the money”. Others said “when it comes to programmes that involve spending money, some of the executive members will be asking for their share of the money and if you do not give them then they will be saying that you are spending the money for your personal use’.

Causes of conflict among the executives in the various groups



Source: fieldwork 2012

Poor Role Clarity

The research revealed that all the executives have their constitution and the role of each position is clearly stated in their constitutions. It was observed that 60% of the executives do not truly understand the role they are to play clearly causing other executives going beyond their roles and responsibilities. In addition, it is often assumed that team members understand what is being asked of them. This assumption can be incorrect, leading to team members being unclear on what needs to be accomplished.

No Trust within Team Member

80% of the respondent stated that executive members do not trust each other or are suspicious of each other's motives; the end result is a team that is not cohesive in its approach to the achievement of the goals they set themselves.

Unproductive Executive Meetings

According to 65% of the respondents some of the executive meetings they attend become unproductive because they argue over the procedures they use in arriving at consensus or the procedure to accomplish a particular programme which sometimes leads to the adjournment of meetings. Respondents stated that when executive members disagree about the procedures to be followed in accomplishing the group goal new procedures may be formulated and a new agenda suggested. Even the group goal may be modified to be able to achieve goals but these goals are not achieved in the end.

This contradicts the assertion of Barker et al. (1987) that procedural conflict, like task conflict may be productive.

Poor Time Management

90% of the respondents stated that poor time management lead to conflict among some of the executive members. This is so because some of the executives are free during some times of the week and will always place activities at their free time forgetting about other executive members. In an interview with some of the executive members this were their responses, “We waste time at most of our meetings arguing over issues that are sometimes unnecessary causing some of us to miss lectures”. “The way we waste time at our meetings does not make me feel like going for the meetings, all I do is to ask for permission to be absent and I use my time to learn.”

Personality Clashes

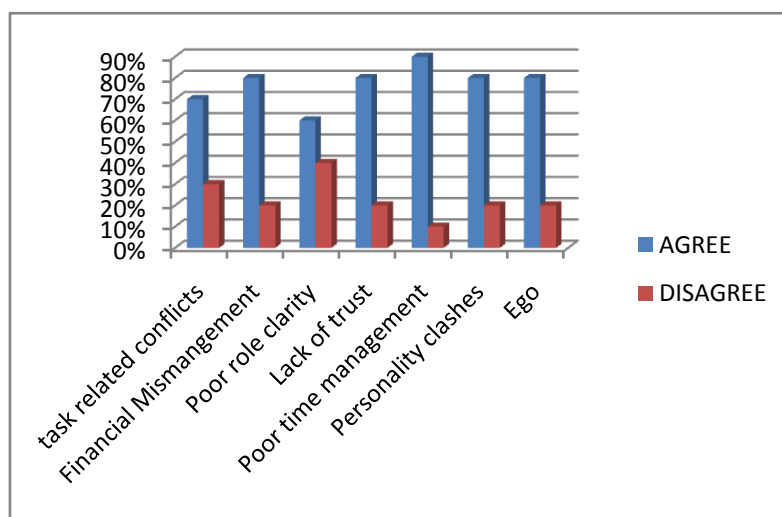
These types of conflict within the executive are often fueled by emotion and perceptions about somebody else's motives and character. 85% of the respondents stated that sometimes some of the executive members' jump on some of the executives for being late because they view those members as being lazy and disrespectful. 70% of the executive members sometimes disagree with the team leaders. This sometimes led to refusal to follow the direction of the team leaders.

Ego

A person's ego is a strong motivator in how some of the executive members act and in the decisions they make. 80% of the respondents stated that the ego of some of the executive members can cause them to feel they are always right. Some of them will refuse to accept they are wrong, even when it is very clear that they are wrong.

A Bar Chart showing Summary of Causes of Conflict among Executives of Identifiable Group

CAUSES	AGREE	DISAGREE
Task related conflict issues (poor planning, lack of focus, incompatible interest	70%	30%
Financial management	80%	20%
Poor role clarity	60%	40%
Lack of Trust	80%	20%
Poor Time management	90%	10%
Personality clashes(emotion and character)	80%	20%
Ego	80%	20%



Source: Field work 2012

Some Effects of Conflicts on the Performance of the Executives

In an interview with some of the respondents on the effects of conflict on the performance of the executive, some of the respondent said, "No decision is reached and problem still exists. Conflicts destroy the morale of the executive members, divides them leading to alliances with other groups to expose some of the members".

70% of the respondents stated that conflicts take attention away from other important activities and reducing cooperation and participation of the entire student body in the programme of the groups.

Some of the comments on the effect of conflict on performance of the executives are: "it leads to irresponsible and harmful behavior, such as fighting, name-calling and gossiping among members which in effect makes those affected stop performing their function". Others interviewed said "the kind of conflict that happens in the group waste time, energy, reduce efficiency and lead to aggression on the part of those who are involved.

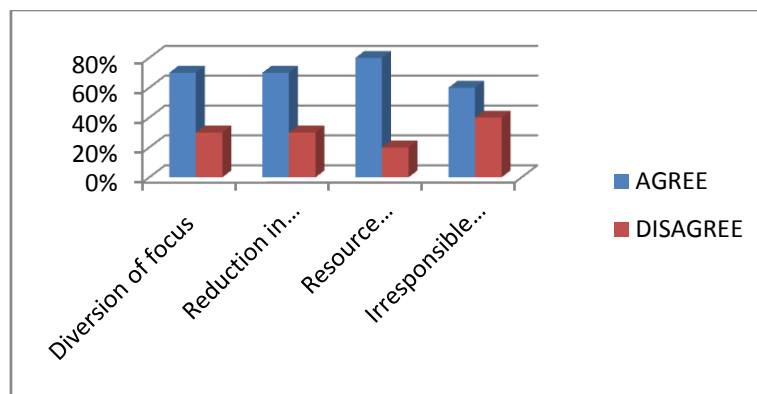
The studies indicated that conflicts lead to reduction in productivity of disputants and their peers when conflicts are unresolved. Tension and stress reduce motivation and disturb concentration and leads to miscommunication with other groups resulting from confusion.

The above effects of conflicts support the assertion of Kirchhoff and Adams, (1982) conflicts lead to **unproductive use of valuable time**. Studies indicate that managers spend between twenty-five and forty percent of their time dealing with employee conflict. The overall result of such negative effects of conflicts is the reduction of team commitment to goals and group efficiency.

Effects of Conflicts on Performance of Executives

Effect	Agree	Disagree
Diversion of focus	70%	30%
Reduction in productivity	70%	30%
Resource mismanagement	80%	20%
Irresponsible behavior	60%	40%

A Bar Chart showing Summary of Result of Effect of Conflicts on Performance.



Source: Field work 2012

Ways of Dealing with Conflict

"Conflicts are part of individual relationships and organizational development, and no relationship or organization can hope to mature to productivity and be successful without being able to resolve conflicts effectively" (Cottringer, 1997, p. 6). Clearly, one of the main responsibilities of any group leader is to resolve conflict. The two key goals for a group leader are to remain impartial, and to facilitate understanding among the group members. However, this research revealed that when conflicts were preserved in most cases they are ignored without the leader calling those involve to find out what the problems were.

Conclusions

In diverse and heterogeneous teams, negative conflict has a tendency to emerge in varying degrees due to the mere dynamics of having diverse individuals with differing backgrounds, ideas, and potential agendas coming together.

Diagnosing is the first step in solving the problem and this is not done among executives in the various groups in the institution. Some of the issues such as not understanding roles and losing focus of business objectives, personality clash and poor time management are the causes of conflict among the groups and this could be solved by a discussion with the team members. Some of the other problems like poor trust, and poor team interaction can be better tackled through team building exercises.

When teams in an organization display problems, then the solution may lie in a deeper analysis of the problem and exploring the areas mentioned above to find a resolution. This strategy was not known to the group members and lead to ignoring the conflict.

Building strong relationships through effective communication is the primary work of any leader. When you have the trust of others and they believe that by collaborating with you their results will improve then you have the world at your feet.

Trust is also critical to this type of conflict, so any means of developing better trust levels within the group would also be effective here. In conflict situations, team members will never trust each other, but they can be trained ahead of time to trust the conflict resolution process.

Recommendation

1. There should be orientation for all who have been elected or appointed to positions in the institution to explain the tasks each member is to perform, their expectations and timeframes to complete each task.
2. Executive members in the various groups should plan their goals and activities well keeping time constraints and deadlines in mind.
3. Executive members of the various groups should be coached on how to communicate effectively.
4. There is the need for each executive group to develop a team agreement on how the group will resolve conflict if it does occur.
5. There should be a training programme for the various executive members on how to work as a team.

Executives should be taken through the causes, effect and prevention of conflict before they begin to work.

Reference

- Alper, S., Tjosvold, D. & Law, K. S. (2000). Conflict management, efficacy, and performance in organizational teams. *Personnel Psychology*, 53, 625–642.
- Barker, Larry L., Kathy J. Wahlers, Kittie W. Watson, Robert J. Kibler, (1987). *Groups in Process: An Introduction to Small Group Communication*, Third Edition. Prentice Hall, Englewood Cliffs, NJ.
- Brown, L. D. (1983). *Managing conflict at organizational interfaces*. Reading, MA: Addison-Wesley.
- Coser, L. A. (1956). *The functions of social conflict*. New York: Free Press.
- Cottringer, W. (1997). Conflict Management. *Executive Excellence Magazine*, Vol 14 (Issue 8), p 6
- Deutsch, M. (1973). *Conflict resolution: Constructive and destructive processes*. New Haven, CT: Yale University Press.
- Gladstein, D. L. (1984). A model of task group effectiveness. *Administrative Science Quarterly*, 29, 499–517.
- Kirchoff, N., & Adams, J.R. (1982). *Conflict Management for Project Managers*. Drexel Hill: Project Management Institute.
- Saavedra, R., Earley, P. C., & Van Dyne, L. (1993). Complex interdependence in task-performing groups. *Journal of Applied Psychology*, 78, 61–72.

- Schulz-Hardt, S., Jochims, M., & Frey, D. (2002). Productive conflict in group decision making: Genuine and contrived dissent as strategies to counteract biased information seeking. *Organizational Behavior and Human Decision Processes*, 88, 563–586.
- Tjosvold, D. (1997). Conflict within interdependence: Its value for productivity and individuality. In C. K. W. De Dreu & E. Van de Vliert (Eds.), *Using conflict in organizations* (pp. 23–37). London: Sage.
- Walton, R. E. (1969). *Interpersonal peacemaking: Confrontations and third party consultation*. Reading, MA: Addison Wesley.

INNOVATIVE HAND OPERATED WATER PUMP FOR RURAL FOLKS

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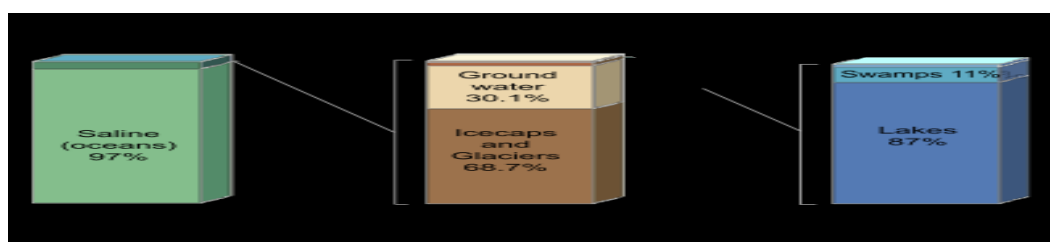
Abstract

Water pumps that use hydro-electricity as their source of energy remain the most affordable and convenient means of supplying water for all human needs, but this means of energy supply is not accessible to our rural folks as well as many in the urban areas. In an effort to meet the ever growing demand of energy to supply WATER for many human activities, stand-alone generators, water pumps and other unconventional methods are used to supply water, sometimes at great cost to our environment due to inefficiencies of such mediums. In our effort to contribute towards this solution, as a relief in the life of our rural folks, a prototype of a hand operated innovative water pump purposely designed to be used in the rural areas to draw water, filter it and pump water from source (without the inhabitants walking to the water source), for domestic and other useful applications has been developed.

Keywords: Prototype; Safe water; Dehydrogenate monoxide

Introduction

Water is a chemical substance with the chemical formula H_2O . *Dehydrogenate monoxide* is the scientific name for water, though it is almost never used. Water can dissolve many different substances, giving it varying tastes and odors. However, pure H_2O is tasteless and odorless. The advertised purity of spring and mineral water refers to absence of toxins, pollutants and microbes, not the absence of naturally occurring minerals. Water covers 70.9% of the Earth's surface,¹ and is vital for all known forms of life. On Earth, 96.5% of the planet's water is found in oceans, 1.7% in groundwater, 1.7% in glaciers and the ice caps of Antarctica and Greenland, a small fraction in other large water bodies, and 0.001% in the air as vapor, clouds (formed of solid and liquid water particles suspended in air), and precipitation. Only 2.5% of the Earth's water is freshwater, and 98.8% of that water is in ice and groundwater. Less than 0.3% of all freshwater is in rivers, lakes, and the atmosphere, and an even smaller amount of the earth's freshwater (0.003%) is contained within biological bodies and manufactured products. (en.wikipedia.org)



Diag:1 showing percentages of earth's water bodies

The human body contains from 55% to 78% water, depending on body size. To function properly, the body requires between one and seven liters of water per day to avoid dehydration. The precise amount depends on the level of activity, temperature, humidity, and other factors. Most of this is ingested through foods or beverages other than drinking straight water. It is not clear how much water intake is needed by healthy people, though most advocates agree that approximately 2 liters (6 to 7 glasses) of water daily is the minimum to maintain proper hydration. Medical literature favors a lower consumption, typically 1 liter of water for an average male, excluding extra requirements due to fluid loss from exercise or warm weather. Access to safe drinking water has improved over the last decades in almost every part of the world, but approximately one billion people still lack access to safe water and over 2.5 billion lack access to adequate sanitation. A recent UN report (November 2009) suggests that by 2030, in some developing regions of the world, water demand will exceed supply by 50%. Water plays an important role in the world economy. Civilization has historically flourished around rivers and major waterways.

Clean drinking water was and is a major factor in human development and approximately 70% of the fresh water used by humans goes to agriculture. Water fit for human consumption is called drinking water or potable water. Water that is not potable may be made potable by filtration or distillation, or by a range of other methods. Poor water quality and bad sanitation are related and deadly, as some five million deaths a year are caused by polluted drinking water. (WFP, WHO UNICER annual reports, 2009-2012)



Diag.2 A young girl drinking bottled waterphoto: (UNICEF)

Water Distribution

The water distribution system is the essential link between the water supply source and the consumer. It is an elaborate conveyance system that allows water to be moved through miles of piping before reaching your tap. Pumps allow water to move through the system; and valves allow water pressure and flow direction to be regulated along the way. In short, the Distribution Division ensures that treated water is delivered to your tap.



Diag. 3: A manual water pump deep well or Bore Hole

Water may require purification for human consumption. Popular methods are filtering with sand which only removes undissolved material, while chlorination and boiling kill harmful microbes. Distillation does all three functions. More advanced techniques exist, such as reverse osmosis. The distribution of drinking water is done through municipal water systems, tanker delivery or as bottled water. Governments in many countries have programs to distribute water to the needy at no charge. Unfortunately, this affordable and convenient means of supplying water for all human needs is not accessible to many of our rural folks and those the urban areas in Africa, and Ghana has had its share of this problem.

In Ghana, people in rural areas ultimately resort to sources of any flowing water with high health risk and many people contract water-borne diseases due to lack of access to clean and safe water supply, or because of massive displacement. ("Reasonable access to safe drinking water is defined as the availability of at least 20 litres per person per day from an improved source within 1 kilometer of the user's dwelling") (en.wikipedia.org)

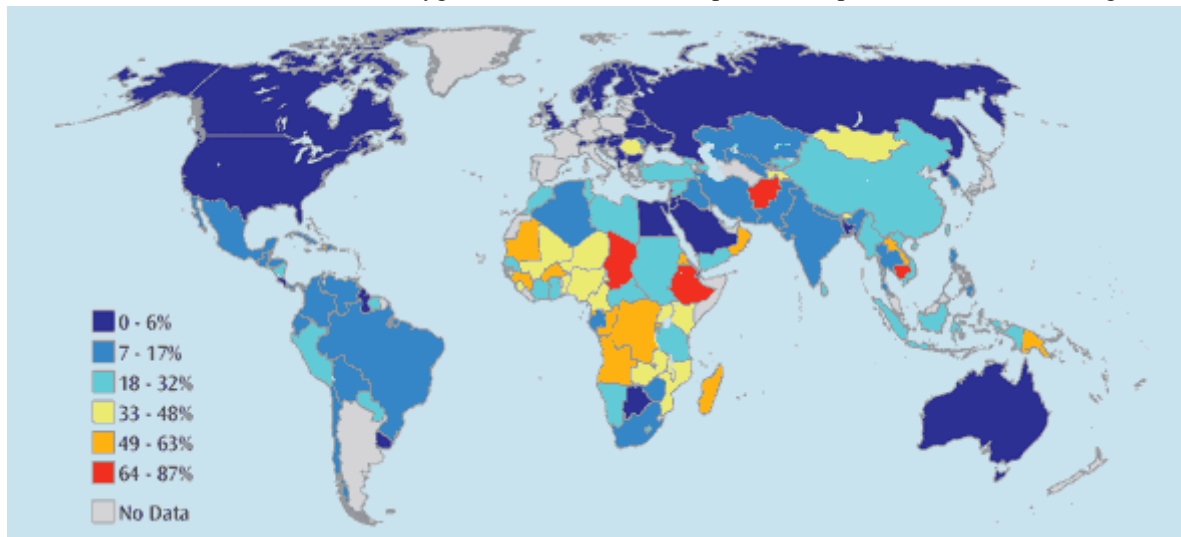
Other Effects; Poor Sanitation

Inadequate access to safe water and sanitation services, coupled with poor hygiene practices, kills and sickens thousands of children every day, and leads to impoverishment and diminished opportunities for thousands more. It is reported that almost fifty per cent of the developing world's population – 2.5 billion people – lack improved sanitation facilities, and over 884 million people still use unsafe drinking water sources.

- (a) Poor farmers and wage earners are less productive due to illness,

- (b) health systems are overwhelmed, and
- (c) National economies suffer.

Without WASH (water, sanitation and hygiene), sustainable development is impossible. .www.unicef.org.



Diag.4: Percentage of Population without Reasonable Access to Safe Drinking Water

Although many people living in cities and urban communities have pipe-borne water supply, yet many refugee camps, some rural communities, many farming villages and countless residential homes stand a stark contrast in relation to other developed places. This is because; it is not only the lack of sufficient water supply but also access to clean and hygienic water. For example,

- uncountable communities still depend on untreated streams sited far away from home for survival, and sadly enough, these streams are also shared by other livestock;
- fortunate communities with boreholes and wells still trek or cover long distances to fetch water. This is because the pumps used in the boreholes can pump water ONLY to the surface;
- although some measures are taken to reduce Bilharzias and Guinea worm spread, tooth decay/corrosion due to Fluoride Contaminated Drinking Waters at some places is still a disaster since the manual pumps cannot handle such processes;
- provisions of boreholes sometimes do not solve the problem, because the water from the borehole is contaminated or salty;
- agriculture and livestock farmers rely on rains and unhygienic streams for survival, making agriculture unattractive;
- the most unfortunate aspect is that, it is our children, sisters, wives and our dear mothers who bear the blunt of this situation by walking over half-a-kilometer daily to fetch water; and finally,
- the associated unforeseen road accidents together with increased immorality by some youths in the name of fetching water cannot be emphasized.

All these situations result in social and economic hardships that affect the development, education, health, sanitation and poverty level of many people in all such undeveloped areas.

One approach that has helped our rural folks in such difficult environment is the advice to boil and filter their drinking water with filtering clothes, or allow the hot water to cool and the particles to settle before it is used. This process comes along with its own challenges; gathering firewood, making the fire, boiling the water and allowing the water to cool discourages folks from using this method because sometimes the taste of the water changes after boiling.

So it was a relief when a special filtering cloth was developed to filter polluted water for drinking without boiling it. This innovation does not change the taste of the filtered water, saves time, and preserves energy and the environment.

Granted, there has been much improvement in the health of rural folks, and direct reduction of direct water related diseases, but reports show that, infections of other related water borne diseases are still prevalent. This may be due to other factors including bathing in the polluted water, using defective filtering element, ignoring other safety rules and poor handling of the process.



Fig.5-A typical rural folks fetching water from a pond (photo; UN)

Methodology

Project designers tried to address each of the problems found in earlier projects by the following approaches;

- Research-careful review of available literature on the subject.
- Interview- data collection of first-hand information from the rural folks about their experiences, challenges, efforts made so far and expectation.
- Laboratory works- analysis of scientific proof of other facts that may contribute to this work
- Experimental works-majority of the results were collected using this methods.

A sociological, economic, and epidemiological baseline study which, according to government officials, was first carried out by other people, also provided an in-depth understanding of local conditions and of the strengths and weaknesses of available pump technologies.

Various pumps already in the system (like solar pump, other hand-operated pumps, foot pumps, wind pumps, engine operated water pumps, among others) were considered based on the following criteria;

- operating cost
- source of primary energy,
- environmental friendliness,
- maintenance cost and rate of servicing
- ability to filter and desalinate, among others.
- ability to draw water from the source without walking to the source,

After careful considerations, none of the pumps currently in the market could satisfy the conditions found in our rural and farming communities. Experimental work was started using scraps from automobile vehicle, and off the counter materials. Almost all the operating principles applied were based on how some parts and systems of the automobile car works.

First: we brainstorm and draw images from our discussions.

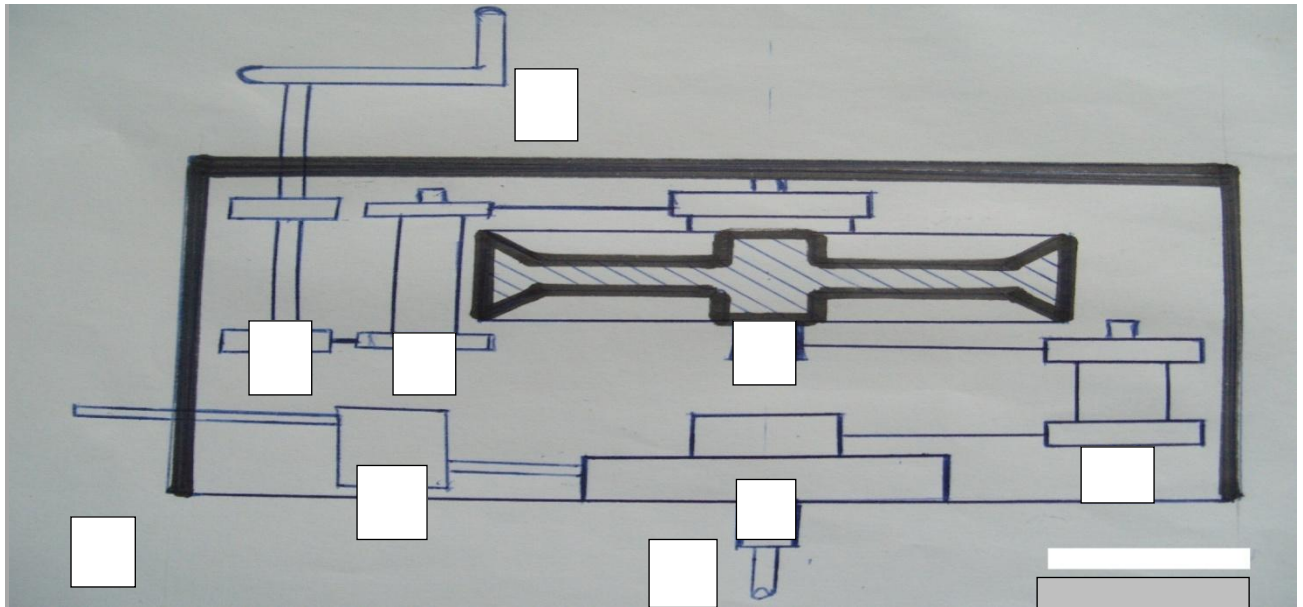
Secondly: paper, tin sheets, PVC, clay or soft wood is used to produce a model from the sketches if possible.

Thirdly: prototype is then produced using measurements from the model.

The final stage is the testing of the prototype which is carried out to see its effectiveness. After many months of experimenting through fabrications, measuring, observations, cutting, welding, drilling, filing, soldering and redefining, dismantling and assembling, one idea worked to our satisfaction.

Principles of Operation

The operation of this innovative Hand Operated Water Pump is based on principles of creating strong vacuum (suction) force and building of strong (pump) fluid pressure. These quantities however depend on many factors such as speed, component design, power available, space, volume, distances involved, and system design. In this pump, high suction vacuum and strong pump pressure is achieved through a very complex arrangement of a compound gears. In order to overcome the critical energy needed to drive the system, a flywheel is incorporated to store the input energy to keep the system in motion.



Layout of the Innovative hand Operated Water Pump system

A	Turning Handle	D	Flywheel	G	Filter
B	Primer Sprocket	E	2 nd Power Gearbox	H	Water Outlet
C	1 st Power Gearbox	F	Pump unit	I	Water Inlet



Complex belt / pulley assemblies

Compound gear train assemblies



Testing pump in a remote area

Tasting filtered water

Results

The outcome of this research work has been successful. We have been able to design, develop, produce and test a prototype of an innovative hand operated Pump that can be used to draw and pump water in the following situations;

- (a) from the source of water (being stream, pond, river, well or borehole) to the village, camp, farm, residence, site, workplace and to any other water income-generating businesses destination without walking to the water source;
- (b) to an elevated water tank for distribution to the community using PVC pipes;
- (c) to solve one of the poor sanitation problems with the use of water.

This innovative water pump is not battery, petrol nor diesel operated but hand operated. The energy for drawing is derived from a complex mechanical energy storage assembly that operates a high speed suction unit to draw water and pressure it. Operation of the pump is non-polluting, quiet and has no negative impact on the landscape or the environment. The mobility of the pump and the use of PVC pipes to connect it from the source make it ideal to serve other needs.

The necessary skills for manufacturing the AES wind turbine water pump are found locally and in many countries, and should not be a constraint to further replication and enlargement. With training and promotional efforts, this technology can provide access to a secure, safe and sufficient source of fresh water as a fundamental requirement for the survival, well-being and socio-economic development of thousands of rural businesses and households. This project will also raise the awareness within the ministry that affordable Alternative Energy System devices can be successfully manufactured locally and make provision for greater funding.

TECHNICAL DETAILS

1	Size	L=118cm x B=200cm x H=28cm
2	Max. Flow (Without Filter Element) GPH	140
3	Max. Low (With Filter Element) GPH	95
4	Effective Distance from source	300m
5	Maximum Lift Height	45 (m)
6	Pressure	1.4-2.8 bar
7	Max flow (GPH)	(m3/h
8	Outlet and Inlet size	20mm
9	Pressure overload protection	Yes
10	Impellers	Glass reinforced thermoplastic

Discussion

The development of this innovative pump is good news because it adds to knowledge. This breakthrough will also

- a. replace the old method and difficulties endured in pumping water only from the ground to the surface;

- b. It will help many to reduce the time and energy spent on just fetching water, but use the additional time saved for other productive ventures;
- c. Provision of clean and access to plenty water will result in social and economic improvement that will positively affect the development, education, health, sanitation and poverty level of many people in all such undeveloped areas;
- d. This will also enable us to cope with, address and eliminate some fundamental water related problems we encounter using scientific and technological development approaches as independent, peaceful and enlightened society;
- e. Finally, it will create some jobs. This is because the production, marketing, uses and servicing of this product would create many jobs for our youths.

Conclusion

We hope, with this favorable results obtained from the prototype of this innovative hand operated water pump, respective institutions and other stake holders would develop it further into a fully operational water pump to benefit the society.

With training and promotional efforts, this technology can provide access to a secure, safe and sufficient source of fresh water as a fundamental requirement for the survival, well being and socio-economic development of thousands of rural businesses and households.

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Reference

- Automotive Technician Training (2008) Available at <http://www.attraining.com> (Accessed: 18 June 2009)
- Power train Electronics: BK2 (5th ed.). CHELTHAM: Nelson Thornes.
- Karassik, Igor J.; Messina, Joseph P.; Cooper, Paul; Heald, Charles C. (2001). Pump Handbook (3rd ed.). New York: McGraw-Hill. ISBN 9781591243618.
- "Online Dictionary – Parish Pump". Retrieved 2012-01-22.
- Pump Statistics Should Shape Strategies. Mt-online.com (2008-10-01). Retrieved on 2011-05-25.
- Pump classifications. Fao.org. Retrieved on 2012-02-25.
- Sealing Multiphase Pumping Applications | Seals. Pump-zone.com. Retrieved on 2011-05-25
- UNDP, "Human Development Report 2004", Tables 7, 33, www.undp.org;
- UNICEF, "State of the World's Children 2004", Table 3, www.unicef.org/sowc04/
- Vacuum pump new on SA market. Engineeringnews.co.za. Retrieved on 2011-05-25
- Wasser, Goodenberger, Jim and Bob (November 1993). "Extended Life, Zero Emissions Seal for Process Pumps". Routledge. ISBN TRP 28017.
- www.unwater.org...9/3/2012, 13;30
- **Text Sources:**a. UN World Water Development, www.unesco.org/water/wwap/wwdr/index.shtml
b. "Blue Gold", 2001, Maude Barlow, www.canadians.org;
c. UN FAO Committee on World Food Security, May 2005;
www.fao.org/docrep/meeting/009/J4968e/j4968e00.htm
d. UN FAO, www.fao.org/newsroom/en/news/2005/102562/

ADOPTION OF E-COMMERCE SOLUTIONS IN SMALL AND MEDIUM-SIZED ENTERPRISES IN GHANA

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Abstract

Extensive research has been done on e-Commerce to demonstrate the tremendous benefits it offer Businesses. However, SMEs have not fully adopted e-Commerce solutions. Therefore there is the need to identify and measure the perceived importance of driving forces and barriers in the adoption of e-Commerce solutions among SMEs. This research highlights findings from survey and interviews with SMEs in Kumasi, Ghana. Findings from this study shows that SMEs online sales is virtually nil, the most common e-Commerce application is the use of e-mail for communication and the main reason for having a website is to show basic information about product and services as well as contact information. Some of the barriers to e-Commerce adoption identified includes: lack of right technical skills, e-Commerce security, initial cost, resistance by people and culture, lack of interest by management, lack of developed legal and regulatory system

Keywords: Small to Medium-sized enterprises; E-Commerce; Surveys; Ghana

Introduction

In the global business environments, SMEs are incrementally using Information and Communications Technologies (ICT)-based electronic commerce to gain competitive advantage and to have access to global markets (Al-Qirim, 2003). This is due to the fact that many researchers hold the view that e-Commerce has positive impact on business operations. Policy makers and managers are certain that e-Commerce conveys wide range of benefits, and companies that are left behind in adopting this new system cannot compete favourably in the global marketplace (Hashim, 2009). Meanwhile, e-Commerce adoption by SMEs has remained relatively low (MacGregor & Vrazalic, 2005) despite the increase in awareness creation on the potential benefits of e-Commerce solutions.

Small and Medium-sized enterprises (SMEs) are often seen as vital for the growth and innovation of dynamic economies as they help to diversify economies. SMEs account for 60 percent to 70 percent of jobs in most developed and developing countries and for most new jobs that are created, within Africa, countries such as South Africa, Egypt, Morocco, Kenya, Uganda, Botswana and Tanzania have prioritised their investment in SMEs (Gordon, 2003). There has been number of studies on the adoption of e-Commerce solutions by SMES (Tan, Tyler, & Manica, 2007; Molla and Licker 2005), these studies identified some of the barriers experienced by SMEs in implementing e-Commerce solutions. However these studies focused on advance economies.

In Ghana, e-Commerce use among SMEs is a new phenomenon. While e-Commerce solutions has been adopted by some multinational and large organisations, Small and Medium-size Enterprises have been slower in adopting these technologies, this low rate of adoption and the SMEs inability to take advantage of this emerging Internet technology to improve their business operations deserves serious attention.

Information and communication technologies (ICT), particularly e-Commerce, are considered very important to Ghanaian economy, and as a result, Ghana is seeking to enact legislation to enable and encourage the adoption of e-Commerce. The rationale behind e-Commerce legislation in Ghana is to create functional legal equivalence between doing business through electronic and traditional means. In addition, there has been proliferation of telecommunication companies in Ghana providing Internet services as a way of encouraging businesses, especially SMEs, to adopt e-Commerce. However, little is known about SMEs e-Commerce activities. This paper seeks to fill this gap in the literature. It addresses three issues: (1) Identify and measure the uses of e-Commerce applications in SMEs (2) the perceived importance of driving forces for the adoption of e-Commerce. (3) Barriers to adoption of e-Commerce

Literature Review

E-Commerce

There is no consensus on definition of e-Commerce, Turban, Lee, King, McKay Lee & Viehland (2008) define e-Commerce as the process of buying, selling, transferring, or exchanging products, services, and/or information via computer networks, including the Internet. Turban et.al further distinguishes between Internet and non-Internet e-Commerce. The non-Internet e-Commerce includes for example buying and paying for services or product with smart card through vending machines and/or transactions undertaking via network such as Local Area networks (LAN), using intranets or even single computerised machine. The most common theme in all the definitions is that e-Commerce concerns activities that are done electronically, like sharing of information, buying and selling. Some researchers see e-Commerce in terms of Internet applications, such as intranet, extranet, website and email (Drew 2003). Others view

e-Commerce as combination of business processes and Internet technologies such as interactions with customers and suppliers (Kendall, Tung, Chua, K.H., Ng, C.H.D., & Tan, S.M., 2001). However there is general consensus among researchers about the main component that shows what e-Commerce is: website, email, intranet, extranet, LAN and wireless area network (WAN).

Reasons or Driving Forces for the Adoption of e-Commerce by SMEs

The academic literature gives very little information on why SMEs adopt e-commerce. However, rather more information can be found on the broader aspects of information and communication technology (ICT) adoption and the use of the Internet in general. Thus, the reasons for ICT, Internet and e-Commerce adoption by SMEs are complex and often interrelated. Chapman, James-Moore, Szczygiel & Thompson (2000). The use of ICT to improve business competitiveness has gained recognition in several studies and indeed SMEs have been trying and testing new e-Commerce models in spite of their scarce resources (Dongen, Maitland & Sadowski, 2002). The main factors that push for successful innovation are a combination of having a dedicated and motivated individual, usually the Chief Executive Officer (CEO) and paying attention to a multitude of good management activities and attitudes (Tidd, Bessant, & Pavitt, 2001). This includes the ability to scan, predict and respond to the dynamic business environment. Actinic (2003) recent surveys suggest that the main reason for e-Commerce adoption amongst UK SMEs is to increase sales while others suggest more illusory motivations for adopting e-commerce. From the other perspective, the pressure from customers and suppliers for electronic business was found to be another determinant of e-Commerce adoption and use within businesses (Mehrtens, 2010).

Kalakota and Robinson (2001) see the adoption of e-Commerce as more of an external pressure brought about by a new type of customer value proposition of what they want, when and how they want it and at the lowest cost. Daniel, Wilson, & Myers (2002) stated that SMEs in the UK are adopting e-Commerce in four stages as: (1) developers; (2) communicators; (3) those with web presence; and (4) transactors. Developers are developing their first e-mail and website, communicators are using e-mail and exchanging documents and designs electronically with customers and suppliers; web presence means websites with online ordering facilities; and transactors are those using online ordering and payment capabilities. This stage approach has been criticised because firms can leapfrog the stages.

Table 1 e-Commerce adoption among SMEs

Study	Major Factors/ Findings
Idisemi et al, (2011)	Investigated factors affecting the effective utilisation of information and communication technology (ICT) and the adoption of more sophisticated ICT solutions in small and medium-sized enterprises (SMEs) in Lagos, Nigeria. The paper identifies eight key factors that affect the effective utilisation and adoption of more sophisticated or advanced ICT solutions in Nigerian SMEs.
Ghobakhloo et al.,	Examine the factors within the technology-organization-environment (TOE) framework that affect the decision to adopt electronic commerce (EC) and extent of EC adoption, as well as adoption and non-adoption of different EC applications within small- and medium-sized enterprises (SMEs). The Findings of the study revealed that e-

(2011)	Commerce adoption within SMEs is affected by perceived relative advantage, perceived compatibility, CEO's innovativeness, information intensity, buyer/supplier pressure, support from technology vendors, and competition.
	Explored the Internet/e-business technologies acceptance in Canada's SMEs: The data analysis confirmed the significance of perceived benefits of IEBT in the adoption process. This result can be interpreted to mean that SMEs' executives in the region are not ignorant about the advantages and benefits of IEBT.
Ifinedo (2011)	
Ada Scupola (2009)	Investigated an insight about factors affecting business-to-business e-commerce adoption and implementation in small to medium-sized enterprises (SMEs), highlighting similarities and differences between Danish and Australian SMEs.
	The findings revealed that customer pressure, quality of ICT consulting, environmental factors, CEO characteristics, management support, significantly influence e-Commerce adoption in both Denmark and Australia.

Methodology

The sampling frame of this study consists of SMEs engaging in manufacturing, retailing and services activities located in Kumasi, Ashanti region of Ghana. Kumasi was selected because it is the second largest city in Ghana with vibrant economic activities. The major economic activities are commerce/services 71 percent, manufacturing/industry 24 percent and primary production 5 percent (KMA.com, 2012). Additionally, it has good Internet access, with most of Telecommunication companies (MTN, Tigo, Expresso, Airtel, Kasapa, Vodafone, GLO) offering Internet services on their network in the city. Other Internet Service Providers (ISPs) such as Africaonline, MyZipnet and UCOMS also offers Internet services.

The data was collected by means of survey and also face-to-face interviews. Businesses were only chosen that fitted the National Board for Small Scale Industry (NBSSI) definition of an SME with not more than 9 employees. Questionnaires were hand delivered to the managers or CEOs, two weeks after the initial delivery of the questionnaire; reminders were sent via SMS, phone and email. Nearly a month after that, second reminder was sent to 35 non-respondents,

67 responses were received, out of these 2 were rejected because it did not fit into definition of SME of not more than 9 employees, and further 5 were excluded from the analysis because the return was incomplete. Therefore, 61 usable responses with response rate of (88%) was the basis for the statistical analysis.

Face-to-face interviews were also carried out to solicit further information for the purpose of the data analysis. Face-to-face interview were conducted personally and lasted between one to two hours. The interviews were recorded both hand written and digitally, a total of 15 Managers were interviewed in the process.

Results and Discussion

The Statistical Package for social Sciences (SPSS) was used to analyse the pre-coded questions and further analysis of the data

Table 2. Distribution of SMEs

SMEs	Frequency	Percentage %
Manufacturing	18	18
Services	21	38
Retailing	22	44
Total	61	100

SMEs with Internet Connection

Table 3. Internet Access Connection

Internet Access Connection	Frequency	Percentage %
None	20	33
Dial up	5	8
Internet Service Provider	25	41
Dedicated Server LAN	8	13
Dedicated High Speed Service	3	5
Total	61	100

Out of a usable sample size of 61, 20 (33%) SMEs did not use Internet at all, 5 (8%) businesses used Dial up Internet connection, 25 (41%) businesses used Internet Service Provider. 8 (13%) businesses also used Dedicated Server LAN and the least (3) among them were those using Dedicated High Speed Service. They had (5%). The results of the internet access connection are reported in table 3.

In order to understand the e-Commerce application and usage better, it is proper to breakdown each application in this study in order to investigate the extent of each component in the e-Commerce applications.

Table 3 lists the percentage use of e-Commerce applications, weighted according to the total number of SMEs. It is worth noting that not all SMEs online activities were captured in the categories stated. Applications were listed under the general headings of web searches, website presence, and interactions with business suppliers and customers. The top usage in the three categories was “searching for potential suppliers and/or product availability information”, “advertising company and product information”, and “e-mail”, Results could total more than 100 percent in each category, since more than one application could be checked for each business surveyed.

Table 4. List the percentage of e-Commerce applications

Applications	Percentage Usage (%)
1. Web searches	
(a) Searching for potential customers	2
(b) Searching for potential suppliers	25
(c) Searching for product availability information	39
2. Web site presence for;	
(a) Advertising our company and product information	48
(b) Online sales transaction through our web site	0
(c) Sales and service support	15
3. Interactions with our organisation's suppliers and customers	
(a) e-mail	48
(b) Instant messaging	7

(c) Video conference	0
(d) Tracking order and delivery information	8

Web Searches

Two percent (2%) of the respondents used the Internet to search for potential customers who are likely to buy from them. Twenty five percent (25%) used the web to search for potential supplier and five (39%) uses the web to search product availability information.

Websites Presence for:

About 50% of the respondents state that their companies have a websites. Out of this (48%) stated that the main reason of having website is to advertise the company and product/service information. The need to provide sales support and service was stated by (15%) of the SMEs as the reason for having website. None of the SMEs intend to use the website for online transactions

Interaction With our Organisation's Suppliers and Customers.

The use of email as medium of communication accounted for (48%) usage of e-Commerce application among the SMEs. The next application usage is tracking order and delivery information which accounted for (8%). Some of the SMEs used instant messaging facilities like Skype, Yahoo and MSN messenger to interact with their customers, these media of communication account for (7%) of e-Commerce application usage by the SMEs. Finally none of the SMEs uses video conferencing as platform to interact with their customers.

Reasons for adopting e-Commerce solutions

Figure 1 shows the main reasons for adopting e-Commerce solutions by SMEs. The important reason for the SME managers in deploying e-Commerce applications is to expand and grow their business, the SMEs sees websites as a platform that can create wider market reach which may ultimately lead to increase in sales and profitability.

The Need to keep up with existing competitors is the next important reason that the SME managers cited for adopting e-Commerce. The reason being that some of the SMEs have observe that some of their competitors have online presence therefore they have to create online presence so that they will not lose their customers to their rivals. The least important factor cited by SME managers for adopting e-Commerce is that, the application can increase employee productivity.

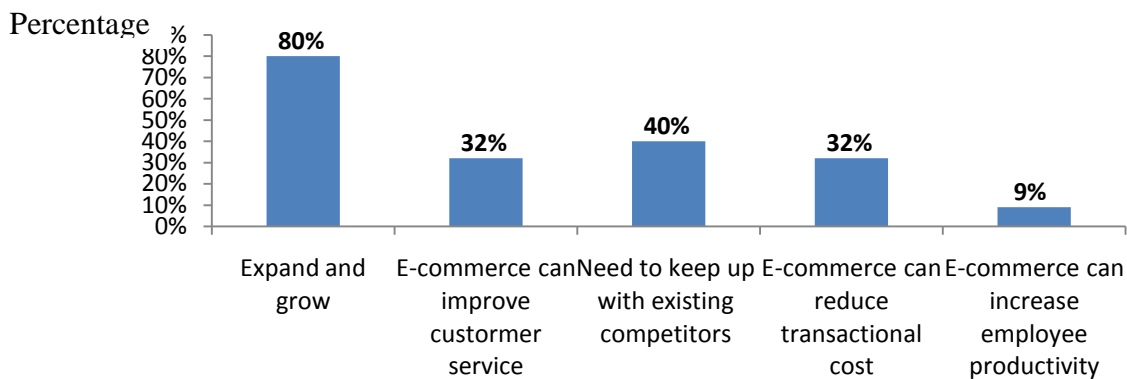


Figure 1 Factors affecting e-Commerce adoption among SMEs

Barriers to E-Commerce Adoption

Some of the SMEs that stated the following barriers for adoption of e-Commerce adoption, during the interview process.

a. Initial investment required for e-Commerce is very high

Some of the SME managers complain about the high initial setting up cost of websites, i.e hiring a webmaster, paying of Internet services and acquisition of computer.

b. Lack of right technical skills

Inadequate technical skills are as one of the factors preventing the adoption of e-Commerce application among Ghanaian SMEs. Chircu and Kauffman (2000) discovered in their study that inability to acquire skill and expertise in new technologies, and a lack of training and education form significant barriers to the adoption of e-Commerce systems.

c. Lack of interest by management

Some of the SME managers displayed total lack of interest in adopting e-Commerce applications. Because they do not see the immediate benefits that will accrue to their business operations. Jeyaraj et al. (2006) found top management support to be one of the best predictors of organisational adoption of Information System innovations.

d. Resistance by people and culture

Some of the SME managers claim that their customers are not particularly interest in Internet sales interactions and are unwilling to engage in interaction using any e-Commerce application which they intend to adopt. And more so some of their customers see e-Commerce as non-traditional way of transacting business with the SMEs.

e. Lack of developed legal and regulatory system

There is no legal and regulatory system facilitating e-Commerce adoption in Ghana, the government attempt to enact law that encourage adoption and usage of e-Commerce has not been successful since the first attempt in 2010 (Ghanaweb, 2012). This affect the utilisation of e-Commerce applications by Ghanaian SMEs as there is no legal framework which the SMEs can use as reference point in their daily business operations.

f. Insufficient knowledge about e-Commerce technology

Some of the SMEs often do not know what kind of e-Commerce solution is more appropriate for them, in addition some of the managers lack necessary expertise and knowledge to identify the full potential and benefits of e-Commerce applications in improving in their business operations.

E-Commerce Security Issues

Internet security is becoming a major issues in Ghana, some of the SME managers stated that their customers sees the internet platform to be insecure to transact business on, more especially with the advent of 'Sakawa' cyber fraud activities among some Ghanaian youth. Therefore the customer prefer to undertake all the transactions offline in order to avoid risk of falling victim to group of people called 'Sakawa boys'.

Conclusion

E-Commerce has received much publicity in Europe, US and lately Asia. The increase in the publicity is due the potential benefits that e-Commerce applications impact can on business operations. Several studies have shown tremendous benefits that SME managers can derive from e-Commerce usage. In Ghana, there has not been much publicity about the usage of e-

Commerce. This research revealed that few Ghanaian SMEs use Internet based technologies in their business operations. The main e-Commerce application use by the SMEs is the use of email for communication with customers and suppliers which are consistent with a study by (Hashim, 2009) that SME in Malaysia mainly uses email component of e-Commerce. The main use of websites presence by the SMEs is to advertise their product or services. Online sales transactions is virtually nil among Ghanaian SMEs, this might be due to poor nature of e-payment infrastructure in the country. This study further revealed some of the barriers to e-Commerce adoption to include: lack of developed legal and regulatory system, initial investment required for e-commerce is very high, insufficient knowledge about e-commerce technology, lack of interest by management, lack of right technical skills, resistance by people and culture and Internet security concerns.

Implications

There is the need for massive education and awareness creation about the pros and cons of deploying e-Commerce applications especially among SMEs, by government and all the relevant agencies about the huge benefits of ICT based business transactions. To facilitate fast and high rate of e-Commerce adoption among business in Ghana, government of Ghana need to pass the e-legislation and incentives should be given to innovative SME managers who readily adopt innovative means of operating their business. The local software vendors in Ghana, who target SMEs, should develop simple and user friendly e-Commerce applications that will meet simple task performed by SMEs.

Limitations and future research directions

This study focused on SMEs in the Ashanti region of Ghana; therefore, the findings cannot be fully generalised to other countries and different business sector.

Secondly, the data was provided by only the SME managers and not the other staff who are the users of the e-Commerce application in the respective SMEs studied.

References

- Actinic (2003) "Actinic e-commerce report 2003" URL <http://www.actinic.co.uk/docs/Ecreport03.pdf> (accessed January, 2012).
- Al-Qirim, N. A. Y. (2003) "E-Commerce in the Aerial Mapping Industry: A New Zealand case study", *Journal of Systems and Information Technology*, Vol. 7 No. 1-2, pp. 67-92.
- No. 1, pp.73-85
- Chapman, P., James-Moore, M., Szczygiel M., & Thompson, D. (2000) "Building Internet capabilities in SMEs". *Logistics Information Management*. Vol. 13 No. 6, pp. 353-360
- Chircu, A.M. and Kauffman, R.J. (2000) "Limits to value in electronic commerce-related IT investments", *Journal of Management Information Systems*, Vol. 17 No. 2, pp. 59-80.
- Daniel, E., Wilson, H. & Myers, A. (2002) Adoption of E-commerce by SMEs in the UK towards a stage model. *International Small Business Journal* 20(3), pp. 253-270
- Dongen, J., Maitland, C., & Sadowski, B. (2002). "Strategic use of the Internet by Small and Medium sized Companies: an Exploratory Study". *Information Economics and Policy*. Vol. 14, pp.75-93
- Drew, S.A.W. (2003). E-Business research practice: Towards an Agenda. *Electronic Journal on Business Research Methods* 1(1)
- Gordon, G. 2003., "SME Survey", Sunday Times Business Times, p. 15
- Idisemi, A., Ann, L., & Moreton, R., (2011) Factors affecting the effective Utilisation and adoption of sophisticated ICT solutions Case studies of SMES in Lagos, Nigeria *Journal of Systems and Information Technology* Vol. 13 No. 2, 2011 pp. 125-143
- Ifinedo, Princely. (2011) Internet/e-business technologies acceptance in Canada's SMEs: an exploratory investigation. *Internet Research* Vol. 21 No. 3, 2011 pp. 255-281
-
- Jeyaraj, A., Rottman, J.W. and Lacity, M.C. (2006) "A review of the predictors, linkages and biases in IT innovation adoption research", *Journal of Information Technology* Vol. 21, No. 1, pp. 1-23.

- KMA.Com (2012) http://www.kma.ghanadistricts.gov.gh/?arrow=atd&_id=6&sa=580
(Accessed May,2012)
- Kolakota, R., & Robinson, M. (2001). *E-business 2.0: Road-Map for success*, Addison- Wesley, Harlow.
- Kendall, J., Tung, L.L, Chua, K.H., Ng, C.H.D., & Tan, S.M. (2001) “Electronic Commerce by SMEs in Singapore
- MacGregor, R.C. and Vrazalic, L. (2005), “A basic model of electronic commerce adoption barriers: a study of regional small businesses in Sweden and Australia”, *Journal of Small Business and Enterprise Development*, Vol. 12 No. 4, pp. 510-27.
- Molla, A., & Licker, P. S. (2005) "e-Commerce adoption in developing countries: a model and instrument", *Information and Management*, Vol. 42 No. 6, pp. 877-899.
- Mehrtens, J., Cragg, P. B., & Mills, A. M. (2001) “A model of Internet adoption by SMEs”, *Information and Management*, Vol. 39 No. 3, pp. 165-176.
- Morteza Ghobakhloo, Daniel Arias-Aranda and Jose Benitez-Amado (2011) Adoption of e-commerce applications in SMEs *Industrial Management & Data Systems* Vol. 111 No. 8, 2011 pp. 1238-1269
- Oliveira, T. and Martins, M.F. (2010). “Understanding E-Business Adoption across Industries in European Countries”, *Industrial Management & Data Systems*, Vol. 110 No. 9, pp. 1337-54.
- Noor, A. H. (2009). e-Commerce and SMEs-The Need for Caution, *Prometheus* Vol 27, No 2
- Scupola, A. (2009), “SMEs’ e-commerce adoption: perspectives from Denmark and Australia”, *Journal of Enterprise Information Management* Vol. 22 No. 1/2, 2009
- Tan, J., Tyler, K., & Manica, A. (2007) "Business-to-business adoption of eCommerce in China", *Information and Management*, Vol. 44 No. 3, pp. 332-351
- Tidd, J., Bessant, J., & Pavitt, K. (2001) *Managing Innovation: Integration Technological Market and Organizational Change*. Chichester: John Wiley & Sons Ltd.
- Turban, E., King D., McKay J., Marshall P., & Lee J., & Viehland D., (2008) *Electronic Commerce: A managerial Perspective* Prentice Hall, (5 ed.).
- UK Online (2002). UK Online Annual Report, 2002, Department of Trade and Industry, London

PROCUREMENT PRACTICES IN URBAN WATER SUPPLY IN GHANA

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Abstract

Procurement is an undervalued sector in the public sector. Cooperative procurement procedures have a positive influence on project performance (cost, time, quality, environmental impact, work environment, and innovation). The aim of this research is to assess the procurement practices in the urban water supply of Ghana. The study analysed the procurement practices in Ghana, identified the factors that contribute to procurement success and the elements that enhanced the success. Recommendations that would enhance the procurement process in urban water supply were outlined. The research revealed that the public procurement act in Ghana makes provision for legal and institutional framework, procurement procedures and documentation, procurement oversight and anti-corruption measures. These provisions ensure the integrity and transparency of the public procurement process. The Ghana Water Company Limited (GWCL) has applied the public procurement act in their activities leading to value for money water projects. The project review body should be empowered to handle all disputes and complaints.

Keywords: Water, Procurement, Performance, Acquiring, Project, Urban.

Introduction

Procurement is an undervalued sector in the public sector. Traditionally, the legal framework for public procurement in Ghana was minimal (Westring, 1997; World Bank, 1996). The Ghana Supply Commission (since January 2000 the Ghana Supply Company Limited) used to be the parastatal procurement agency for the procurement of all public goods. However, lack of qualified personnel, lack of planning for the required goods, and lack of a proper database, and problems in the timely acquisition of funds led to long delivery times.

Procurement is the process of acquiring materials, equipment and services from external sources for use in a project. Procurement is a process that usually starts long before the start of the construction process and ends with project completion or project closeout. The procurement team must work in close coordination with both the estimating and scheduling teams and the project management team as a whole. For some institutions, the Procurement Manager works independent of the Project Manager (Mubarak, 2010).

Efficient procurement practices play a major role in both the public and private sectors of economies. This helps to ensure reduction of wasteful activities. Achieving such efficiency is an ambitious task as procurement faces numerous challenges. These challenges are due to market structure, the legal framework and the political terrains that procurers face (Thai, 2009).

The public procurement system is built on four cardinal pillars – procurement laws and regulations, procurement workforce, procurement process and methods and procurement organizational structure. This system is mostly determined by government and influenced by its economic, cultural, legal, political and social environment (Thai, 2009).

Although procurement procedures need to be tailored to enhance the fulfilment of different project performance objectives (Cox and Thompson, 1997; Wardaniet al., 2006), clients tend to choose those procurement procedures that they have a good knowledge of and a habit of using, regardless of any differences between projects (Love et al., 1998; Eriksson, 2008b). For a new procurement procedure to be implemented, clients need to feel confident of how to use it and have positive attitudes towards its effect on outcomes (Tysseland, 2008).

According to Eriksson and Westerberg (2010), cooperative procurement procedures (joint specification, selected tendering, soft parameters in bid evaluation, joint subcontractor selection, incentive-based payment, collaborative tools, and contractor self-control) generally have a positive influence on project performance (cost, time, quality, environmental impact, work environment, and innovation).

The World Bank (2003) estimated the annual value of public procurement for goods, works, consultancy services, at six hundred million dollars (US \$600 million). This value is about 10% of the country's GDP. The bulk of the public procurement expenditures were spent on Ministries, Departments, Agencies (MDAs) and District Assemblies (DAs). The MDAs and DAs spent much on capital investment procurement (Westring, 1997).

The aim of this study is to assess the procurement practices in the urban water supply of Ghana. This study is intended to help investigate the procurement procedures and factors that would enhance water supply to the urban citizens.

To achieve the aim of the research, the following activities were carried out:

1. Analysis of the procurement practices in Ghana with respect to cost and quality of construction.
2. Identification of the factors that contribute to procurement success in urban water supply in Ghana.
3. Recommendations that would help in the procurement process of urban water supply.

Research Methodology

The research was based mainly on the project management activities being under by the Ghana Water Company Limited (GWCL).

Project Management Structure of Ghana Water Company Limited

Objectives of the Urban Water Project

The objectives of the Urban Water Project are:

- To expand the reliable supply of safe water in the urban areas.
- To ensure that low income consumers have access to potable water at affordable price.
- To ensure sustainability of the sector through cost recovery.
- To ensure steady flow of investment fund, with emphasis on low cost and concession financing.
- To support the introduction of the private sector into management and operation of the water supply systems.

Components of the Urban Water Project

The Urban Water Project comprises four components:

1. System Expansion and Rehabilitation

This component is to support:

- Increasing the amount of treated water for sale,
- Extending service to low income areas,
- Rehabilitating existing network to reduce non-revenue water.
- Dam safety upgrades, procurement and installation of meters, and provision of engineering services, vehicles and equipment for Grantor's regional and district offices.

2. Public-Private Partnership Development

This component supports the payment to the operator under the Management Contract as well as payment to Technical and Financial Auditors to measure the Operator's performance.

3. Capacity Building and Project Management

This component mainly includes training of seconded staff and technical assistance. Also included under this component are allocations for training at GWCL's headquarters, vehicles, office equipment, support for the Project Management Unit and the PURC as well as provision for environmental safeguards.

4. Severance Programme

This component was designed to finance the severance programme undertaken by Ghana Water Company Limited.

Services undertaken by GWCL may be categorised as follows:

- Rehabilitation of existing water supply schemes to bring them up to their designed capacities;
- Provision of operational support equipment;
- Limited extensions and improvements to existing systems;
- Construction of new water schemes

In general, GWCL is responsible for:

- Urban water sector planning and development.
- Investment planning.
- Sector financial management.
- Quality control over urban water sector operations.
- Monitoring the Private Operator over compliance with performance standards and targets.
- Contracting for design and construction and/or rehabilitation and expansion of existing as well as new works.
- Consumer information and sensitization.
- Community outreach activities.
- Regulatory applications and negotiations.
- Legal and policy issues including linkages to relevant ministries.
- Assets Management.

The study was conducted within a period of ten months; from November 2010 to August 2011.

To be able to achieve the objectives of this study, seventy (70) questionnaires were sent out to stakeholders. The stakeholders were top level management in the water industry, consultants and other professionals involved in contracts and project delivery. Sixty-two (62) of the respondents returned their questionnaires and fifty-five (55) were used for analysis. literature and research works done by other scholars relating to the topic were reviewed. This gave information on the research and the methods employed by these scholars. Also, the findings and challenges of these researchers were assessed and incorporated into the final analysis. The literature review was a good source of secondary data that proved to be very essential in achieving the objectives of the research.

Interviews were conducted with project staff of GWCL, consultants working with GWCL, some contractors using a structured questionnaire as a guide. These provided the required information from the interview sessions and also go into specific areas.

A structured questionnaire was distributed to consultants and contractors who were not reached for the interview sessions.

Both primary data from field and secondary data from literature were analysed and salient conclusions and recommendations provided.

Results and Discussion

The respondents had ages ranging from twenty (20) years and above. Table1 below shows the age distribution of respondents. It can be deduced from table1 that about seventy-five percent (75%) of the respondent have ages of forty and above.

Table 1: Age of Respondents

Age	Number of Respondents	Percentage (%)
20 – 29	4	7.3
30 – 39	8	14.5
40 – 49	25	45.5
50 and Above	18	32.7
Total	55	100

About eighty-five (85%) of the respondents have at least five years of experience in their field of work, especially on issues relating to contract delivery in the construction industry.

Results from the field data indicate that about 96% of the respondents were involved procurement processes in their operations. The respondents are in high management positions and therefore involved in procurement activities for their organizations. Table 2 shows the respondents that are involved in procurement activities.

Table 2: Respondents involved in procurement activities

Response	Number of Respondents	Percentage (%)
Yes	53	96.4
No	2	3.6
Total	55	100

Procurement Practices in Ghana

The procurement of construction works and services have been regulated mainly through circulars from the Ministry of Finance, which complement a set of procedures evolved by convention in connection with the control of procurement exercised by the ministry. Central, Regional and District Tender Boards process and award contracts within thresholds defined by the Ministry of Finance. World Bank projects use the World Bank Procurement Guidelines (World Bank, 1995) and the World Bank Consultant Guidelines (World Bank, 1997).

The traditional method of procurement is mainly used for public works with design split from construction. There is a provision for mandatory registration and classification of contractors under guidelines administered by the Ministry of Water Resources, Works and Housing (MWRWH). However, the MDAs and many DAs maintain separate lists for the pre-qualification of contractors and use different standard conditions of contract for works procurement. World Bank-administered projects use the FIDIC conditions of contract for works contracts and shortlists for the selection of consultants.

The classification procedures by MWRWH have been observed to be too general and the registration criteria, lists of contractors and monetary thresholds are not updated regularly (Eyiah and Cook, 2003, World Bank, 1996). Except for major or complex assignments, most government-financed architectural consultancy services and project supervision have been assigned to the Architectural and Engineering Services Limited (AESL) on sole basis (World Bank 1996).

The shortlists used on World Bank-administered projects for the selection of consultants have been observed to be repetitive, with the same firms recurrently selected in civil engineering and building works supervision (World Bank, 1996). Many instances of a single contractor buying and pricing all the bidding documents, and of the award of a number of contracts (or lots) to the same contractor/supplier, under different contracting names have also been observed (Crown Agents, 1998, Westring, 1997).

Osei-Tutu et al (2010) posits that conflict of interest, bribery, embezzlement, kickbacks, tender manipulation and fraud are observed corrupt practices in the Ghanaian infrastructure projects delivery and procurement system. The severity of corruption practices has intensified the search for more innovative means of delivering infrastructure projects that will achieve value for money.

To address corruption practices, it would require the constitution of a sound procurement system and pro-social equity policies that would foster good governance, corporate social responsibility, transparency, accountability, judicious public expenditure and national progress.

Ghana's Public Procurement Reforms

The public procurement reforms are part of a programme to improve the public financial management. The procurement reforms would help the country achieve the following:

- Promote national development
- Enhance harmony with other local and international laws and regulations
- Foster competition, efficiency, accountability and transparency
- Facilitate ease of procurement administration
- Ensure value for money

Annual savings of about US\$150 million are predicted through better management of government-financed procurement alone (World Bank 2003). In view of the procurement reform, a draft Public Procurement Bill was presented to the Parliament of Ghana. This Bill was enacted into law by the Parliament in 2003. Some of the measures undertaken by the Government of Ghana include the following (in pursuance of the procurement reforms):

- The issuance and monitoring of expenditures of MDAs and DAs
- Creation of expenditure ceilings in consonance with annual budgets and updated cash flow forecasts
- Implementation of anti-corruption strategies and code of conduct for public officials

All procuring entities must obtain clearance from the Ministry of Finance through a certification to show as a proof of the availability of funds for the intended project before a contract is awarded.

The procurement reforms have led to the engagement of professionals from various backgrounds as consultants by Government and its allied agencies. Professional consultants who are regularly engaged by the government and other clients are Architects, the Quantity Surveyors (QS), Geodetic Engineers (GE), Structural Engineers (St.E), Electrical Engineers (EE) and Services Engineers (SE). Geodetic Engineers are often called when it is about roads construction. All these professionals are regulated by their professional institution, namely, Ghana Institution of Engineers (GhIE), Ghana Institution of Surveyors (GhIS), Ghana Institution of Architects (GIA).

Construction contractors in Ghana are classified into eight (8) categories. The classification is in accordance with the works undertaken by the contractor. The contractors are classified as A, B, C, D, E, G, K and S. The works undertaken by the contractors are:

- Roads, Airports, and Related Structures (A);
- Bridges, Culverts and other Structures (B);
- Labour based road works (C);
- General building works (D);
- Electrical works (E); and

- Plumbing works (G).
- General civil works (K);
- Steel bridges and structures: construction, rehabilitation and maintenance (S);

The contractors in each classification are grouped according to their financial status. These financial classifications are from 1 to 4 (Vulink, 2004). In addition, Dansoh (2005) notes a combined category of AB for road contractors. According to Dansoh (2005) Class 4 contractors can tender for contracts up to \$75,000; class 3 up to \$200,000; class 2 up to \$500,000. Class 1 take contracts of all amounts. The two upper classes (D1 and D2) are more organised and hence more stable, taking on both bigger and smaller works.

Vulink (2004) notes that because of the poor performance of Ghanaian local contractors most of the nation's major projects are usually awarded to foreign contractors. Assibey- Mensah (2008) attributes this to the "non-business-like culture" with which indigenous firms operate in Ghana.

The Public Procurement Act (ACT 663)

In 2003, the Parliament of Ghana enacted the Public Procurement Act to help in procurement activities in the country and enhance the procurement reforms. Act 663 has contributed some level of sanity into the construction sector (Gyedu-Asiedu, 2009). Act 663 establishes the five basic pillars of public procurement (World Bank 2003):

- 1) Comprehensive, transparent legal and institutional framework;
- 2) Clear and standardised procurement procedures and standard tender documents;
- 3) Independent control system;
- 4) Proficient procurement staff; and
- 5) Anti-corruption measures

According to Osei-Tutu et al (2010), the Public Procurement Act 2003 (Act 663) is observed to proffer solutions for some of the challenges in the construction industry.

Act 663 incorporates the following provisions:

- **Legal and Institutional Framework:** the Procurement Act makes provision for the establishment of a Public Procurement Authority at the National level and Procurement Boards and Procurement Entities at decentralized levels. Procurement entities are defined as comprising MDAs and all parastatal establishments that utilise public funds. A tender committee in each procurement entity provides a one-stop shop for concurrent approvals, awards and management of contracts to predefined value thresholds.
The tender committee may use external consultants in the performance of its functions. The tender committee shall refer any procurement exceeding its value threshold to the appropriate tender review board at the district, regional, ministerial or central government level. The tender review board reviews all procurement activities for compliance with Act 663, provides concurrent approval or otherwise of procurement referrals, hears complaints and escalates unresolved issues to the Board.
- **Procurement Procedures and Documentation:** Act 663 stipulates the procedures tender packaging, soliciting and evaluation of tenders leading to the award of contracts. The Act makes provision for pre-qualification procedures of tenderers for large, complex and technical services contracts. All contracts must be tendered on an open competitive basis. Restricted tendering is justifiable based on the grounds that it will result in the provision of an efficient, economic and the best of services. Restricted tendering is subject to the approval of the Tender Board. Two-stage tendering is only allowed where detailed specifications cannot be made available before going to tender or the optimal solution is unknown and tenders are solicited to provide this. National Competitive Bidding shall be used when the procurement entity so decides and subject to contract value thresholds specified in Act 663. International

Competitive Bidding shall be used when effective competition cannot be achieved without the inclusion of foreign firms.

- **Scope of Application:** Act 663 applies to all procurement financed in whole or in part from public funds. Notwithstanding this provision, procurement with international obligations arising from any grant or concessionary loan to the government shall be in accordance with the terms of the grant or loan. However, it has been suggested that the World Bank/ FIDIC procurement procedures are used on World Bank-administered projects because MDAs have no set of comprehensive guidelines for procurement (Westring 1997, World Bank 1996). There is therefore reason to expect that donor partners will defer to the use of the Act 663. The agreement between the Ministry of Health and its cooperating partners, under a World Bank-administered programme, to organise procurement under specific Ministry of Health procedures is perhaps evidence of this expectation (World Bank 2003).
- **Procurement Oversight, Capacity Building and Anti-corruption Measures:** it is the duty of the Procurement Authority to perform the following functions:
 - Provide policy and oversight responsibility oversight
 - Provide training and capacity building for officials involved in procurement activities
 - Aid local industries to become competitive and also efficient suppliers of goods and services to the public sector
 - Help resolve appeals, complaints and grievances

Corrupt practices as enshrined in the Constitution of Ghana and the Criminal Code 1960 are outlawed in Act 663. Violation of the provisions in the Public Procurement Act, upon conviction, is punishable by a fine, imprisonment or both.

Factors that contribute to Procurement Success

The following were identified as the factors that contribute to the success of procurement practices in urban water supply:

- Legal and regulatory framework
- Institutional framework and management capacity
- Procurement operations and practices
- Integrity and transparency of the public procurement processes

Cronbach's Alpha was used in measuring the consistency of the various elements under the four (4) major factors namely: legal and regulatory framework, institutional framework and management capacity, procurement operations and practices and finally integrity and transparency of the public procurement process.

The Cronbach's Alpha is a tool which is used in measuring or assessing the degree of internal consistency to which multiple measures of the same thing agree with one another. It can also be seen as a tool for assessing the degree of internal consistency of scores from a set of indicators (questionnaire items). Simply put it is a measure of internal consistency or how closely related a set of questionnaire items are as a group.

Table 3 below shows a summary of the Cronbach Alpha values for the four (4) thematic areas of the Procurement Assessment process.

Table1: Results of Reliability Test

S/N	Item	Cronbach Alpha	Number of elements assessed
1	Legal and Regulatory Framework	0.855	11
2	Institutional Framework and Management Capacity	0.561	6
3	Procurement Operations and Practices	0.610	7
4	Integrity and Transparency of the Public Procurement Process	0.860	9

Elements that Contribute to Procurement Success

The study identified eleven (11) factors that contribute to procurement success in the Legal and Regulatory Framework. These factors are:

- The scope of application and coverage of the legislative and regulatory framework in the procurement method used.
- Advertising of rules and time limits
- Tender documentation and technical participation.
- Adequate rules regarding to participation.
- Tender submission, receipts and opening of tenders
- Tender evaluation and criteria for award of contracts
- Adequate rules for handling of complaints.
- Model tender documents for goods, works and services
- Adequate procedures for pre-qualification.
- Procedures suitable for contracting services and other requirements that is included in the national laws.
- Procedures for contracting services and other requirements in which technical capacity is key criterion.

The research identified six (6) factors that contribute to procurement success in the institutional framework and management capacity of GWCL. These factors are:

- Procurement planning and data relating to costing are part of the budgetary formulation process and contribute to multi-year planning.
- Financial law and budget procedures support timely procurement, contract execution and payments.
- Budgetary approval before initiation of procurement processes.
- Completion reports prepared for certification of budgets, project execution and reconciliation of delivery with budgetary programming.
- Quality control standards used to evaluate performance of procurement staff.
- Provisions to avoid conflict of interest and direct involvement of officers in the procurement in the execution of procurement transactions.

Seven (7) factors that enhance the success of procurement operations and practices in urban water supply were identified. These factors are:

- The competence of the procurement officials within tender entities is consistent with procurement responsibilities
- There are established norms for the safeguarding or safekeeping of records and documents related to transactions and contract management
- There are established provisions for the delegation of authority to officials who are deemed to be competent and have the capacity to perform the functions assigned to them

- There are no systemic constraints such as inadequate access to credit facilities, contracting practices, etc. that inhibit the private sector from accessing the procurement market
- There are clearly defined procedures for undertaking contract administration responsibilities such as inspection, quality control procedures, acceptance of performance, etc.
- Contracts include dispute resolution procedures that define efficient and fair process to resolve disputes arising during the performance of the contract.
- Procedures exist to enforce the outcome of the dispute resolution process

The integrity and transparency of the public procurement process is influenced by nine (9) factors. The factors are:

- The procurement system has a legal framework, organization, policy and procedures for control and audit of procurement activities
- Procurement auditors are well informed about procurement control systems and procurement requirements to enhance quality audits that contribute to compliance.
- Internal control systems are clear enough to allow performance audits to be carried out.
- Enforcement and follow-up on findings and recommendations of the control framework provides an environment that enforces compliance.
- Decisions made during the procurement process are based on available information and the final decision can be reviewed and ruled upon by a body with enforcement authority under the law.
- The procurement system operates in a fair manner and the outcomes of the decisions made balanced and justified based on available information.
- The procurement system ensures that the complaints review body has the authority and independence for resolution of complaints.
- Special measures exist to detect and prevent fraud, corruption and conflict of interest in the procurement process.
- The legal and regulatory framework for procurement including tender and contract documents incorporates provisions for addressing corruption, fraud, conflict of interest, unethical behaviours and actions, etc.

Experiences of the GWCL

The GWCL undertakes the procurement of works and services. In 2004 and 2005, the GWCL undertook the procurement – management contract – with Vitens Rand Water Services BV of Netherlands, a consortium of Vitens International BV of the Royal Netherlands and Rand Water Services Pty of South Africa. The overall objective of the Management Contract is to restore GWCL to a sound financial footing and make a significant improvement in the commercial operations of the company.

GWCL oversees the expansion of water supply systems in urban centres. In 2008, a procurement process was undertaken to expand the water supply to the people of the Central Region in Ghana. The tender process followed used the World Bank procurement documents to guide the process. Ms Spaans Babcock B.V. of the Netherlands executed the Baifikrom Water Supply Project at a cost of Euro 25.870 million.

The scope of works consisted of installation of mechanical and electrical equipment, construction of permanent dam/weir across the Ochi-Amissa River, construction of raw water intake station, two new reservoirs and two booster pumping stations and construction of a new 11,400 metre cube (2.5 million gallon daily) per day treatment plant at Baifikrom.

Similar works such as the Koforidua Water Works, the Sekyere Hemang Water System, the Rehabilitation of the Barekese and Owabi Headworks, construction and maintenance of water assets are some of the project that the procurement process was used for.

The traditional method of procurement employed by GWCL i.e. before the Public Procurement Act (PPA) was empanelling of a procurement team who would do the evaluation of bids. The bid evaluation was dependent on the Engineers' Price for project. This approach has caused the GWCL to pay more money for less work.

The above finding conforms to the assertion that the sole reliance upon the traditional method and the use of largely price-based contractor selection criteria is a fundamental mistake that leads to poor delivery of projects (Palaneeswaran *et al.* 2001, Rwelamila *et al.* 1999).

The introduction of the PPA has brought sanity into the procurement activities of GWCL and also created the necessary conditions for best value for money. The evaluation of bids is based on the lowest responsive bidder. The PPA has come with a challenge of awarding bids to tenderers who do not have the required capacity to complete the given task.

Conclusion and Recommendations

From the study above, the following are the conclusions drawn:

The GWCL has been using the Public Procurement Act in its procurement processes. The PPA establishes the legal and institutional framework for ensuring transparency, probity and accountability in public construction procurement. The PPA has helped GWCL to conduct transparent and cost effective procurement processes.

The factors that contribute to procurement success in urban water supply by the GWCL procurement processes are:

- Legal and regulatory framework
- Institutional framework and management capacity
- Procurement operations and practices
- Integrity and transparency of the public procurement processes

The following are recommended for the improvement of the procurement practices in urban water supply in Ghana:

- Procedures suitable for contracting services and other requirements should conform to the national laws.
- Special measures should be put in place to detect and prevent fraud, corruption and conflict of interest in the procurement process.
- The legal and regulatory framework for procurement including tender and contract documents incorporates provisions for addressing corruption, fraud, conflict of interest, unethical behaviours and actions, etc.
- The complaints review body must have the authority and independence for resolution of complaints and disputes.

References

- **Assibey-Mensah, G.O.** (2008), *Ghana's Construction Industry and Global Competition: A research Note*, Journal of Black Studies, Sage Publication.
- **Cox, A., Thompson, I.**, (1997). *Fit for purpose contractual relations: Determining a theoretical framework for construction projects*. European Journal of Purchasing & Supply Management 3 (3), 127–135.
- **Dansoh, A** (2005), "Strategic Planning for Construction Firms in Ghana", Construction Management and Economics, Vol. 23, No.2, PP. 163-168.

- **Eriksson, P.E., and Nilsson, T.,** (2008). *Partnering the construction of a Swedish pharmaceutical plant: case study*. Journal of Management in Engineering 24 (4), 227–233.
- **Eriksson, PE, and Westerberg, M,** (2010) *Effects of cooperative procurement procedures on construction project performance: A conceptual framework*. International Journal of Project Management, doi:10.1016/j.ijproman.2010.01.003
- **Gyedu-Asiedu W.** (2009) *Assessing Construction Project Performance in Ghana: Modelling Practitioners' and Clients' Perspectives*. PhD Thesis submitted to the Technology University of Eindhoven, The Netherlands.
- **Love, P., Skitmore, M., Earl, G.,**(1998). *Selecting a suitable procurement method for a building project*. Construction Management and Economics 16 (2), 221–233.
- **Mubarak S.** (2010). *Construction Project Scheduling and Control*. 2nd Edition. Published by John Wiley and Sons Limited Inc.
- **Osei-Tutu, E., Badu, E., and Owusu-Manu, D.** (2010) *Exploring corruption practices in public procurement of infrastructural projects in Ghana*. International Journal of Managing Projects in Business, Vol. 3 Iss: 2, pp.236 – 256
<http://www.emeraldinsight.com/journals.htm?articleid=1852571&show=html>
- **Palaneeswaran, E, Kumaraswamy, M. M. and Zhang, X Q** (2001) Reforging construction supply chains: a source selection perspective. *European Journal of Purchasing and Supply Management*, 8(1), 7-12.
- **Rwelamila, P. D, Talukhaba, A. A. and Ngowi, A. B.** (1999) Tracing the African Project Failure Syndrome: the significance of 'ubuntu'. *Engineering, Construction and Architectural Management*, 6(4), 335-346.
- **Thai, K.V.** (2009). *International Public Procurement: Concepts and Practices*. International Handbook of Public Procurement, Public Administration and Policy / 146 pages 1-22.
- **The Public Procurement Act (2003)** Ghana
- **Tysseiland, B.,** (2008). *Life cycle cost based procurement decisions: a case study of Norwegian defence procurement projects*. International Journal of Project Management 26 (4), 366–375.
- **Vulink, M** (2004), *Technology Transfer in the Construction Industry of Ghana: Human Resource Development through International Collaboration between Foreign and Local Contractors in the Greater Accra Region*.
- **Wardani, M., Messner, J., Horman, M.,** (2006). *Comparing procurement methods for design-build projects*. Journal of Construction Engineering and Management 132 (3), 230–238.
- **Westring, G.** (1997). *Ghana Public Procurement Reform*. Accra, Ghana: Ministry of Finance.
- **World Bank** (1995) *Guidelines: Procurement under IBRD Loans and IDA Credits*, Washington, DC: The World Bank.
- **World Bank** (1996). *Country Procurement Assessment Report for Ghana*. Washington, DC: Author.
- **World Bank** (2003) *Ghana 2003 Country Procurement Assessment Report*, Washington, DC: Ghana Country Department, the World Bank.

THE RELATIONSHIP BETWEEN THE LIQUIDITY AND THE PROFITABILITY OF LISTED BANKS IN GHANA

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Abstract

The study sought to find out the relationship between the liquidity and the profitability of banks listed on the Ghana Stock Exchange. Seven out of the nine listed banks were involved in the study. It adopted the longitudinal time dimension, specifically, the panel method. Document analysis was the main research procedure adopted to collect secondary data for the study. The financial reports of the seven listed banks were studied and relevant liquidity and profitability ratios were computed. The trend in liquidity and profitability were determined by the use of time series analysis. The main liquidity ratio, Temporary Investment Ratio (TIR) was regressed on profitability ratio, Return on Asset (ROA) using the model $y = ax + b$; where $y = \text{ROA}$; $x = \text{TIR}$. It was found that for the period 2005-2010, both the liquidity and the profitability of the listed banks were declining. Again, it was also found that there was a very weak positive relationship between the liquidity and the profitability of the listed banks in Ghana. The regression equation was $Y = 0.025X + 2.545$, Correlation Coefficient (R) was 0.237 and Coefficient of Determination (R^2) was 0.056. This means that only 5.6% of increase in profitability could be explained by increase in liquidity

Key words: Bank; Profitability; Liquidity; Assets; Ratios.

Introduction

Background of the Study

General Banking business involves the mobilization of funds from excess or surplus units of the economy and giving out to deficit units as loans and advances. This is called financial intermediation. The liquidity of a commercial bank is its ability to fund all contractual obligations as they fall due. These may include lending and investment commitments and deposit withdrawals and liability maturates, in the normal course of business (Amengor, 2010). In other words, bank liquidity refers to the ability to fund increases in assets and meet obligations as they fall due. In Ghana, Banking Act 2004 (Act 673) Section 31 urges banks to keep 9% of their deposits as primary reserves in an account with Bank of Ghana, which is used primarily to settle inter-bank indebtedness, and also as insurance for depositors.

Bank profitability is the ability of a bank to generate revenue in excess of cost, in relation to the bank's capital base. A sound and profitable banking sector is better able to withstand negative shocks and contribute to the stability of the financial system. (Athanasoglou, Brissimis and Delis, 2005). The majority of studies on bank profitability, such as Short (1979), Bourke (1989), Molyneux and Thornton (1992), Demircuc-Kunt and Huizinga (2000) and Goddard et al. (2004), used linear models to estimate the impact of various factors that may be important in explaining profits. Bank profitability is usually expressed as a function of internal and external factors. The internal determinants of bank profitability are also known as micro or bank-specific determinants. These can be broadly classified into two – financial statement variables and non-financial statements variables. The financial statement variables which determine bank profitability are: expense management, loan composition and bank credit, composition of bank deposits, market interest rates, bank earning and operating efficiency, changes in capital and liquidity management. The non-financial statement variables which determine bank profitability include number of bank branches, bank size and bank location. The external determinants are variables that are not related to bank management but reflect the economic and legal environment that affect the operation and performance of financial institutions (Athanasoglou, Brissimis and Delis, 2005). These factors include: financial regulation, competitive condition, concentration, market share, market growth and ownership

Statement of the Problem

There have been many researches on the determinants of bank profitability and almost all find liquidity to be one of the determinants of bank profitability. Examples include Bourke, (1989), Bashir, (2000), Karasulu, (2001), Guru, Staunton and Balashanmugam (2002), Staikouras, and Wood (2003) and Naceur, (2003).

Meanwhile, there have been varying reports on the relationship between bank liquidity and profitability. Some argue, per their research findings, that banks holding more liquid assets benefit from a superior perception in funding markets, reducing their financing costs and increasing profitability. For example, Bourke (1989) finds some evidence of a positive relationship between liquid assets and bank profitability for 90 banks in Europe, North America and Australia from 1972-1981. On the other hand, other researchers argue that, holding liquid assets imposes an opportunity cost on the bank given their low return relative to other assets, thereby having a negative effect on profitability. For example, Molyneux and Thornton (1992) and Goddard, et al (2004) find evidence of a negative relationship between the two variables for European banks in the late 1980s and mid-1990s, respectively. According to Eichengreen and Gibson (2001), the fewer the funds tied up in liquid investments, the higher we might expect profitability to be. In effect, various authors have found varying relationships between the liquidity and profitability of banks in various countries. This research therefore sought to find out the relationship existing between the liquidity and the profitability of banks in Ghana, with specific reference to those listed on the Ghana Stock Exchange.

Objectives of the Study

The purpose of the study was to find out the relationship between the liquidity and the profitability of banks listed on the Ghana Stock Exchange. The objectives of this research were to determine:

- the profitability trend of banks listed on the Ghana Stock Exchange, within the period 2005-2010
- the liquidity trend of banks listed on the Ghana Stock Exchange, within the period 2005-2010
- the relationship/correlation between the liquidity and the profitability of banks listed on the Ghana Stock Exchange

Research Questions

The questions to which the researcher wanted to find answers were:

- What is the profitability trend of banks listed on the Ghana Stock Exchange, within the period 2005-2010?
- What is the liquidity trend of banks listed on the Ghana Stock Exchange, within the period 2005-2010?
- What is the relationship existing between the liquidity and the profitability of banks listed on the Ghana Stock Exchange?

Methodology

Research Design

The study is descriptive in nature. In descriptive research, a researcher begins with a well-defined subject and conducts a study to describe it accurately and the outcome is a detailed picture of the subject (Neuman, 2007). This study seeks to describe the relationship between the liquidity and the profitability of banks listed on the Ghana Stock Exchange. The study adopts the longitudinal time dimension, specifically the panel study type. Panel study is a powerful type of longitudinal research in which the researcher observes exactly the same people, group, or organisation across multiple time points (Neuman, 2007). In this study, particular banks listed on the Ghana Stock Exchange were examined in terms of their liquidity and profitability across time period of 2005-2010.

Population and Sampling

Target Population

The population of this study was made up of all commercial banks listed on the Ghana Stock Exchange. These included CAL Bank Limited, Ecobank Ghana Limited, Ecobank Transnational Incorporated, Ghana Commercial Bank Ltd., HFC Bank Ltd, SG-SSB Ltd., Standard Chartered Bank Ltd., Trust Bank Ltd. and UT Bank Limited.

Sampling

In this study, purposive sampling was used to select seven (7) out of the nine (9) banks listed on the Ghana Stock Exchange. The two banks excluded were Ecobank Transnational Incorporated and Trust Bank Ltd. These banks were excluded from the study because their financial statements were reported in currencies other than Ghana Cedis. Ecobank Transnational Incorporated reported in US Dollars while Trust Bank Ltd reported in Dalasi. Including the above two banks in the research would distort the analyses and comparison.

Instrumentation and Data Collection

Data was mainly collected from secondary sources. Data emanated from listed banks' financial reports, scholarly journals, business and financial news papers and other magazines and corporate journals. As the study needs historical financial data, which are from corporate reports, accessing publicly available data is assumed as the suitable method for the accuracy of the data. As public data is accessible to everyone; the study made use of the financial performance data which were of interest to the present research. Financial reports and other relevant information of the listed banks for the period 2005-2010 were retrieved from the internet, by search engines. The researcher is a shareholder of some of the banks under consideration so some of the annual reports were readily available for use.

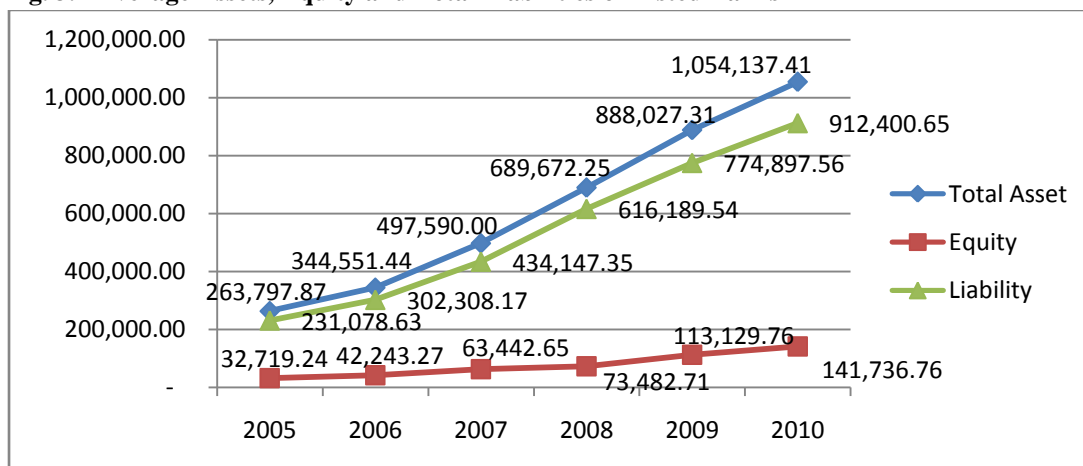
Analysis of Data

Quantitative analysis techniques were adopted for the study. These included profitability and liquidity ratios analyses, time series analysis, and regression and correlation analyses.

Absolute profit and liquid assets figures of the listed banks were analysed and compared, to see the trend within the period 2005-2010. Profitability and liquidity ratios of the banks were also analysed and compared to notice the trend in profitability and liquidity within the period 2005-2010. The profitability ratios of the listed banks (Y – axis) were then regressed against their liquidity ratios(X – axis) to determine the least square regression lines and equations. The correlation coefficients and coefficients of determination were identified to describe the strength of the relationship existing. For the purpose of the regression, the profitability measure was Return on Asset (ROA) – Profit after Tax over Total Assets. The liquidity measure used was Temporary Investment Ratio (TIR) – Cash and Cash Equivalents over Total Assets. The least squared regression line equation was in the form: $y = ax + b$; where y = profitability (dependent variable); x = liquidity (independent variable); a = the gradient of the regression line; b = the y intercept

Results

Fig. 3.1 Average Assets, Equity and Total Liabilities of Listed Banks

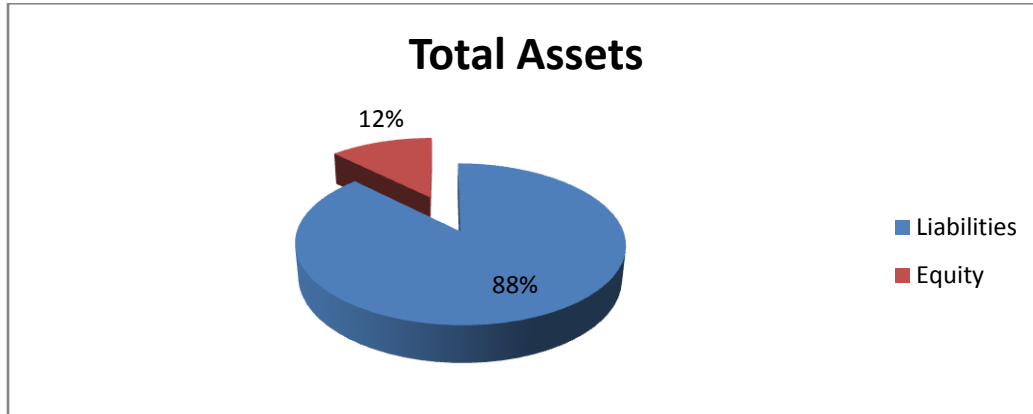


(Source: Author's Computation, 2011)

Fig. 3.1 shows the Total Assets, Total Liabilities and Equity of the average listed bank. It clearly indicates that the Total Assets and the Total Liabilities of the average listed bank increased at the same pace. It meant that a very huge proportion of a (listed) bank's Total Assets was financed by external debt. This is in line with normal

banking business because banking, to a greater extent, has to do with accepting customers' deposits, (liabilities) which in turn could be lent as loans and advances (assets) to individuals and corporate entities. Majority of a bank's assets are financed by liabilities.

Fig. 3.2: Average Proportions of Total Liabilities and Equity



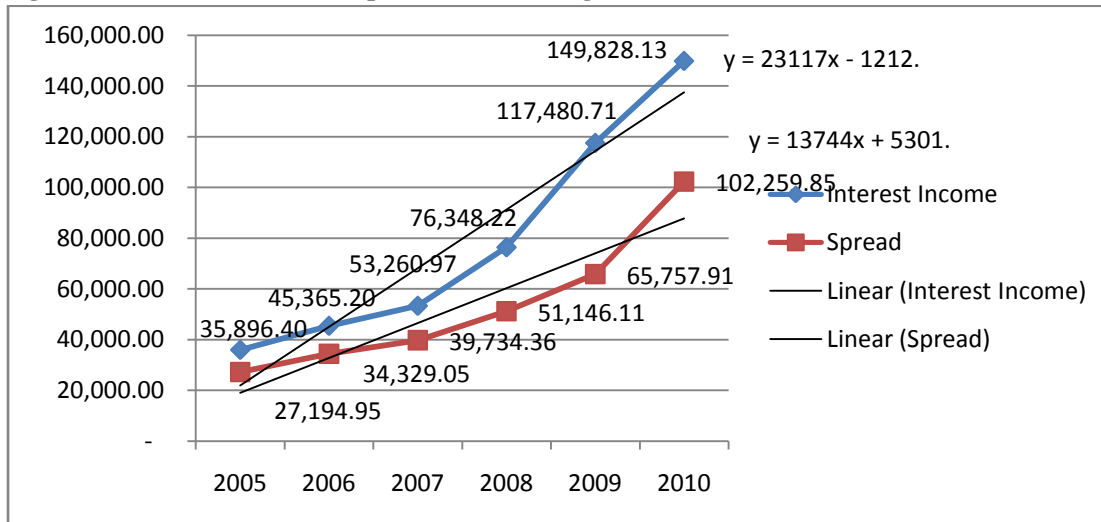
(Source: Author's Computation, 2011)

Fig. 3.2 shows that about 88% of the Total assets of the average listed bank at a point in time are financed by Total Liabilities. The remaining 12% is financed by Equity.

Research Question One

What is the profitability trend of banks listed on the Ghana Stock Exchange within the period 2005-2010?

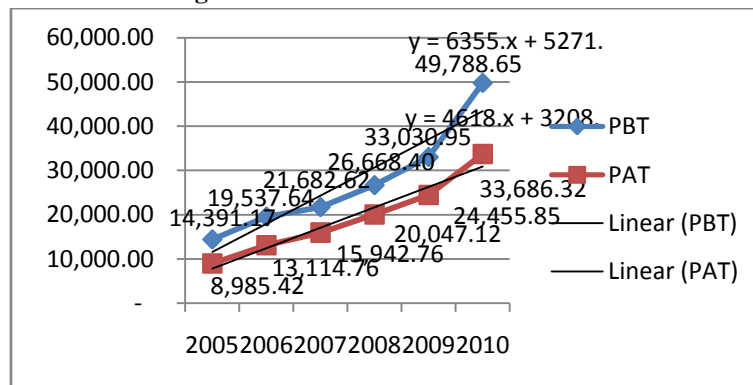
Fig. 3.3: Interest Income and Spread of the Average Listed Bank



(Source: Author's Computation, 2011)

Fig. 3.3 presupposes that there is a direct positive relationship between the Interest Income of the average listed bank and its Spread. Both have been increasing from the period 2005 up to 2010. Spread is the Excess of Interest Income over Interest Expense.

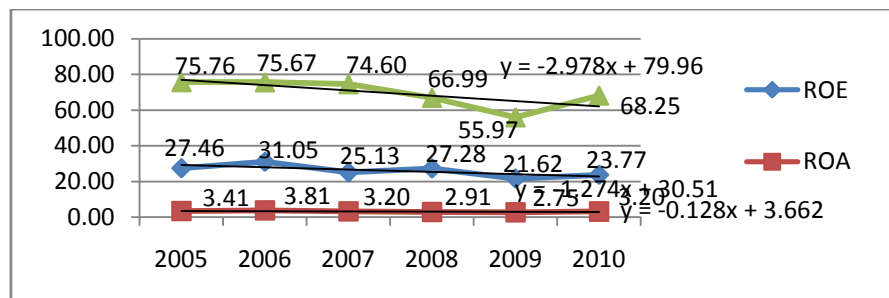
Fig 3.4: PBT and PAT of the Average Listed Bank



(Source: Author's Computation, 2011)

Fig. 3.4 shows that the trends in Profit before Tax and Profit after Tax of the average listed bank were almost the same. Both PBT and PAT of the average listed bank had been increasing within the period 2005-2010. This means that generally, profits of the listed banks were increasing within the period 2005 – 2010.

Fig. 3.5: Profitability of the Average Listed Bank



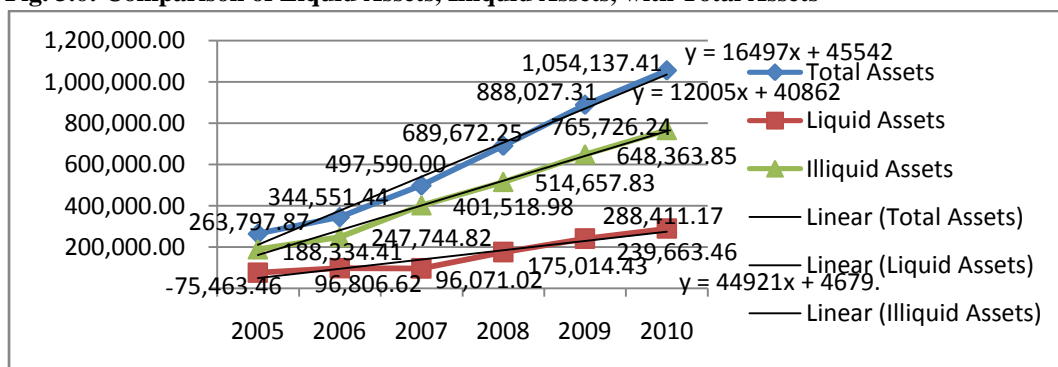
(Source: Author's Computation, 2011)

Fig. 3.5 shows the Spread Margin (SM), Return on Assets (ROA) and Return on Equity (ROE). It indicates that the profitability of the average listed bank has been reducing generally. These are shown by the trend lines of Spread Margin, Return on Assets and Return on Equity. Spread Margin is the Spread over Interest Income times 100.

Research Question Two

What is the liquidity trend of banks listed on the Ghana Stock Exchange within the period 2005-2010?

Fig. 3.6: Comparison of Liquid Assets, Illiquid Assets, with Total Assets

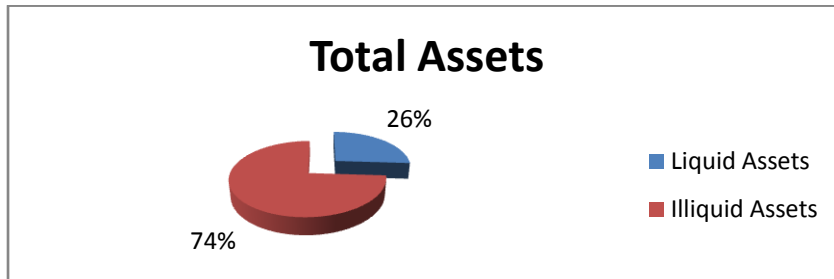


(Source: Author's Computation, 2011)

Fig. 3.6 shows that there have been increases in all categories of assets. However, the increase in Total Assets results in higher increase in Illiquid Assets than in Liquid Assets. The Liquid Assets increased in 2006 and

reduced by a margin in 2007. Thereafter, it increased continuously up to the year 2010. The equations of the trend lines show general increase in Liquid Assets over the years 2005-2010, though there was a fall in 2007.

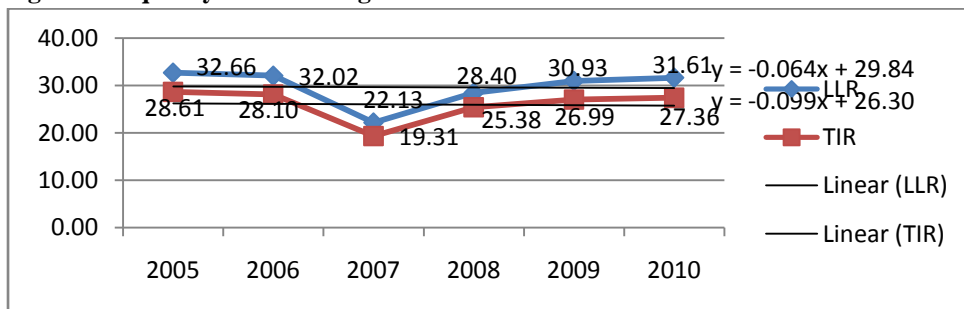
Fig. 3.7: Percentages of Liquid Assets and Illiquid Assets



(Source: Author's Computation, 2011)

Fig. 3.7 shows that the average listed bank holds about 26% of its Total Assets in the form of Liquid Assets, while the remaining 74% is locked up in the form of Illiquid Assets.

Fig. 3.8: Liquidity of the average listed bank



(Source: Author's Computation, 2011)

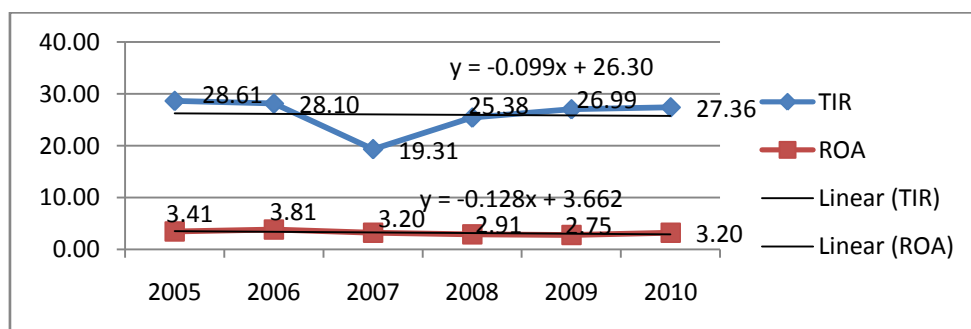
Fig. 3.8 shows that both Temporary Investment Ratio (TIR) and Liquid Assets to Long-term Liabilities (LLR) of the average listed bank portray the same trend in liquidity. The trend lines show that there has been a general decreasing effect in liquidity within the period 2005-2010. Even though the average listed bank has been increasing its Liquid Assets, there has been a reduction in the general level of liquidity.

Research Question Three

What is the relationship between the liquidity and the profitability of banks listed on the Ghana Stock Exchange?

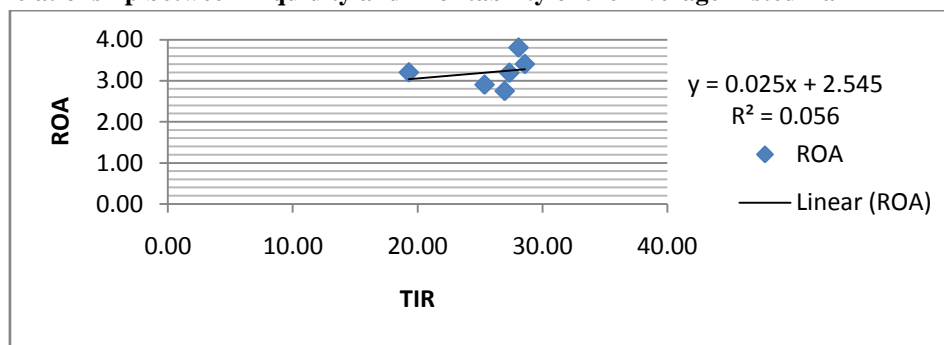
In order to find out the relationship which exists between the liquidity and the profitability of the banks listed on the Ghana stock exchange, their profitability (ROA) were regressed against their liquidity (TIR).

Fig. 3.9a: Liquidity and Profitability of the Average Listed Bank



(Source: Author's Computation, 2011)

Fig. 3.9b: Relationship between Liquidity and Profitability of the Average Listed Bank



(Source: Author's Computation, 2011)

Fig. 3.9a and 3.9b show that the relationship between the liquidity and the profitability of the average listed bank is a weak positive relationship. The regression line of ROA on TIR is $Y = -0.025X + 2.545$. The coefficient of correlation (R) is 0.237 while the coefficient of determination (R^2) is 0.056.

Discussion

The results show that within the period 2005-2010, the listed banks were increasing both liquid assets and illiquid assets. Despite the fact that the liquid asset holdings of the listed banks were increasing, their liquidity was decreasing in the period, 2005-2010. The listed banks had their lowest liquidity in 2007. The listed banks were increasing their absolute profit figures within the period 2005-2010. Despite this, their profitability was actually declining within the period 2005-2010. The research revealed a weak positive relationship between the liquidity and the profitability of the average listed bank in Ghana. Using Return on Assets (ROA) and Temporary Investment Ratios (TIR) as the main representatives of profitability and liquidity respectively, The regression equation was $Y = 0.025X + 2.545$,

Where Y = Return on Asset (Profitability)

X = Temporary Investment Ratio (Liquidity)

Correlation Coefficient (R) is 0.237

Coefficient of Determination (R^2) is 0.056

This means that only 5.6% of increase in profitability could be caused by increase in liquidity.

Conclusion

In conclusion, both the liquidity and the profitability levels of the listed banks were decreasing within the period 2005-2010. There was a weak positive relationship between the liquidity and the profitability of the listed banks. These findings support Bourke (1989) who found some evidence of a positive relationship between liquid assets and bank profitability for 90 banks in Europe, North America and Australia from 1972 to 1981. In view of the fact that liquidity has some amount of bearings on the profitability of a bank, it is important that banks manage their liquidity very well. When banks hold adequate liquid assets, their profitability would improve. Adequate liquidity helps the bank minimise liquidity risk and financial crises. The bank can absorb any possible unforeseen shock caused by unexpected need for decrease in liabilities or increase in assets side of the Statement of Financial Position. However, if liquid assets are held excessively, profitability could diminish. Liquid assets usually have no or little interest generating capacity. The opportunity cost of holding low-return assets would eventually outweigh the benefit of any increase in the bank's liquidity resiliency as perceived by funding markets.

References

- Amengor, E. C. (2010). Importance of Liquidity and Capital Adequacy to Commercial Banks". A Paper Presented at Induction Ceremony of ACCE, UCC Campus

- Athanasoglou, P. P., S. N. Brissimis and M. D. Delis, (2005) "Bank-Specific, Industry- Specific and Macroeconomic Determinants of Bank Profitability".Banking Act (2004); Act 673
- Bashir, A. (2000). Determinants of Profitability and Rates of Return Margins in Islamic Banks: Some Evidence from the Middle East, Grambling State University, Mimeo.
- Bourke, P., (1989), "Concentration and other Determinants of Bank Profitability in Europe". Journal of Banking and Finance, pp65-80.
- Demircuc-Kunt, A., & Huizinga, H. (2000): "Financial Structure and Bank Profitability" PolicyResearch Working Paper 2430, World Bank.
- Eichengreen, B. and H.D. Gibson (2001). "Greek banking at the dawn of the newmillennium." CERP Discussion Paper 2791, London.
- Goddard, J., Molyneux, P. & J.O.S. Wilson (2004). "Dynamics of Growth and Profitability in Banking," Journal of Money, Credit and Banking 36, 1069-1090.
- Guru B., J. Staunton & B. Balashanmugam (2002), "Determinants of Commercial Bank Profitability in Malaysia," University Multimedia Working Papers.
- Karasulu, M. (2001), "The Profitability of the Banking Sector in Korea," IMF Country Report, July.
- Molyneux, P. & J. Thornton (1992), "Determinants of European Bank Profitability: A Note," Journal of Banking and Finance, Vol. 16, No. 6, 1173-8.
- Naceur, S. B. (2003), "The Determinants of the Tunisian Banking Industry Profitability: Panel Evidence," Universite Libre de Tunis Working Papers.
- Neuman, W. L. (2007). Basics of Social Research, 2nd Ed. Boston: Allyn and Bacon
- Short, B. (1979), "The Relationship between Commercial Bank Profit Rates and Banking Concentration in Canada, Western Europe and Japan," Journal of Banking and Finance, Vol. 3, 209-19.
- Staikouras, C. & Wood G., (2003). The Determinants of Bank Profitability in Europe, Paper presented at the European Applied Business Research Conference.(1956). "The Interest-Elasticity of Transactions Demand For Cash," *Review of Economics and Statistics*, 38(3), pp. [241-247](#). Reprinted in Tobin, *Essays in Economics*, v. 1, *Macroeconomics*, pp. [229- 242](#).

MALARIA PARASITE DETECTION USING IMAGE PROCESSING

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Abstract

This work describes a computer image analysis algorithm that counts the number of cells in a digital image in addition to finding and counting cells with the malarial *P. vivax* parasite. The process is based on morphological operators using flat, disk-shaped, structuring elements to count the number of cells. A morphological operation top-hat filter is used to detect parasites in human red blood cells. The output is 100% sensitive and 75% specific to malarial parasites; The method is potentially valuable tool for the diagnosis of malaria.

Introduction

Malaria is a life-threatening parasitic disease transmitted through female *Anopheles* mosquitoes. It is found throughout the tropical and subtropical regions of the world (figure 1), and affects over 300 million people annually. Over one million people die due to malaria every year. The first apparent mention of malaria-like symptoms was recorded in the ancient *Nei Ching* (The Canon of Medicine) about 4700 BCE. In 1880, Charles Louis Alphonse Laveran, a French physician, discovered the parasite that causes malaria in humans, receiving the Nobel Prize for Medicine and Physiology in 1907. (Bernard H. et al Clinical Diagnosis & Management, by Laboratory Methods. Philadelphia 1991 .1168-1172)

Counting cells and finding foreign bodies (i.e. bacteria and parasites) in human blood is often challenging, especially if many experiments are involved. Thus, studies have evaluated a variety of methods for algorithms to evaluate sick cells.

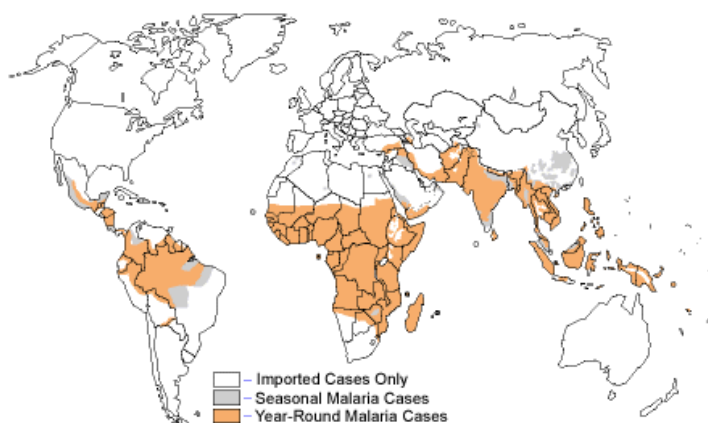


Figure1. Prevalence of malaria around the world. (Morphological Operations. Online. 26 March 2004).

Problem Statement

The “gold standard” for diagnosis involves examination of Giemsa-stained¹ thick and thin blood smears under a microscope by an expert in examination of blood smears for malaria parasites. This procedure is neither 100% sensitive nor 100% specific, since lowlevel parasitemia and mixed infections are frequently not detected. and The biggest detraction of microscopy, namely its dependence on the skill, experience and motivation of a human Technician. And it is laborious and time consuming Additional methods exist to diagnose malaria, mainly rapid chromatographic assays (similar to a pregnancy test, a color bar shows up on the testing kit if the parasite is

present (Classen R.et al Topodermatographic Image Analysis for Melanom Screening and the Quantitative Assessment of Tumor Dimension Parameters of the Skin. *Cancer*. 75.4 1995 pp 981-988.)

Objective

The object of this project is to develop and test a software algorithm that counts the number of healthy and sick cells in a set of images. Unlike microscopy and rapid chromatographic assays, the software should be able to find parasites in any number or quantity of blood; and the results should come out within minutes. Morphological operators are use as main method of approach.

Methodolgy

Materials

Giemsa-stained blood films

Digital Camera

Microscope

Computer

Block diagram

The System architecture used for Malaria parasite detection involves the following steps: input image, image processing, cell counting and parasite detection . The Block diagram of system architecture is shown in Figure 2. A set of ten Giemsa-stained blood films was obtained from PATBRENDA Laboratory ltd for analysis in Koforidua. Magnification was set at 1,000X The processing step includes noise reduction, smoothening of image.

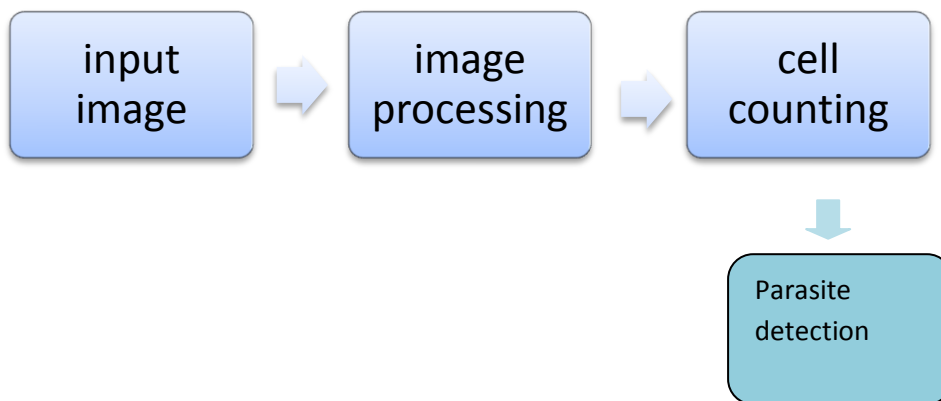


Figure 2: system block diagram

Flow Chart

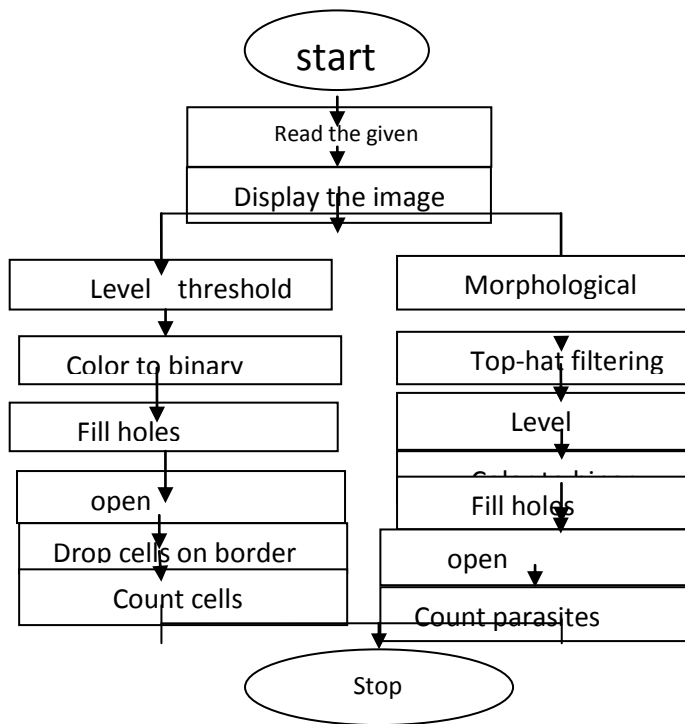


Figure3. Matlab algorithm overview

Input image: The original digital images had a few dust particles from the lenses in the microscope. Since these were present in the exact same place in every image, and could cause errors in the cell count, they were removed prior to processing. After reading the images into Matlab, the algorithm can process the cell and parasite count. The inverse of all images was taken (i.e. black turns to white, red turns to blue, etc.). This step is required so that points of interest (i.e. cells) are offset from the background prior to converting the image to binary (figures 4 and 5).

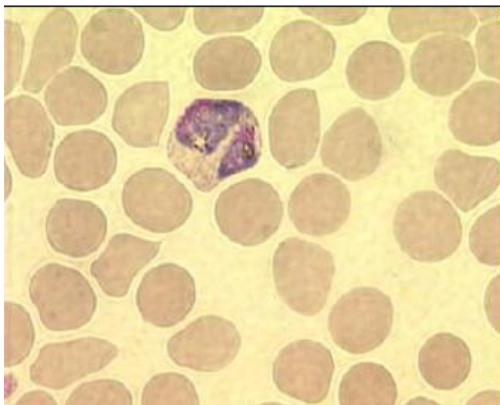


Figure 4 Sample image analyzed by Algorithm

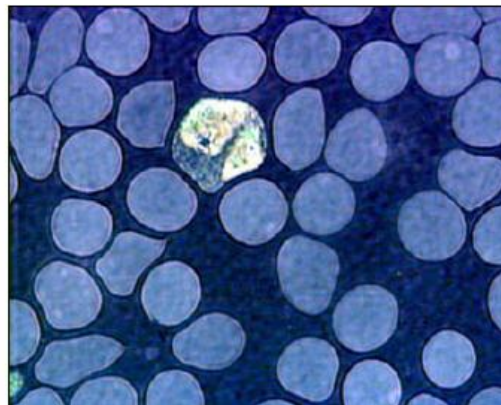


Figure 5, inverse of sample image

Level Threshold

This step precedes turning the image to binary(0 and 1), as it provides the global threshold level information needed for the command to highlight bright pixels as white, and dark pixels as black. Since the cells are lighter than the background, they receive a value of 1. The dark background receives a value of 0. There is no output for this command. The line command is `level = graythresh (I)`. The term I stands for the inverse image.

Color to Binary

The color image is then processed to black and white (figure 6). The line command is `bw = im2bw (I, level)`, where `im2bw` is the Matlab command that calls image I with intensity information level discussed above. The term `bw` stands for a black and white image.

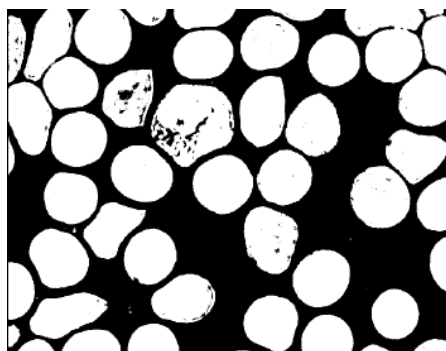


Figure 6. Binary of sample image

Fill Holes

Some cells will show up with holes within them (Figure 7, red arrows). The cause may be dark spots where not enough light came through, borders that are out of focus, or irregular elements inside, such as a malaria parasite or DNA in a white cell. To prevent these holes from causing cells to be dropped due to sizes smaller than usual (a red cell has approximately 40-60 pixels in these images; white cells are larger), a command is used to fill them. The line command is `bw2 = imfill (bw, 'holes')`, (figure 8).

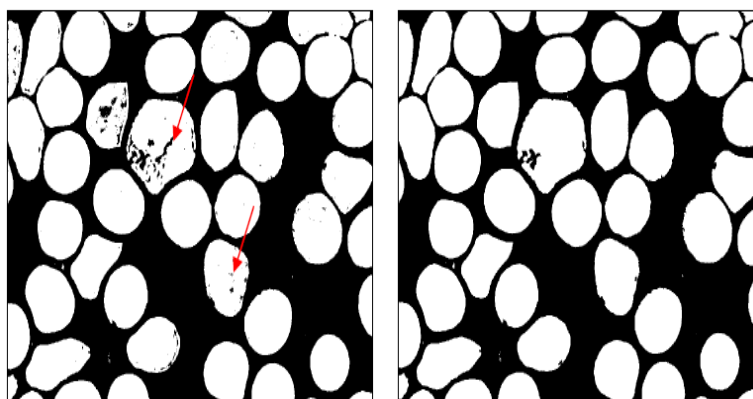


Figure 7. Presence of holes within cells Figure 8. Image after holes were filled

Open

The image at this point still has a few elements that are not relevant, including parts of cells on the periphery of the image (figure 9, arrow 1), and other small elements unknown to the author (arrows 2 and 3). To eliminate these items, a morphological opening is performed, consisting of an erosion and a dilation of the elements on the image. An essential part of these two operations is the structuring element (named `strel` in the code) used to

probe the input image (Di Ruberto .C . et al Analysis of Infected Blood *Image and Vision Computing*. 2002 .pp20133-20146)

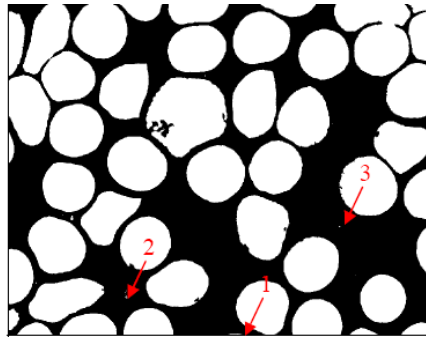


Figure 9. Small elements in sample image; 1. Part of a cell

The command line is `background = imopen(bw2,strel('disk',20));`

The term background will carry the new image to the next step. See figure 18, the new image, clear of any elements smaller than 20 pixels. Notice how the cells have more of a rounded form. Small inlays on the edges are either erased or enlarged.

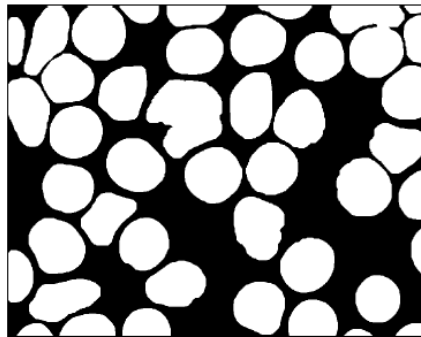


Figure 10. Sample image after morphological operation open

A radius larger than 20 pixels will drop more elements (i.e. those two cells on the bottom right of the image) and will also assist in separating connected cells (see top right figures 10 and 11); however, it also causes an increased effect on the morphology of the cells. Smaller, non-circular cells also drop out. See figures 19 and 20, for a pixel radius of 40 and 60, respectively.

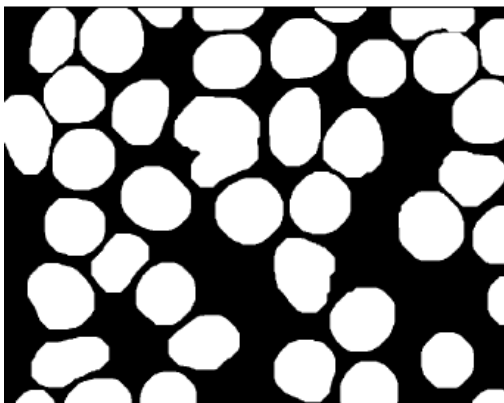


Figure 11. Sample image after morphological operation open a radius of 60pixel

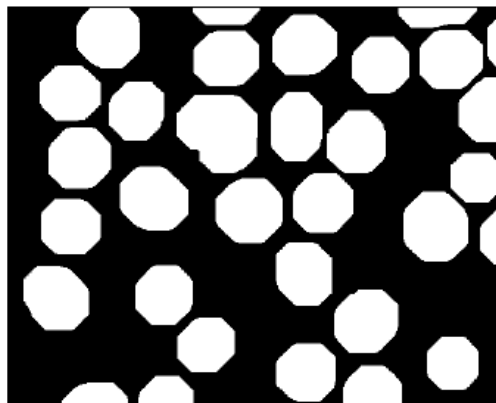


Figure 12. Sample image after radius of 40 pixels

Drop Cells on Borders

Since it is often difficult to differentiate which type of cell is present on the periphery of an image, the algorithm removes them.

The command line is `nobrd = imclearborder(background,26)`.

The largest distance from the border that Matlab allows for analysis is 26 pixels; hence some cells stay in the output (Figure 13).

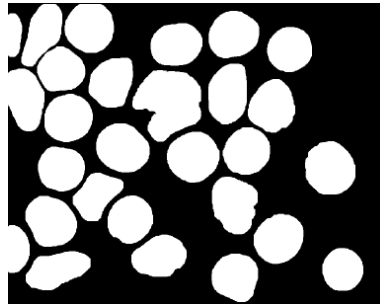


Figure 13. Sample image after clear border command

Count Cells

The Euler number command is used to count the number of cells. It functions by considering patterns of convexity and concavity in local 2-by-2 pixel neighborhoods.

The command line is `eul = bweuler (nobrd)`.

Morphological Structuring

This step involves creating a structuring element with a 25-pixel disk-shaped radius of the inverse image. The command line is `structure = strel ('disk',25);`

Healthy red cells do not have DNA (figure 4). The algorithm takes into account the different physical shapes of each cell by performing a morphological top-hat filter on the inverse image using the structuring element structure above.

Top-Hat Filtering

As the open removes narrow protrusions or spikes on the contour of cells, and tiny elements altogether, the top-hat filter reveals exactly these residues that the structuring element does not fit ; hence, all the small elements inside abnormal cells come up stronger in the output than healthy red cells (figure 22), or the edges of white cells.

The line command is `Itop = imtophat (I,structure);`

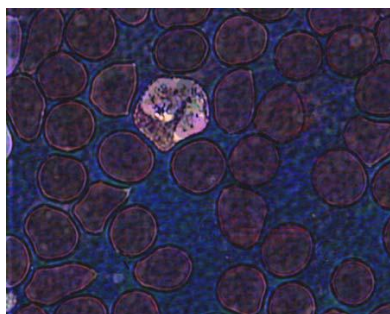


Figure 14. Sample image after top-hat filter

Level Threshold 1

At this point, the algorithm needs the global threshold value discussed earlier to convert to binary. The line command is `level = graythresh (Itop);`

Color to Binary 1

Using the same method discussed earlier, the image is converted to binary (Figure15). The line command is `bw = im2bw(Itop,level);`

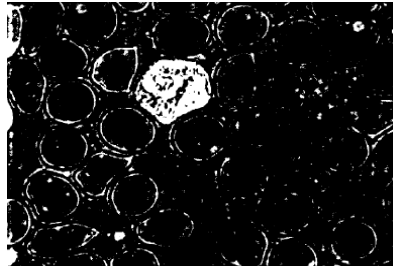


Figure 15. Binary of sample image with parasite

Fill Holes 1

The holes are then filled to prevent the parasite from being dropped along with other smaller elements during the *open*.

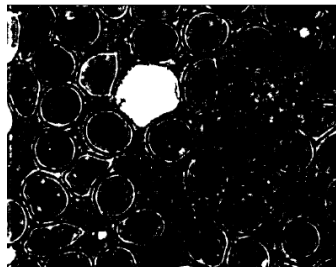


Figure 16. Sample image with parasite and holes filled

The line command is `bw2 = imfill (bw,'holes')`

Open 1: A smaller radius will not drop enough of the remnant elements on the image; while a larger radius will drop the smaller sick cells found in some images.

The command line is `background2 = imopen (bw2,strel ('disk',26);`

Count Parasites

Last step in the algorithm is an Euler number command.

The command line is `eul = bweuler (background2)`. The output is 1; which is correct

Figure.17

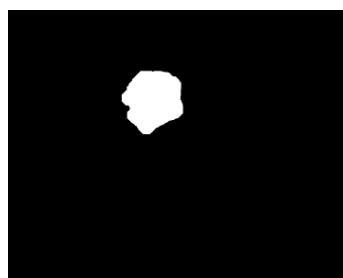


Table of Results

Table 1

The Table 1 shows the number of cells in each image per a manual count by the author (where only cells within the image boundaries are considered), whether there is a parasite or not in each image, the algorithm output for the total number of cells (includes white cells, and healthy and sick red cells), the actual number of sick cells, and the algorithm output for the number of sick cells.

Discussion and Conclusions

Table 2 outlines the sensitivity, specificity and accuracy of the algorithm — defined by the equations below. In table 4, the term positive microscopy represents the number of images that contain the malaria parasite; while

Photo Number	Sick (YES/NO)	Actual Count: Total Number of Cells	Algorithm Count: Total Number of Cells	Actual Number of Sick Cells	Algorithm Count of Sick Cells
1	Yes	15	14	1	1
2	Yes	25	27	1	1
3	Yes	24	24	1	1
4	Yes	28	28	1	1
5	No	24	30	0	1
6	No	20	20	0	0
7	No	15	15	0	0
8	No	25	24	0	0
9	Yes	13	14	1	1
10	Yes	23	25	1	2

negative microscopy represents images with only healthy cells. Algorithm positive represents images that the algorithm found a parasite, whether it was right or not; and algorithm negative represents images the algorithm did not find any parasite.

True ppositive value (TP) 7

True negative value (TN) 3

False positive value (FP) 1

False negative value (FN) 0

Table 2. Actual presence of parasite vs. algorithm detection

$$\text{Sensitivity} = \frac{TP}{TP + FN} = \frac{7}{7+0} = 100\%$$

$$\text{Specificity} = \frac{TN}{TN + FP} = \frac{3}{3+1} = 75\%$$

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FN+FP} = \frac{3+7}{3+7+1+0} = 91\%$$

The algorithm has high sensitivity, which is desirable since one would like a test of high success rate of detecting positive cases.. Conversely, the test is not highly specific at 75%, hence there are false positives. Overall, the algorithm had an accuracy of 91%, which is considered good under clinical parameters. The algorithm developed to find and count parasites is a novel alternative to current diagnostic methods. The software is able to find parasites in low quantities and quantify the extent of infection, all in less than five minutes.

Recommendations and limitations

After implementation of the proposed approach as outlined in table 2. To increase the accuracy of the output, and diminish error, we suggest an algorithm that collects an array of results based on a large number of cells. The algorithm would adjust the image factors depending on the given step .those factors would include image brightness and contrast, open radius, structuring element radius for the top-ha filter, and perhaps a color overlay for the inverse image .

The better the spacing between cells, the less likely the chance of errors; where multiple cells were counted as one, and one or more cells were dropped

In future, we may go for the evaluation of proposed approach that can identify and specify, different species of the plasmodium parasite affecting the red blood cells.

References

- Bernard H.et al Clinical Diagnosis & Management, by Laboratory Methods. Philadelphia 1991 .1168-1172
- Classen R.et al Topodermatographic Image Analysis for Melanom Screening and the Quantitative Assessment of Tumor Dimension Parameters of the Skin. *Cancer*. 75.4 1995 pp 981-988.
- Di Ruberto .C . et al Analysis of Infected Blood *Image and Vision Computing*. 2002 .pp20133-20146
- Morphological Operations. Online. 26 March 2004.
- Nattkemper.W .Evaluation of Fluorescence Micrographs. *Computer in Biology and Medicine*.2003 pp31-43
- Structuring Elements: Morphological Operations (Image Processing Toolbox). Online. 19 April, 2004.

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Inflation analysis is indispensable in a developing country like Ghana, which is struggling to achieve the Millennium Development goals. It is therefore essential for Ghana to adopt and apply robust statistical models in analysing its inflation for accurate planning and forecast. This paper presents a model of Ghana's monthly inflation from January 1985 to December 2010 and use the model to forecast twelve (12) month inflation for the country. Using the Box – Jenkins (1976) framework, the autoregressive integrated moving average (ARIMA) was employed to fit a best model of ARIMA. The seasonal ARIMA model, SARIMA (1, 1, 2) (1, 0, 1) was chosen as the best fitting from the ARIMA family of models with least Akaike Information Criteria (AIC) of 1156.08 and Bayesian Information Criteria (BIC) of 1178.52. The selected model was used to forecast monthly inflation for Ghana for twelve (12) months.

Keywords: Inflation; Time Series; SARIMA; Autoregressive, Moving Average; Differencing.

Introduction

Inflationary analysis or modeling is one of the most important research areas in monetary planning. This is due to the fact that a high and sustained economic growth in conjunction with low inflation is the central objective of macroeconomic policy. Achieving and maintaining price stability will be more efficient and effective if the causes of inflation and the dynamics of its evolution are well understood. It is a fact that monetary policy-makers and planners worldwide are more interested in stabilizing or reducing inflation through monetary policies (price stability).

Inflation is usually defined as a sustained rise in a broadly based index of commodity prices over some period of time, (Bomberger and Makinen, 1979). Major components of this definition are that the rise in prices takes place in a variety of sectors dealing with goods and services; also this increase spans from a rather lengthy period of time rather than two or more quarters. This means that when the price increases, each unit of currency buys fewer goods and services and as a result, inflation is an erosion of the purchasing power, which results in loss in real value in the medium and unit of account in the economy (Stokes, 2009).

Inflation dynamics and evolution can be studied using a stochastic modeling approach that captures the time dependent structure embedded in time series inflation as a stochastic process. Autoregressive Integrative Moving Average (ARIMA) models can be applied to describe the component structure of statistical time series especially to financial/economic time series that show seasonal behaviour, random changes and trends (non-stationary) time series. Unfortunately, the management of inflation in Ghana over the years has been ineffective. High inflation has rendered the cost of loanable funds prohibitive. Subsequent high interest rates have in turn prevented productive sectors of the economy from accessing finance for growth and development (FIAS, 2002). Additionally, in a recent study by Catoa and Terrones (2003), Ghana was cited as one of the top 25 countries in the world with high inflation levels. In most cases, economic theories were employed to analyze Ghana's inflationary experience. A more vigorous statistical analysis would be more informative and precise.

The question that comes up here therefore is "what is the best time series model and structural form of Ghana's inflationary experience?" This paper among others seeks to answer the following research questions:

- What is the trend of Ghana's inflation (1985 – 2010)?
- What is the structural form of Ghana's inflation?
- What type of Time Series model can best be used to forecast Ghana's inflation?
- What is the estimated inflation in the next twelve (12) months?

As a matter of fact, Ghana's inflation experience since independence has been one with a difficulty that policy makers have been fighting with till today but with little success. From 1957 through 1962, inflation was relative

stable in Ghana and in the neighborhood of the much desired single digit bracket. After 1962, there was unprecedented macroeconomic instability and very high inflation particularly in the 1970s and early 1980s.

Inflation exceeded 100% on four occasions between July 1977 and March 1983. During these periods, Ghana embarked on a stabilization policy supported by the Breton Woods Institutions but the stabilization appeared to have done very little to resolve the persistent high and variable inflation. Over the past 35 years, the country has not had an occasion of sustained single-digit inflation; indeed, it has recorded annual average inflation rates in excess of 25% in more than half of those years. It was not until **2007** when the then government declared single digit yearly inflation of around 9.64%. However, in just a period of three (3) years, this figure had risen to 18.6%. Again in 2010 the government of the day declared a single digit yearly inflation of 9.56% with its attending problems.

These developments provide enough grounds to be able to model and forecast or predict inflation more accurately and reliably.

Literature Review

The few available studies on inflation in Ghana were conducted in the early to middle 1990s (Sowa, 1996, 1994; Sowa and Kwakye, 1991; Chhibber and Shaffik, 1991). Recent studies relating to inflation in Ghana have been mostly part of multi-country efforts and have been broad and less focused (Catao and Terrones, 2003; Loungani and Swagel, 2001; Braumann, 2000; Bawumiah and Abradu-Otto, 2003, Ocran 2007). Again, many of these studies have focused on explaining historical nature of inflation and less on the predictive power of the models that were used.

Bawumiah and Atta-Mensah (2003), using a vector error correction forecasting (VECF) model, concluded that inflation was a monetary phenomenon in Ghana. The authors did not explore the potential for real factors in price determination.

Sims (1980) has criticized standard macro-econometric policy models for embodying ‘incredible restrictions’, particularly in the light of the rational expectations hypothesis. The hypothesis suggests that agents use information about the economy as a whole to generate expectations, which influence variables such as wages, prices or consumption. In principle, this would imply that any one sectoral equation could embody variables from the system as a whole. But standard macro-models use relatively restrictive specifications of sectoral equations. As an alternative,

Sims (1980) called for the use of Vector Autoregressive Models (VARs), now among the most widely-used tools in academic and central bank macro-econometrics (e.g., for studying the transmission mechanism of monetary policy.) However, there are substantial difficulties in interpreting and using VARs for policy and forecasting, arising from omitted variables (a restriction in another form), omitted structural breaks and relevant lags, omitted non-linearities, and the use of sometimes doubtful identifying restrictions to give economic interpretations to shocks.

Univariate Time series modelling techniques are becoming an increasingly popular method of analyzing inflation (Janine et al., 2004). These techniques include models such as Autoregressive (AR), Moving Average (MA), and Autoregressive Integrated Moving Average (ARIMA).

Aidan et al., (1998) considered autoregressive integrated moving average (ARIMA) forecasting on South African inflationary data from 1990 to 2000. They concluded that ARIMA models are theoretically justified and can be surprisingly robust with respect to alternative (multivariate) modeling approaches. Indeed, Stockton and Glassman (1987) upon finding similar results for the United States commented that it seems somewhat distressing that a simple ARIMA model of inflation should turn in such a respectable forecast performance relative to the theoretically based specifications.

The Box-Jenkins (1976) approach in using ARIMA seeks to conduct identification, estimation, diagnostic checking, and forecasting a univariate time series. ARMA models can be viewed as a special class of linear stochastic difference equations. By definition, an ARMA model is covariance stationary in that it has a finite and time-invariant mean and covariance. For an ARMA model to be stationary, the characteristic roots of the difference equation must lie inside the unit circle. Moreover, the process must have started infinitely far in the past or the process must always be in equilibrium.

Specification of a time series process

The specification of a time series processes are guided by some set conditions. First and foremost, the data must be stationary. This can be observed from the autocorrelation and partial autocorrelation functions generated from a stationary time series data (Akinboade et al., 2001).

Pankratz (1983) provided theoretical autocorrelation functions (ACFs) and partial autocorrelation functions (PACFs) for various models chosen for various values of orders of autoregressive and moving average components that is for various p and q . According to Pankratz, 1983, the technique is to compare the correlograms obtained from given time series data with these theoretical ACFs/PACFs, to find a reasonable good match and tentatively select one or more ARIMA.

Box – Jenkins forecasting approach

For a given time series, there are a number of ways in which one can build a suitable model. Among these approaches is one developed by Box and Jenkins (1974). The approach is a three - stage iterative one involving:

1. Model identification
2. Model fitting or estimation and
3. Model verification/diagnostic checking.

If the model checking, which is the last stage, reveals that there are problems, the process is repeated. This approach has been adopted for many studies.

Model Identification

This stage involves the specification of the correct order of ARIMA model by determining the appropriate order of the AR, MA and the integrated parts or the differencing order. The major tools in the identification process are the (sample) autocorrelation function and partial autocorrelation function (Ramasubramanian, 2000). The identification approach is basically designed for both stationary and non-stationary processes.

Chinomona and Ramasubramanian (2003) identified a frame work for the identification as is shown in the Table 1 below.

Table 1: Model identification criteria

Model	ACF	PACF
$AR(1)$	decays exponentially	single spike
$MR(1)$	single spike	decays exponentially
$AR(p)$	decays exponentially with damped oscillations	p spikes
$MR(q)$	q spikes	decays exponentially with damped oscillations
$ARMA(p, q)$	decays exponentially and damped oscillations	both decays exponentially

Source: Chinomona and Ramasubramanian, 2003

The existence of non-stationarity can be indicated by an ACF, which is large at long lags. As stated earlier, the stationarity can be induced by differencing. Differencing once is generally sufficient, but twice may be needed.

In an era of several competing models, the use of model selection criteria becomes necessary. Information Criteria is a tool used to compare two or more competing models using their likelihood function (LF). These include Schwartz's Bayesian Criteria (SBC), Akaike's Information Criteria (AIC) and the Bayesian Information Criteria.

Model Fitting

Depending on the ACF and PACF of the sequence plots a model is run with appropriate software. The best fitting model must also have few parameters as much as possible alongside best measures of other model statistics according to the information selection criteria.

Model Diagnostic Checking

These residuals of a best fitting model should be normally distributed with zero mean, uncorrelated, and should have minimum variance or dispersion. That is model validation usually consist of plotting residuals over time as well as checking the various t-ratio parameters estimates.

Residual analysis can also be done through formal test using the Portmanteau test and other statistical tests.

The KPSS Test

Kwiatkowski, Phillips, Schmidt and Shin (1992) developed the most popular stationarity test, the KPSS test. Non stationary tests such as the Augmented Dickey Fuller (1972) and Phillips-Perron unit root tests are tested on a null hypothesis that the time series process is non-stationary. KPSS, as a stationary test however, is for the null hypothesis that the times series process is stationary against the alternate that the process is non-stationary. The KPSS hypothesis may be stated as

$$H_o : \sigma_{\varepsilon}^2 = 0, (stationarity)$$

$$H_1 : \sigma_{\varepsilon}^2 > 0, (non - stationary)$$

The KPSS test statistic is the Lagrange multiplier for testing $\sigma_{\varepsilon}^2 = 0$ against the alternate $\sigma_{\varepsilon}^2 > 0$ and is given by

$$KPSS = \frac{\left(T^{-2} \sum_{t=1}^T \hat{S}_t^2\right)}{\hat{\lambda}^2}$$

Where $\hat{S}_t^2 = \sum_{j=1}^t \hat{u}_j$ and \hat{u}_t is the residual of a regression of y_t on D_t and $\hat{\lambda}^2$ is a consistent estimate of the long-run variance of u_t using \hat{u}_t Kwiatkowski et al, (1992).

Methodology

The conceptual framework adopted for this work is that of the Box – Jenkins traditional forecasting also known as autoregressive integrated moving average (ARIMA) model. The model outlines a three-stage procedure; model identification, model fitting or estimation, model verification or diagnostics.

It is important that any identified model be subjected to a number of diagnostic checks (usually based on checking the residuals). If the diagnostic checks indicate problems with the identified model one should return to the model identification stage. Once a model or selection of models has been chosen; the stability of the estimated parameters should be tested with respect to time frame chosen.

First of all, statistical properties as well as distribution of all time series will be tested by means of coefficient of skewness and kurtosis, normal probability plots and Jarque-Bera test of normality, to check presence of typical stylized facts.

Secondly, time series will then be tested for stationarity both graphically and with formal testing schemes by means of autocorrelation function, partial autocorrelation function and using KPSS test of unit root. If the original or differenced series comes out to be non-stationary some appropriate transformations will be made for achieving stationarity, otherwise we will proceed to next phase.

In third phase, based on Box-Jenkins methodology, an appropriate model(s), which best describes the temporal dependence in the inflation series, will be identified using Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) and estimated through Ordinary Least Square (OLS) method. Estimated model(s) will be considered most appropriate if it typically simulates historical behaviour as well as constitute white-noise innovations (Ferridum, 2007). The former will be tested by ACF and PACF of estimated series while the latter will be tested by a battery of diagnostic tests based on estimated residuals as well as by over-fitting. The best fitting model(s) will then undergo various residual and normality tests and only qualifying model(s) will be selected and reserved for forecasting purpose.

Finally, Forecasting performance of the various types of ARIMA models would be compared by computing statistics like Akaike Information Criteria (AIC), Schwarz Information Criteria (SIC), Thiele Inequality Coefficient (TIC), Root Mean Square Error (RMSE), Root Mean Square Percent Error (RMSPE), Mean Absolute Error (MAE). On the basis of these aforementioned selection and evaluation criteria concluding remarks have been drawn.

Results

To be able to examine the trend of inflation in Ghana, a time plot of the inflation data has to be examined. The data and time plots of the data are discussed separately in the next session.

Preliminary Analysis

Table 2 shows the summary descriptive statistics of Ghana's inflation from January 1985 – December 2010. The data is divided into the various decades within the span of data for the study.

[Table 2: Summary Statistics for Ghana's Monthly inflation]					
Period	Statistic			Mean	Standard Deviation
	N	Min	Max		
Jan. 1985 – Dec. 1989	60	1.14	45.91	26.34	10.66
Jan. 1990 – Dec. 1999	120	7.33	70.82	28.23	16.27
Jan. 2000 – Dec. 2010	132	8.58	41.95	17.84	8.31
Overall Period (Jan. 1985 – Dec. 2010)	312	1.14	70.82	23.47	13.26

Source: SPSS Output, 2011.

From Table 2, it is evident that the period January 1985 – December 1989 recorded the lowest level of inflation of 1.14 percent (%). Also, the period January 1990 – December 1999 recorded the highest inflation of 70.82%. Again, January 1990 – December 1999 recorded highest average and standard deviation of 28.23% and 16.27 respectively. This high average and corresponding standard deviation implies the period was the most volatile.

After this era, however, there was decrease in inflation to an average of 17.84 % with a deviation of 8.31. This implies the period January 2000 to December 2010 recorded the most stable inflation levels compared to the past two periods. This can be attributed to the targeting inflation policy pursued during this era (starting 2007) in pursuance of the Millennium Development Goals (MDGs) and stable democratic governance within the period.

The non constant mean and standard deviation in the data suggest that Ghana's inflation data may be non-stationary; this however needs to be verified formally. This means inflation over the period has been very volatile.

Time Plot of Data

Plots of data actually reveal important features of a time series, such as trend, seasonal variation, outliers and discontinuities, which can be seen.

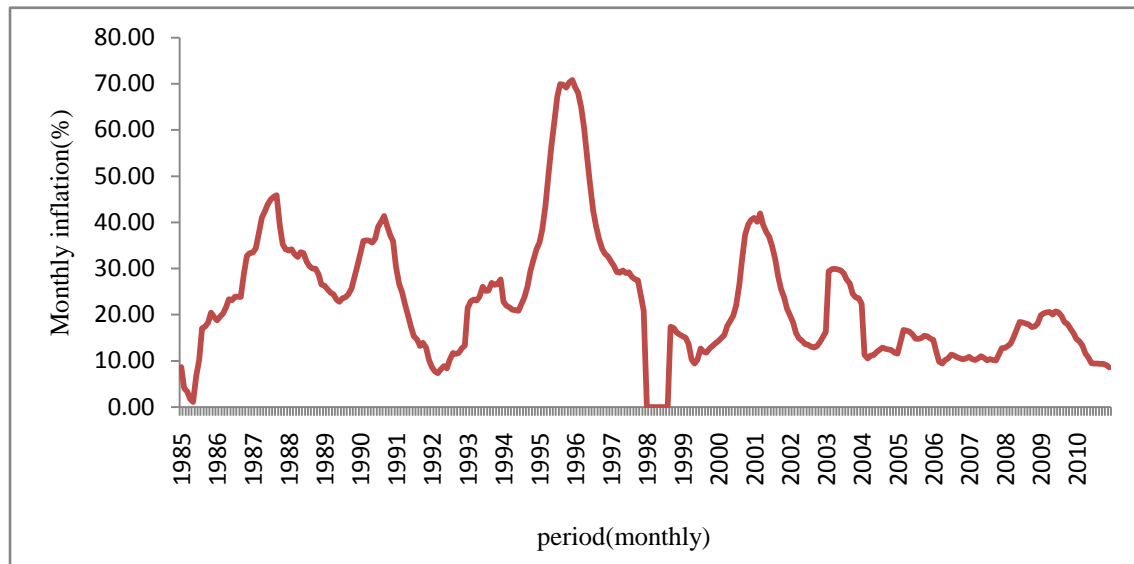


Figure 1 Plot of Ghana monthly inflation. (Jan. 1985 - Dec. 2010)

From Figure 1, the plots of Ghana inflation do not reveal a clear trend, outlier or discontinuity but a slight seasonal effect can be noticed. It can be seen that inflation in Ghana was soaring 1986 to the last quarter of 1994 where the variation peaked; through to the end of 1996. The 2000s began with another moderate inflation episode with a period average of 25.7% having come from inflationary experience where the three-year period average was 18.7%. Unlike other countries that did not stay in moderate inflationary experience for long (Dornbusch and Fisher, 1993), Ghana appears to have been saddled with persistent moderate inflation for far too long.

The structural form of Ghana's inflationary data (1985:01 – 2010:12)

Evidence from the data statistics and the time plot suggest that the monthly inflation may not be stationary. To formally test various variations identified, the KPSS test for stationarity is applied.

Test for Stationarity: KPSS Unit root test

The KPSS test for stationarity was conducted to check for stationarity at levels and the results is as presented in Table 3.

The hypothesis to test for stationarity in using the KPSS is stated as follows:

$$H_0 : \sigma_{\varepsilon}^2 = 0, (stationarity)$$

$$H_1 : \sigma_{\varepsilon}^2 > 0, (non - stationary)$$

Table 3: Unit Root test for stationarity		Before differencing	After (1 st) difference
KPSS Test Statistics for constant term		0.9251	0.0866
KPSS Test Statistics for constant term and a drift		0.2247	0.0372
	1% Critical Value	0.216	0.216
	5% Critical Value	0.146	0.146
	10% Critical Value	0.119	0.119

From Table 3, we reject the null hypothesis at the level of monthly inflation data. This suggests that the data (before differencing) is non-stationary for both suggested models (a model with a drift and one with a constant

term and drift) at critical values at 1%, 5% and 10%. In such circumstances Box-Jenkins technique recommends differencing.

After first differencing, however, the test statistics for both models are less than the critical values at 1%, 5% and 10%, hence the null hypothesis is not rejected and we conclude that the data is stationary at first difference; that is the integrated part of the ARIMA is one (1).

The time plot of the differenced data (Figure 2) shows overwhelming evidence of stationarity at first difference. This is further verified by formally using the KPSS test as shown in Table 3

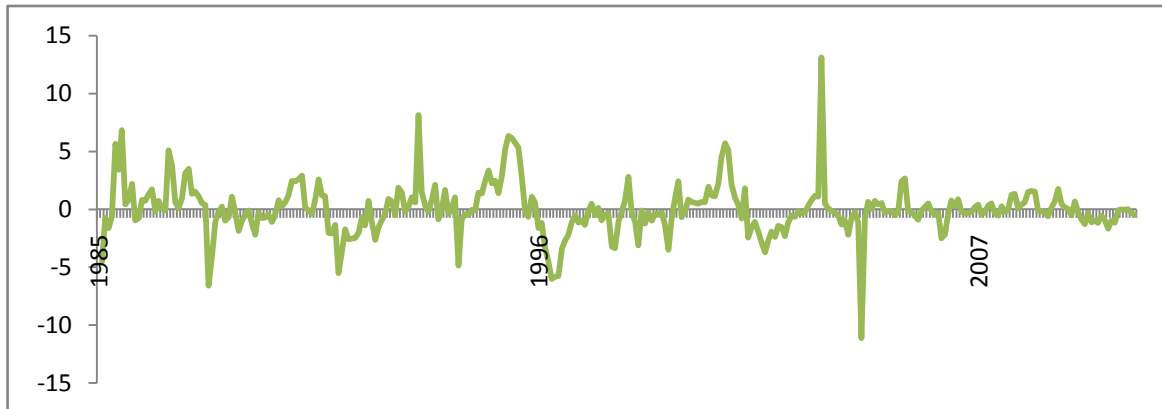


Fig. 2: Plot of differenced monthly inflation for Ghana. (Jan. 1985 - Dec. 2010)

Based on the transformed data, we now find the best ARIMA model for the stationary data in order to identify the model and estimate the parameters.

Model Identification

A closer look at the ACF plot in Figure 3 shows clear evidence of exponential decay and damped oscillation and this is evidence of the presence AR and MA parameters.

An ARMA process with both ordinary and seasonal terms can be considered. The large spike that occurs at lag 12 shows that there may be seasonal parameters. Figure 3 also shows a sample PACF, up to lag 30 for the data.

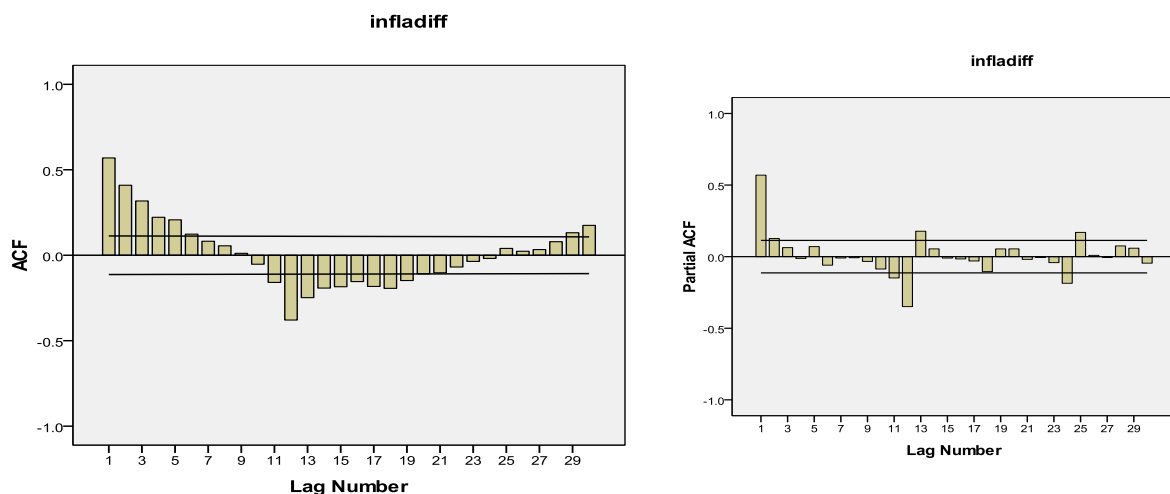


Fig. 3: Sample ACF and PACF of the differenced series

As suggested by Kendal and Ord, (1990) the spikes at lags 1, 12 and 24 as well as the exponential decay also suggest that the model contains both AR and MA terms. A large spike at 12 and a relatively smaller one at 24, from the PACF gives indication of seasonal MA term(s).

Evidence from the sampled ACF and PACF means that a number of models should be developed and the best model chosen for forecasting using selection criteria.

Model Estimation

The identified model was run for stationary series by using R (software) and the output is as shown in Table 4.

Table 4: Estimated model for inflation: $ARIMA(1, 1, 2) \times (1, 0, 1)_{12}$

Call: Arima(x = D, order = c(1, 1, 2), seasonal = list(order = c(1, 0, 1)))					
	AR1	MA1	MA2	SAR1	SMA1
Coefficient	0.7715	- 0.2517	- 0.0491	0.0621	- 0.7337
Std error	0.0849	0.1054	0.0818	0.0896	0.0693
Sigma^2 estimate					2.255
Log likelihood					-572.04
Durbin – Watson statistics					1.926*
AIC					1156.08
BIC					1178.52
*Durbin–Watson statistics computed from SPSS					

From Table 4, model indicators are $p = 1, d = 1, q = 2, P = 1, D = 0$ and $Q = 1$ with $s = 12$. This implies that the suggested for Ghana's monthly inflation is a seasonal ARIMA model (SARIMA) of the form $ARIMA(1, 1, 2) \times (1, 0, 1)_{12}$. Hence, the suggested model has five parameters that need to be estimated. The general form of the model as suggested by the results in Table 5 is:

$$(1 - \alpha_1 \mathbf{B} - \alpha_2 \mathbf{B}^{12})Y_t = (1 + \beta_1 \mathbf{B} + \beta_2 \mathbf{B} + \beta_3 \mathbf{B}^{12})\epsilon_t$$

This yield

$$\hat{Y}_t = 7.77Y_{t-1} + 0.272Y_{t-12} - 0.272Y_{t-13} + 4.39\epsilon_t - 1.32\epsilon_{t-1} - 3.21\epsilon_{t-12}$$

The standard errors, which are used to assess the accuracy of the estimates, are also provided in the low standard errors for the parameters (0.0849, 0.1054, 0.0818, 0.0896, and 0.0693) are indication of accurate model estimate. Again, how well the model fits the data is also checked by using the model fit statistics, the AIC and BIC. The corresponding values are $AIC = 1156.08$ and $BIC = 1178.52$.

Correlation between the parameters also gives indication of the strength of the model. Table 5 gives the correlations of the parameter estimates.

Table 5: Correlation of parameter estimates: $ARIMA(1, 1, 2) \times (1, 0, 1)_{12}$

Parameter		AR($p=1$)	SAR($P=1$)	MA($q=2$)		SMA($Q=1$)
		α_1	α_2	β_1	β_2	β_3
AR($p=1$)	α_1	1				
SAR($P=1$)	α_2	0.215	1			
MA($q=2$)	β_1	0.124	0.113	1		

	β_2	0.317	0.316	0.052	1	
SMA(Q=I)	β_3	0.661	0.222	0.311	0.042	1

From Table 5 the correlations of the estimated model parameters are low, showing that they do not explain the same variations in the model.

The parameter estimate for the model together with the corresponding t – values are as presented in Table 6.

Table 6: Significance of the parameter estimates for SARIMA : (1, 1, 2) (1, 0, 1)₁₂

Parameter	Estimate	Standard error	t - value	$P(> t)$
α_1	0.7715	0.0849	0.0628	< 0.0001
α_2	- 0.2517	0.1054	0.0222	< 0.0001
β_1	- 0.0491	0.0818	0.1240	< 0.0001
β_2	0.0621	0.0896	0.0920	< 0.0001
β_3	- 0.7337	0.0693	0.0101	< 0.0001

From Table 6, all the parameters are significant and this also confirms that the model best fits the data.

In an attempt to find a more parsimonious model (if it does exist), a number of models are run and their outcomes compared with the model identified above.

The models included $ARIMA(1, 1, 2)$, $SARIMA(1, 1, 1)(1, 0, 1)_{12}$ and $SARIMA(2, 1, 1)(1, 0, 1)_{12}$. In all these models, the parameters of the estimated models were found not to be superior to that of the $ARIMA(1, 1, 2) \times (1, 0, 1)_{12}$

The corresponding fit statistics for the $ARIMA(1, 1, 2)$ are:

$AIC = 1231.97$ and $BIC = 1247.77$. Thus the $ARIMA(1, 1, 2)$ has bigger AIC and BIC than the seasonal $ARIMA(1, 1, 2) \times (1, 0, 1)_{12}$. It is worth mentioning also that though the $ARIMA(1, 1, 2)$ has fewer parameters, all the parameters are also not significant.

Another model tested was $ARIMA(2, 1, 1) \times (1, 0, 1)_{12}$, which has the same number of parameters as $ARIMA(1, 1, 2) \times (1, 0, 1)_{12}$. The Durbin-Watson statistics of 1.047 in the model suggests that $ARIMA(2, 1, 1) \times (1, 0, 1)_{12}$ exhibits heteroscedasticity. Its fit statistics are $AIC = 1505.11$ and $BIC = 1218.89$ which are all greater than the fit statistics of the seasonal $ARIMA(1, 1, 2) \times (1, 0, 1)_{12}$

Another candidate tested was more parsimonious model, a seasonal $ARIMA(1, 1, 1)(1, 0, 1)_{12}$ with equal number of AR and MA terms, $ARIMA(1, 1, 1) \times (1, 0, 1)_{12}$ and fewer parameters than the $ARIMA(1, 1, 2) \times (1, 0, 1)_{12}$ which stands out as the best fit model so far.

The $ARIMA(1, 1, 1)(1, 0, 1)_{12}$ results show that all the estimated parameters are significant with its Durbin-Watson statistic of approximately 2, which shows evidence of no heteroscedasticity. However, the model fit statistics of $AIC = 1212.05$ and $BIC = 1385.99$ are greater than that of $ARIMA(1, 1, 2)(1, 0, 1)_{12}$.

Table 7 shows the estimated models with the corresponding estimates, standard errors, significant probabilities, AIC and BIC for each parameter.

Table 7: Comparison of selected models

Model	Estimate	Standard error	$P(> t)$	AIC	BIC
ARIMA (1, 1, 2)	$\alpha = 0.843$	0.941	0.2835	1231.97	1247.77
	$\beta_1 = 0.329$	0.720	0.765		
	$\beta_2 = 0.631$	0.917	0.964		
SARIMA (1, 1, 2) (1, 0, 1) ₁₂	$\alpha_1 = 0.7715$	0.0849	< 0.0001	1156.08	1178.52
	$\alpha_{2(s)} = -0.2517$	0.1054	< 0.0001		
	$\beta_1 = -0.0491$	0.0818	< 0.0001		
	$\beta_2 = 0.0621$	0.0896	< 0.0001		
	$\beta_{3(s)} = -0.7337$	0.0693	< 0.0001		
SARIMA (2, 1, 1) (1, 0, 1) ₁₂	$\alpha_1 = 0.231$	0.291	0.2835	1505.11	1218.89
	$\alpha_2 = -0.971$	0.0984	< 0.0001		
	$\alpha_{3(s)} = -0.835$	0.374	< 0.0001		
	$\beta_1 = 0.643$	0.967	< 0.0001		
	$\beta_{2(s)} = -0.395$	0.446	< 0.0001		
SARIMA (1, 1, 1) (1, 0, 1) ₁₂	$\alpha_1 = 0.723$	0.042	< 0.0001	1212.05	1385.99
	$\alpha_{2(s)} = -0.813$	0.051	< 0.0001		
	$\beta_1 = 0.1934$	0.373	< 0.0001		
	$\beta_{2(s)} = 0.622$	0.111	< 0.0001		

Considering the significance of the estimated parameters for the various models, the number of parameters estimated together with the least AIC and BIC fit statistics, it can be established that the best fit model for inflation from 1985 to 2010 in Ghana is the seasonal

SARIMA (1, 1, 2) (1, 0, 1) given by

$$\hat{Y}_t = 7.77Y_{t-1} + 0.272Y_{t-12} - 0.272Y_{t-13} + 4.39\varepsilon_t - 1.32\varepsilon_{t-1} - 3.21\varepsilon_{t-12}$$

This means holding all factors constant, this month inflation is a linear function of the previous month, the twelfth month's inflation, less the thirteenth month's inflation and some innovation terms.

Diagnostics check of the identified model: SARIMA (1, 1, 2) (1, 0, 1)₁₂

Residuals from a model that fits the data well should have zero mean, uncorrelated and show uniform random variability over time, that is, it should be a white noise.

Table 8 shows the autocorrelations at some lags together with Q – statistics for the Box – Ljung test, based on the asymptotic chi-square approximation. The results show that none of the Q – statistics is statistically significant, meaning the absence of autocorrelation.

Table 8: Autocorrelation check for residual for SARIMA (1, 1, 2) (1, 0, 1)₁₂

Autocorrelations				
Lag	Autocorrelation	Std. Error ^a	Box-Ljung Statistic	
	n		Value	df
				Sig. ^b

1	.569	.056	101.742	1	.000
2	.409	.056	154.565	2	.000
3	.317	.056	186.408	3	.000
4	.222	.056	202.048	4	.000
5	.207	.056	215.691	5	.000
6	.123	.056	220.543	6	.000
7	.082	.056	222.682	7	.000
8	.055	.056	223.658	8	.000
9	.011	.056	223.697	9	.000
10	-.053	.056	224.592	10	.000
11	-.159	.056	232.800	11	.000
12	-.379	.055	279.593	12	.000

- a. The underlying process assumed is independence (white noise).
b. Based on the asymptotic chi-square approximation.

The plot of standardized residuals, ACF of the residuals and the p – values of the Box – Ljung statistics are presented in figure 4 below.

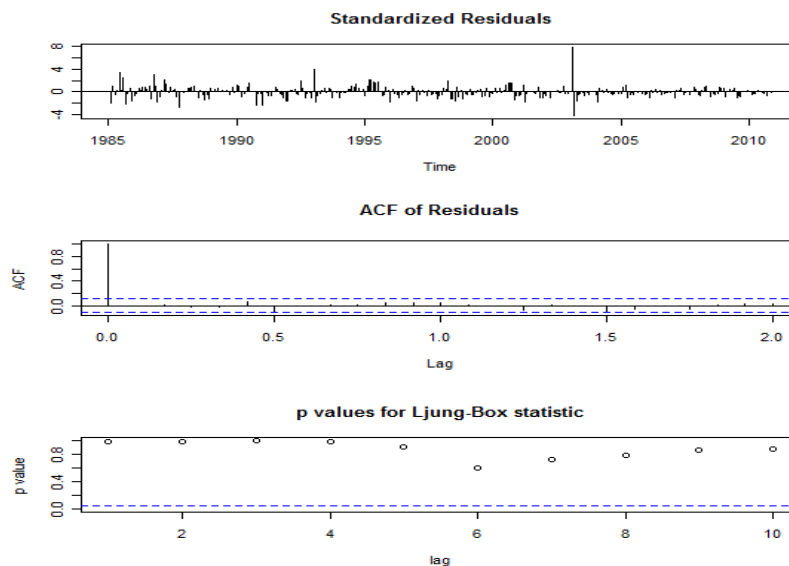


Figure 4: Plots of residuals

The ACF of the residuals immediately die out from lag one (1), which means the residual are white noise. Any significant autocorrelation gives an indication of misspecification.

The pattern of the standard residuals, ACF and the p – values for the Ljung – Box statistics show overwhelming evidence that the residuals are independent implying the model fits the data well.

Now that a best fit model has been fitted, the next step is to use the identified model estimated to forecast future values of the series.

Forecasting

The principal objective of time series modelling and analysis is forecasting. The Holt-Winters forecasting procedure was applied in forecasting inflation for the next twelve months.

Table 9: One year forecast of inflation from seasonal ARIMA (1, 1, 2) (1, 0, 1)₁₂

Date	Forecast	Actual*	Interval	Std. error	Lower 95% CL	Upper 95% CL
Jan 2011	8.23	9.08	0.85	1.50	5.28	11.17
Feb 2011	8.46	9.16	0.70	2.73	3.11	13.81
Mar 2011	8.76	9.13	0.37	3.92	1.08	16.44
April 2011	9.23	9.02	- 0.21	5.07	- 0.71	19.17
May 2011	9.29	8.90	- 0.39	6.18	- 2.85	21.38
June 2011	9.18	8.59	-0.56	7.24	- 5.01	23.37
July 2011	9.42	8.39	-1.03	8.26	- 6.76	25.60
Aug 2011	9.92	8.41	-1.51	9.22	-8.15	27.99
Sep 2011	10.85	8.40	-2.45	10.14	-9.01	30.73
Oct 2011	11.32	8.56	-2.76	11.02	-10.26	32.92
Nov 2011	11.80	8.55	-3.25	11.85	-11.43	35.03
Dec 2011	12.12	8.58	-3.54	12.65	-12.67	36.91

*From Ghana Statistical Service

The seasonal ARIMA (1, 1, 2) (1, 0, 1)₁₂ was used to generate the forecast of inflation for the period January 2011 to December 2011. The forecast values, and the standard deviation as well as a 95% confidence interval are presented in Table 9.

The forecast values are superimposed on the actual data values to aid visual inspection of the series. The output from the R software is as shown in Figure 5.

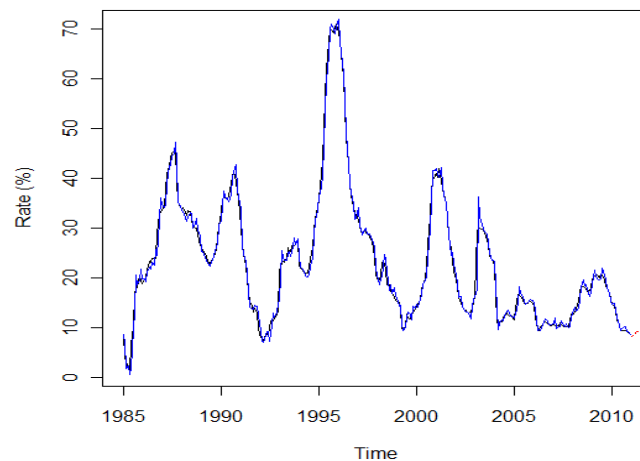


Fig. 5: Actual and Forecast (Jan. – Dec. 2011)

From Table 9, the forecast values lie within the limits. Although the model fits the data well, the wider confidence limit gives an indication of low forecasting power, which may be as a result of the time span of the data used.

Conclusion

The study was based on monthly inflation data, and has been used to estimate various possible ARIMA models according to suggestions from ACF and PACF sequence plots. Among the estimated models, the best model for inflation forecast for the period 1985:01 – 2010:12 have been obtained. The comparative performance of these ARIMA models have been checked and verified by using the statistics; AIC, BIC and Durbin – Watson statistics. The comparison indicated that the best ARIMA model was the seasonal ARIMA (1, 1, 2) (1, 0, 1)₁₂. It has also been observed that the plots of actual values and the forecasted values of inflation were very close. This means that the selected model best fit the data and hence, appropriate for forecasting. The forecast error of less than 4% (forecast error of 3.4%) also gave further evidence that the model selected has very strong power of predictability. The proposed model for Ghana's inflationary data is

$$\hat{Y}_t = 7.77Y_{t-1} + 0.272Y_{t-12} - 0.272Y_{t-13} + 4.39\varepsilon_t - 1.32\varepsilon_{t-1} - 3.21\varepsilon_{t-12}$$

This means holding all factors constant, this month inflation is a linear function of the previous month, the twelfth month's inflation, less the thirteenth month's inflation and random terms from the previous and last twelfth month.

References

- Adam, C., B. Ndulu and N. K. Sowa (1996). Liberalization and Seigniorage revenue in Kenya, Ghana and Tanzania. *Journal of Development Studies*, vol. 32, pp 531 – 553.
- Akinboade, O. A, Niedermeier, E. W. and Siebrits, F. K. (2001). Inflation dynamics: implication for policy. *Discussion paper*, Department of Economics, University of South Africa.
- Aron, J and Muellbauer, J (2008). Construction of CPIX data for forecasting and modelling in South Africa. *Economic journal of South Africa*, vol. 72 no 5, page 884 – 912.
- Atta, J. K, Jefferis K. R. and Mannathoko I. (1996). Small countries experience with exchange rate and inflation: the case of Botswana. *Journal of African Economics*, vol. 5(2), pp 293 – 326.
- Bawumiah, M and Atta-Mensah (2003). Monetary Growth, Exchange rates and Inflation in Ghana: An error Correction Analysis. *Working paper, WP/BOG – 2003/05*, Bank of Ghana.
- Box, G. E. P. and Jenkins, G. M. (1976). *Time series analysis, forecasting and control*, San Francisco: Holden Day.
- Catoa and Terrones (2003). Fiscal deficits and inflation: Evidence from emerging markets. IMF Working Paper.
- Chhibber, G and Shaffik, H. K. (1991). The inflationary consequences of devaluation and Parallel Market. The case of Ghana, *World Bank Symposium*, Washington DC.
- Dornbusch, R and Fischer S. (1985). Moderate inflation. *The World bank Economic Review*, vol.7, pp 1 – 44.
- Hendry, D. F. and Clements J. A. (2000). *Empirical Econometric Modelling Using PCGive*. London: Timberlake Consultants Press.
- Meyler, A, Kenny, G and Quinn, T (1998). Forecasting Irish inflation using ARIMA models, *Central Bank of Ireland Technical paper. Paper 3/RT/98, December*.
- Ocran, M. K. (2007). A modelling of Ghana's Inflation experience: 1960 – 2003. *African economic Research Consortium, Nairobi, AERC Research Paper 169*.
- Sowa, N. K. and Kwakye J. (1991). Inflationary trend and Control in Ghana. AERC Research paper no. 22. *African Economic Research Consortium*, Nairobi, Kenya.
- Stockton, D. J. and Glassman, J. E. (1987). An evaluation of the forecast performance of alternative models of inflation, *Review of Economics and Statistics*, vol. 69, No. 1, February, pp108 – 117.
- Stokes, G. (2009). FA news on line *South Africa's premier financial and advisory news and information portal*.

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Ghana's demand for crude oil and refined petroleum products has been growing over the past decade. This growth has been driven by socio-economic and technical factors that have influenced each category of final energy use. The growing urban population is demanding new vehicles and new roads, raising the demand for energy in the transportation and all other sectors of the economy. Consequently, Oil prices rose from 2004 to historic highs in mid-2008, only to fall precipitously in the last four months of 2008 and lose all the gains of the preceding four and a half years. The steep price increase was challenging for all economies including Ghana. The high price of oil will invariably affect revenue mobilisation, expenditure, and therefore the fiscal position of government and inflation. The study is an attempt to forecast and analyse the macroeconomic impact of oil price fluctuations in Ghana using annual data from 2000-2011. It focuses on studying the feasibility forecast using nested conditional mean (ARIMA) and conditional variance (GARCH, GJR, EGARCH) family of models under such volatile market conditions. A regression based forecast filtering simulation is proposed and studied for any improvements in the forecasted results.

Keywords: ARIMA model; Stochastic; Volatility; Forecast; Crude oil; Price shocks

Introduction

Oil is very important in Ghana's economy. It runs in every industry and every utility device in our modern technology all over the world. It is obvious that any increase in oil prices will trickle down to each and every part of the economy causing inflation in every sector. Oil policies form an important part of national policy in all oil consuming countries. Some countries provide subsidy on oil and petroleum products to promote domestic industries and check inflation, whereas some countries impose tax on oil consumption to check demand. Economies all over the world constantly monitor oil price movements (WAMA, 2008).

In Ghana, demand for oil and refined petroleum products has been growing over the past decade. This growth has been driven by socio-economic and technical factors that have influenced each category of final energy use. The growing urban population is demanding new vehicles and new roads, raising the demand for energy in the transportation and all other sectors of the economy. Consequently, Oil prices rose from 2004 to historic highs in mid-2008, only to fall precipitously in the last four months of 2008 and lose all the gains of the preceding four and a half years. The steep price increase was challenging for all economies including Ghana. The high price of oil will invariably affect revenue mobilisation, expenditure, and the fiscal position of government and inflation (Banapurmath, et. al., 2011; WAMA, 2008).

The objective of the study is to determine model(s) that explain(s) the observed data and allow(s) extrapolation into the future to provide a forecast. In this regard, we will be looking at the family of ARIMA models. Auto Regressive Integrated Moving Average (ARIMA) models have been already applied to forecast commodity prices (Weiss, 2000), such as oil (Morana, 2001) or natural gas (Buchanan, et. al., 2001). In power systems, ARIMA techniques have been used for load forecasting (Gross and Galiana, 1987), (Hagan and Behr, 1987) with good results. Currently, with the restructuring process that is taking place in many countries, simpler Auto Regressive (AR) models are also being used to predict weekly prices, like in the Norwegian system (Fosso, et. al., 1999).

Materials and Method

The ARCH Model

The first model that provides a systematic framework for volatility modeling is the ARCH model of Engle (Gujarati, 2006). The basic idea is the ARCH model is that the shock a_t of an asset return is serially uncorrected but dependent; also the dependence of a_t can be described by a simple quadratic function of its lagged values. Specifically, an ARCH (m) model assume that

$$a_t = \sigma_t \varepsilon_t, \quad \sigma_t^2 = \alpha_0 + \alpha_1 a_{t-1}^2 + \dots + \alpha_m a_{t-m}^2 \quad ((\text{Gujarati, 2006}).$$

where $\{\varepsilon_t\}$ is a sequence of independent and identically distributed (iid) random variables with mean zero and variance 1, $\alpha_0 > 0$ and $\alpha_i \geq 0$ for $i > 0$. The coefficient α_i must satisfy some regularity condition to ensure that the unconditional variance of a_t is finite. In practices, ε_t is often assumed to follow the standard normal or a standardized student - t distribution or a generalized error distribution.

From the structure of the model, it is seen that large past squared shocks $\{a_{t-i}^2\}_{i=1}^m$ imply a large conditional variance σ_t^2 for the innovation a_t . Consequently, a_t tends to assume a large value (in modulus). This means that, under the ARCH framework, large shock tend to be followed by another shock; because a large variance does not necessarily produce a large realization. It only says that the probability of obtaining a large variate is greater than that of a smaller variance.

To understand the ARCH models, it pays to carefully study ARCH (I) model

$$a_t = \sigma_t \varepsilon_t, \quad \sigma_t^2 = \alpha_0 + \alpha_1 a_{t-1}^2,$$

Where $\alpha_0 > 0$ and $\alpha_1 \geq 0$.

The unconditional mean of a_t remains zero because

$$E(a_t) = E[E(a_t / F_{t-1})] = E[\sigma_t E(\varepsilon_t)] = 0$$

The conditional variance if a_t can be obtained as

$$\text{var}(a_t) = E(a_t^2) = E[E(a_t^2 / F_{t-1})] = E(\alpha_0 + \alpha_1 a_{t-1}^2) = \alpha_0 + \alpha_1 E(a_{t-1}^2).$$

Because a_t is a stationary process with $E(a_{t-1}^2) = 0$

$$\text{var}(a_t) = \text{var}(a_{t-1}) = E(a_{t-1}^2)$$

Therefore, we have $\text{var}(a_t) = \alpha_0 + \alpha_1 \text{var}(a_t)$ and $\text{var}(a_t) = \frac{\alpha_0}{1 - \alpha_1}$. Since the variance of a_t must be

positive, we require $0 \leq \alpha_1 \leq 1$. In some applications, we need higher order moments of a_t to exist and, hence, α_1 must also satisfy some additional constraints. For instance, to satisfy its tail behavior, we require that the fourth moment of a_t is finite. Under the normality of in we have

$$E(a_t^4 / F_{t-1}) = 3[E(a_t^2 / F_{t-1})]^2 = 3(\alpha_0 + \alpha_1 a_{t-1}^2)^2 \quad (\text{Brockwell and Davis, 1996}).$$

Therefore, $E(a_t^4) = E[E(a_t^4 / F_{t-1})] = 3E(\alpha_0 + \alpha_1 a_{t-1}^2)^2 = 3E(\alpha_0^2 + 2\alpha_0\alpha_1 a_{t-1}^2 + \alpha_1^2 a_{t-1}^4)$

If a_t is fourth – order stationary with

$$\begin{aligned} m_4 &= E(a_t^4), \text{ then we have} \\ m_4 &= 3[\alpha_0^2 + 2\alpha_0\alpha_1 \text{var}(a_t) + \alpha_1 m_4] \\ &= 3\alpha_0^2 \left(1 + 2\frac{\alpha_1}{1-\alpha_1}\right) + 3\alpha_1^2 m_4 \end{aligned}$$

Consequently

$$m_4 = \frac{3\alpha_0^2(1+\alpha_1)}{(1-\alpha_1)(1-3\alpha_1^2)}.$$

This result has two important implications: since the fourth moment of a_t is positive, we see that α_1 must also satisfy the condition $1-3\alpha_1^3 > 0$; that is, $0 \leq \alpha_1^2 \leq \frac{1}{3}$; and the unconditional Kurtosis of a_t is

$$\frac{E(a_t^4)}{[\text{var}(a_t)]^2} = 3 \frac{\alpha_0^2(1+\alpha_1)}{(1-\alpha_1)(1-3\alpha_1^2)} \times \frac{(1-\alpha_1)^2}{\alpha_0^2} = 3 \frac{1-\alpha_1^2}{1-3\alpha_1^{2>3}}$$

Thus, the excess of a_t is positive and the tail distribution of a_t is heavier than that of a normal distribution. In other words, the shock a_t of a conditional Gaussian ARCH (I) model is more likely than Gaussian white noise series to produce “outcome”. This is in agreement with the empirical finding that “outlines” appear more often in asset returns than that implied by an iid sequence of normal random variates. These properties continue to hold for general ARCH models, but the formula becomes more complicated for higher order ARCH models.

The condition $\alpha_i \geq 0$ in $\sigma_t^2 = \alpha_0 + \alpha_1 a_{t-1}^2 + \dots + \alpha_m a_{t-m}^2$ can be related. It is a condition to ensure that the conditional variance σ_t^2 is positive for all t. The model has some weakness: it assume that positive and negative shocks have the same effects on volatility because it depends on the square of the previous shocks. In practices it is well known that price of a financial asset responds differently to positive and negative shocks.

The ARCH model is rather restrictive. For instance, α_1^2 of an ARCH (I) model must be in the interval $\left[0, \frac{1}{3}\right]$ if the series has a finite fourth moment. The constraint becomes complicated for higher order ARCH models. In limits, the ability of ARCH models with Gaussian innovations is to capture excess kurtosis. The ARCH model does not provide any new insight for understanding the sources of variation of a financial time series. It merely provides a mechanical way to describe the behavior of the conditional variation. It gives no indications of what causes such behavior to occur. ARCH models are likely to over predict the volatility because they respond slowly to large isolated shocks to the return series(Brockwell and Davis, 2002)..

The GARCH Model

Although the ARCH is simple, it often requires many parameters to adequately describe the volatility process of an asset return some alternative models must be sought. Shrivastava, et al. (2010) and Hull(2006) proposed a useful extension known as the generalized ARCH (GARCH) model. For a long return series γ_t , let $a_t = \gamma_t - u_t$ be the innovation at time t. Then a_t follows a GARCH (M,S) model if $a_t = \sigma_t \epsilon_t, \sigma_t^2 = \alpha_0 + \sum_{i=1}^m \alpha_i a_{t-i}^2 + \sum_{j=1}^s \beta_j \sigma_{t-j}^2$

Where again $\{\epsilon_t\}$ is a sequence of iid random variables with mean 0 and variance 1.0, $\alpha_0 > 0$; $\alpha_i \geq 0$; $\beta_j \geq 0$ and $\sum_{i=1}^{\max\{m,s\}} \alpha_i + \beta_i < 1$

The EGARCH Model

This model is used to allow for symmetric effects between positive and negative asset returns. An EGARCH (m, s) model can be written as (Dhar, et. Al. , 2009).

$$\alpha_t = \sigma_t \varepsilon_t, \quad \ln(\sigma_t^2) = \alpha_0 \frac{1 + \beta_1 B + \dots + \beta_{s-1} B^{s-1}}{1 - \alpha_1 B - \dots - \alpha_m B^m} g(\varepsilon_{t-1})$$

where α_0 is a constant, B is the back-shift (or lag) operator such that $Bg(\varepsilon_t) = g(\varepsilon_{t-1})$ and $1 + \beta_1 B + \dots + \beta_{s-1} B^{s-1}$ and $1 - \alpha_1 B - \dots - \alpha_m B^m$ are polynomials with zeros outside the unit circle and have no common factors. By outside the unit circle, we mean that absolute values of the zeros are greater than 1. Here, it is understood that $\alpha_i = 0$ for $i > m$ and $\beta_j = 0$ for $j > s$. The latter constraint on α_i and β_i implies that the unconditional variance α_t is finite, whereas its conditional variance σ_t^2 evolves over time, and ε_t is often assumed to be a standard normal standardized student-t distribution or generalized error distribution.

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^m \alpha_i \alpha_{t-i}^2 + \sum_{j=1}^s \beta_j \sigma_{t-j}^2$$

reduces to a pure ARCH (m) model if $s=0$.

The α_i and β_j are referred to as ARCH and GARCH parameters respectively. The unconditional mean of $\ln(\sigma_t^2)$ is α_0 . It uses logged conditional variance to relax the positiveness constraint of model coefficients. The use of $g(\varepsilon_t)$ enables the model to respond asymmetrically to the positive and negative lagged values of α_t . The model is nonlinear if $\theta \neq 0$. Since negative shocks tend to have larger impacts, we expect θ to be negative. For higher order EGARCH model, the nonlinearity becomes much more complicated. This model can be used to obtain multistep ahead volatility forecasts.

The ARIMA Models

ARIMA processes are a class of stochastic processes used to analysis time series. The application of the ARIMA methodology for the study of time series analysis is due to Box and Jenkins. The proposed general formulation is

$$\phi(B)P_t = \theta(B)\varepsilon_t \quad (\text{Shrivastava, et, al. , 2010; Abu and Behrooz, 2011})$$

where

P_t is the price of at time t,

$\phi(B)$ and $\theta(B)$ are functions of the back-shift operator B: $B_{P_t}^\ell = P_t - \ell$

ε_t is the error term.

Functions $\phi(B)$ and $\theta(B)$ have special forms. They contain factors of polynomial functions of the form

$$\phi(B) = 1 - \sum_{\ell=1}^{\Phi} \phi_{\ell} B^{\ell} \quad \text{and/or} \quad \theta(B) = 1 - \sum_{\ell=1}^{\Theta} \theta_{\ell} B^{\ell} \quad \text{and/or} \quad (1 - B^s). \quad \text{Where several values of}$$

ϕ_{ℓ} and θ_{ℓ} can be set to 0. The error term ε_t is assumed to be a randomly drawn series from a normal

distribution with zero mean and constant variance σ^2 , that is a white noise process. Frequently, a diagnosis check is used to validate this assumption.

Fitting the Parameters of the Model

Once a model is selected and data are collected, it is the job of the researcher to estimate the parameters of the Model. These are values that best fit the historical data. It is hypothesized that the resulting model will provide a prediction of the future observation. It is also hypothesized that all values in a given sample are equal.

The time series model includes one or more parameters. We identify the estimated values with a hat. For instance, the estimated value of β is denoted $\hat{\beta}$. The procedure also provide estimates of the standard deviation of the noise, σ_{ε} .

Forecasting from the Model

The main purpose of modeling a time series is to make a forecast which are then used directly for making decisions. In this analysis, we let the current time be T , and assume that the prices for periods 1 through T are known. We now want to forecast the price for the period $(T + \zeta)$. The unknown price is the random variable $X_{(T+\zeta)}$,

and its realization is $X_{(T+\zeta)}$. Our forecast for the realization is $\hat{X}_{T+\zeta}$.

Measuring the Accuracy of the Model

The forecast error is the difference between the realization and the forecast. Thus

$$e_{\zeta} = X_{(T+\zeta)} - \hat{X}_{T+\zeta}$$

Assuming the model is correct, then we have

$$e_{\zeta} = E[X_{T+\zeta}] + \varepsilon_{\zeta} - \hat{x}_{\zeta}$$

We investigate the probability distribution of the error by computing its mean and variance. One desirable characteristics of the forecast $\hat{X}_{T+\zeta}$ is that it is unbiased. For an unbiased estimate, the expected value of the forecast is the same as the expected value of the time series. Because ε_t is assumed to have a mean of zero, an unbiased forecast implies $E[\varepsilon_{\zeta}] = 0$. The fact that the noise is independent from one period to the next period means that the variance of the error is:

$$Var[\varepsilon_t] = Var\{E[X_{T+\zeta}] - \hat{x}_{T+\zeta}\} + Var[\varepsilon_{T+\zeta}] \text{ and } \sigma_{e^2}(\zeta) = \sigma_{E^2}(\zeta) + \sigma^2.$$

Data Analysis and Results

The data employed in this study are the yearly Ghana National Petroleum Authority (GNPA) oil prices from, 1999 to 2011.

Table 1: Retail Prices Of Petroleum Products:1999 - 2006 (Prices in Cedis per litre)

Year	LPG	Premium Gasoline	Kerosene	Diesel	Residual Fuel Oil	Total
1999	2,070	1,420	1,325	1,325	1,031	7,171
2000	2,070	1,420	1,325	1,325	1,031	7,171
2001	2,200	2,321	2,464	1,956	1,343	10,284
2002	2,200	2,320	2,464	1,956	1,343	10,283
2003	3,800	4,444	3,889	3,889	1,927	17,949
2004	3,800	4,444	3,889	3,889	1,927	17,949
2005	5,384	6,852	5,036	6,133	2,850	26,255
2006	6,200	8,056	5,610	7,253	3,311	30,430
2007	6244	7522	6156	7390	3312	32192
2008	6862	8380	6802	8263	3638	35955
2009	7480	9239	7448	9135	3964	39719
2010	8097	10097	8094	10007	4291	43483
2011	8715	10955	8739	10879	4617	47247

Figure 1 displays the yearly Ghana National Petroleum Authority (GNPA) oil prices from, 1999 to 2011. Figure 1 depicts a sturdy upward rise in oil prices. There is also an indication of a positive trend, implying that future oil prices will continue to increase.

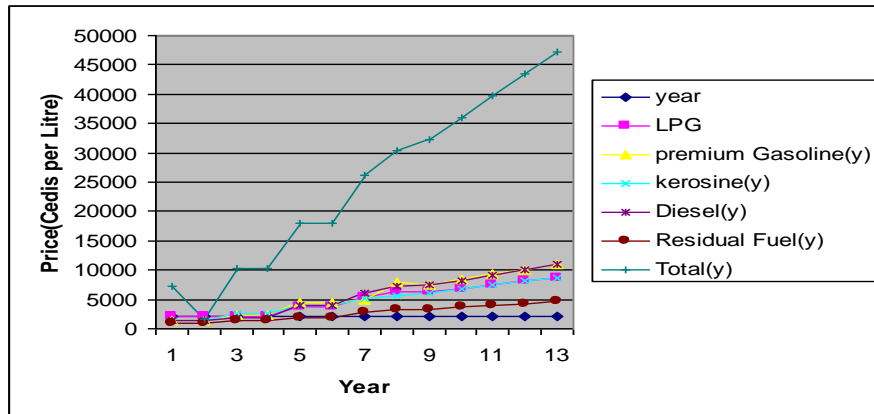


Figure 1: GNPA oil price data from 1999 to 2011.

Table 2 presents descriptive summary of the yearly Ghana National Petroleum Authority oil prices from, 1999 to 2011.

Table 2: Descriptive Statistics of yearly GNPA oil prices

Value					Standard		
	Mean	Median	Minimum	Maximum	Deviation	Skewness	Kurtosis
Statistic	13,866.00	10,284.00	7,171.00	26,255.00	7,096.29	0.879	-0.162

A kurtosis value of -0.162 is an indication of the presence of platy kurtosis in the probability distribution of the series. This means that the presence of tiny tails in the probability distribution of oil price series. In a tiny-tailed distribution, there is a lower-than-normal likelihood of a big positive or negative realization which represents non-symmetry. The autocorrelation and partial autocorrelation structures provide a summary of the dynamics of oil price series.

The standard deviation value of GHc 7,096.29 is an indication of the large dispersion of oil price about the mean value of GHc13,866.00. This value shows how the various oil prices differ from the mean value. It could be realized that about half of oil prices are below GHc10,284.00 per litre. It can be noticed that the coefficient of skewness is positive (0.879). This is an indication that oil price distribution is positively skewed. That is, it has a long tail tapering to the right which confirms the fact that the mean is larger than the median.

Forecasting

Figure 2 shows the plot of the differenced series and it is clear from the plot that the assumption of stationarity is reasonably.

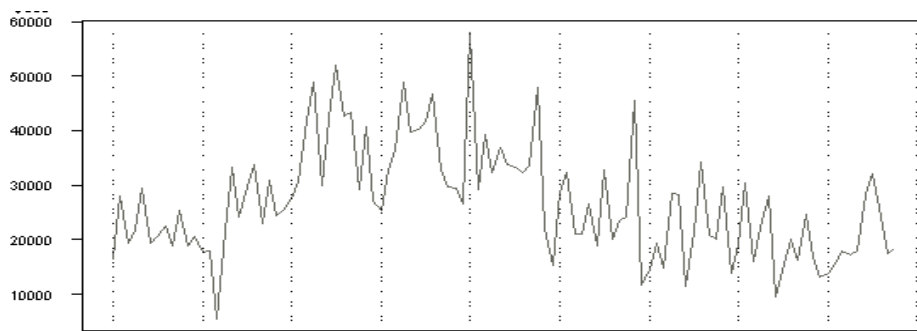


Figure 2: Differenced Yearly Oil Prices

To confirm this and to suggest possible models, we need to examine the ACF and PACF functions. These are shown in Figures 3 and 4. The model here is less certain indicating that the ACF is showing a rapid decay and the PACF is showing a sharp cutoff after one lag. This suggests that the original series can be modeled as ARIMA (1,1,0) series. The fitted model in this case is $\nabla Y_t = 0.457\nabla Y_t + \varepsilon_t$, where ε_t is an estimated variance of 84.23948. The model is used to predict the oil price from 2012 to 2016. Tables 3 and 4 show the results of the in-sample and out-sample forecasts for the ARIMA model.

Table 3: Forecast for the ARIMA Model from the Sample Data

Date	Actual	Forecast	Error
1999	7171	2081.25	5089.75
2000	1717	5845.107	-4128.11
2001	10284	9608.964	675.036
2002	10283	13372.82	-3089.82
2003	17949	17136.68	812.32
2004	17949	20900.54	-2951.54
2005	26255	24664.39	1590.61
2006	30430	28428.25	2001.75
2007	32192	32192.11	-0.11
2008	35955	35955.96	-0.96
2009	39719	39719.82	-0.82
2010	43483	43483.68	-0.68
2011	47247	47247.53	-0.53

Table 4: Forecast for the ARIMA Model from 2012 to 2015

Date	Forecast
2012	51011.39
2013	54775.25
2014	58539.11
2015	62302.96
2016	66066.82

Conclusions

To study the long-term memory, DFA method was employed to GNPA oil price series, and evidence was found that there existed comparatively strong long-term memory in it. An ARIMA (p,d,q) model was selected and estimated automatically using the Hyndman-Khandakar algorithm to select p and q and the Haslett and Raftery algorithm to estimate the parameters including d. the best model was ARIMA (1,1,0) which was used to predict the of oil prices in GNPA till the end of 2016.

The study has an important implication for managers of the OMC. Decision-makers choosing an appropriate model for their monthly and quarterly arrivals forecast should include an ARIMA-based model in their consideration. The results of the study would serve as a possible aid for policymakers in responding to oil price shocks.

Reference

- Abu H. S. N. and Behrooz, G., (2011): Application of Dynamic Models for Exchange Rate

Prediction. *International Journal of Innovation, Management and Technology*, Vol. 2, No. 6, December.

- Banapurmath, N. R. et. Al.(2011): Combustion characteristics of a four-stroke CI engine operated on Honge and Jatropa oil methyl ester-ethanol blends when directly injected and dual fuelled with CNG induction. *International Journal of Sustainable Engineering* 4, no. 2 : 145-152
- Brockwell, P.J. and R.A. Davis, (2002): *Introduction to time series and forecasting*, second edition Springer-Verlag, New York.
- Brockwell, P.J. and R.A. Davis, (1996): *Time series: theory and methods*, second edition Springer-Verlag, New York.
- Buchanan W. K., Hodges P., and Theis, J. (2001): "Which way the natural gas price: An attempt to predict the direction of natural gas spot price movements using trader positions," *Energy Economics*, vol. 23, no. 3, pp. 279–293.
- Dhar, J. et. al. (2009): "Simulative approach to Constant Mean and Conditional Variance Heteroscedastic model selection analysis using Likelihood Ratio Test for Indian Market Returns", *Proc. IEEE Advance Computing Conference, Patiala*.
- Fosso, O. B., Gjelsvik, A., Haugstad, A., Birger, M., and Wangensteen, I.(1999):"Generation scheduling in a deregulated system. The norwegian case," *IEEE Trans. Power Syst.*, vol. 14, no. 1, pp. 75–81.
- Gujarati, D.(2006): *Essentials of Economics(3rd edition)*. McGraw Hill International.
- Gross G. and Galiana, F. D. (1987): "Short-Term load forecasting," *Proc. IEEE*, vol. 75, no. 12, pp. 1558–1573.
- Hagan M. T. and. Behr S. M(1987): "The time series approach to short term load forecasting," *IEEE Trans. Power Syst.*, vol. 2, pp. 785–791,
- Hull, J.(2006): *Options, Futures and Other Derivatives*. New Delhi: Pearson Education
- Javier C., Rosario, E., Francisco J., Nogales, and Antonio J. C. (2003): ARIMA Models to Predict Next-Day Electricity Prices. *IEEE Transactions on Power Systems*, vol.18, NO. 3,
- Morana, C.(2001): "A semiparametric approach to short-term oil price forecasting," *Energy Economics*, vol. 23, no. 3, pp. 325–338.
- Shrivastava, et, al., (2010):Regression Based Approach to Filter Conditional Mean and Variance
- Model Forecast of Stock Market Returns. *International Research Journal of Finance and Economics* ISSN 1450-2887 Issue 5.
- WAMA(2008):Impact of Petroleum Price Fluctuations on Key Convergence Criteria in ECOWAS Member States. *West African Monetary Agency*.
- Weiss, E. (2000): "Forecasting commodity prices using ARIMA," *Technical Analysis of Stocks & Commodities*, vol. 18, no. 1, pp. 18–19.

RELATIONSHIP MARKETING PRACTICES AND CUSTOMER LOYALTY: EVIDENCE FROM THE BANKING INDUSTRY IN GHANA

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The present competitive landscape in Ghana's banking industry has accentuated the need for effective management of relationships as a customer retention strategy. The objective of this study was to explore the relationship between relationship marketing (RM) and customer loyalty in Ghana's banking industry. In order to achieve the objective of the study, data was collected using questionnaires from 247 relationship staff of universal banks in Ghana. Reliability test and multiple regression analysis were carried out using Statistical Package for Social Sciences (SPSS) version 16. The study found that the six Relationship Marketing (RM) constructs cumulatively had significant positive effect on customer loyalty. Individually, Competence, commitment and communication were found to be significant drivers of customer loyalty. The study recommends that if banks desire to achieve high customer loyalty then RM has to be considered as a strategy. In addition, top management must demonstrate genuine commitment and active involvement in relationship marketing issues.

Key words: Banking industry; Customer loyalty; Ghana; Relationship marketing

Introduction

Banks are moving to adopt relationship -based approach to marketing to increase customer loyalty and retention due to increased competition, changing trends of customer demand and advancement in information technology. The basic philosophy underlying this move is that it costs more to attract new customers than to nurture and develop existing ones. Reichheld and Sasser (1990) found that when a company retains just 5 percent more of its customers, profits increase by 25 percent to 125 percent. This is further corroborated by Kim and Cha (2002) who found that by reducing customer defections by just 15 percent, companies can improve their profits by 25 percent to 85 percent (Kim and Cha, 2002).

Relationship Marketing (RM) strategy gives rise to the development of IT systems or application often referred to as Customer Relationship Management (CRM) system which acts as an enabler, synthesizing relevant customer information and making them readily available to various touch points. This promotes closer targeting for the effective delivery of customer value.

From a customer perspective, well implemented RM can offer a great opportunity for effective customer interface that enables customization and personalization. This means the firm can track the flow of interactions in that at each transaction, the relevant account details, and knowledge of customer preferences, past transaction and history of a service problem are at the fingertips of the person serving or managing the customer. This can result in a tremendous service improvement and increased customer value culminating in win-win or positive reciprocal exchanges. From a company's perspective, RM allows a company to better understand, segment and tier its customer base, better target promotions and cross-selling and even implement alert systems that signal if a customer is in danger of defection (Lovelock and Wirtz 2007).

The financial services sector has often been touted as a fertile ground for the adoption of relationship marketing strategy because most financial services are classified as high-risk, and long term purchases require relationship participation for effective service delivery (Ennew and Binks, 1996). Furthermore, according to Colgate and Stewart (1998), some financial decisions persist throughout life hence customers prefer to remain with their service providers over a long time. One reason frequently mentioned for the adoption of relationship marketing in the banking sector is competition resulting in the need for the effective management of relationships to ensure long term beneficial relationships and thereby promote competitive advantage on sustainable basis.

The banking industry in Ghana has witnessed significant changes over the past two decades following the liberalization of the financial services sector (Aryeetey, 2008). The number of universal banks as at December 2008 stood at twenty-six with extensive branch network (BoG, 2009) leading to stiff competition within the industry (see Table 1).

Authors, such as Chen and Popovich (2003), assert that Customer Relationship Marketing (CRM) works well where there is an organization-wide customer-centric philosophy, a comprehensive CRM strategy, well differentiated customer needs, an effective IT infrastructure and/or a databases system, mass customization systems and finally a well focused management commitment.

Following the liberalization of the banking industry in Ghana, competition has assumed such alarming dimension that the very survival of individual banks has come under serious threat. What is more, with growing customer acquisition costs, increased customer expectations and high rate of customer defection, banks have realised the need to foster closer relationships with their customers in order to ensure customer loyalty and retention.

Staying ahead of the competition and achieving competitive advantage appear to be one of critical challenges facing many a bank in Ghana today. RM has, therefore, emerged as a possible viable solution for banks.

The lure for RM adoption has been bolstered by the fact that RM has effect on customer loyalty. Since there are various construct of relationship marketing, and their implementations involve cost, it is important to find out which of the construct has highest or most influence on customer loyalty. The understanding of the effect of various construct and mediating variable on customer loyalty would assist bank in reducing cost by concentrating on most important construct and mediation variables. However, most of the studies on RM have tended to focus on opinions of customers in order to determine customer loyalty (Cadotte and Turgeon, 1988; Dominici and Guzzo, 2010; . Amoako et al, 2012). This study, therefore, sought to explore the relationship between RM and customer loyalty in the Ghanaian banking industry. Specifically to evaluate the effect of Relationship management constructs and key mediating variables on customer loyalty.

Conceptual Framework

Three conceptual models are developed based on the precepts of relationship marketing, strategic marketing and strategic management literature. These concepts delineate the likely relationships among the components or constructs of relationship marketing. Relationship marketing comprises five dimensions, namely Competence, Conflict handling, Commitment, Communications, 'Social and financial bonds'. It is assumed that these dimensions influence firm performance in collaboration with mediating variables. The mediating variables include Top Management Commitment, Employee Motivation and Information Technology (IT) infrastructure. Therefore, relationship marketing practices plus the presence of mediating variables is hypothesised to lead to customer loyalty. Customer loyalty component of this framework focuses more on the behavioural dimensions of loyalty such as relationship longevity or repeat purchase, Share of customer (wallet), Up-Selling, Word-of-Mouth, Cross selling and Referrals. Figure 1 depicts the relationships between the constructs of relationship marketing practices coupled with the interplay of mediating variables to derive customer loyalty. These relationships are hypothesized to provide pervasive [complete] understanding of dimensions of RM and how relationship marketing practice relates to firm performance and is based on the theories discussed in entrepreneurship and strategic marketing literature.

A review of current literature has clearly established that there seems to be a consensus that relationship marketing practices is multi-faceted (Claycomb and Martin, 2002). In their empirical investigations, the authors identified eighteen practices that lead to effective relationship marketing. For example, Morgan and Hunt (1994) have proposed commitment and trust as key antecedents for success of a relationship management strategy (Narteh, 2009). However, Ndubisi and Wah, (2005) identified six variable. These practices have been adopted by Ndubisi and Wah, (2005) as a blueprint for effective practice of Relationship Marketing (RM).

The framework for Relationship Marketing has certain core underpinning or practices which are clearly delineated by Ndubisi and Wah (2005) as trust, commitment, communication, conflict handling, competence, and relational bonds. The study adopts the framework proposed by Ndubisi and Wah (2005) because the concepts have been widely discussed in the literature as either key antecedents or relationship marketing practices. The study proceeds to link the RM practices with relational outcomes to determine customer loyalty and finally the effect of mediating variables on customer loyalty.

Customer Loyalty, Relationship Marketing Practices and Mediating Variables

Customer loyalty is defined as a deeply held commitment to re-buy or re-patronize a preferred product/service consistently in the future, thereby causing repetitive same-brand or same brand-set purchasing, despite situational influences and marketing efforts having the potential to cause switching behaviour (Oliver, 1999, p. 34). Lovelock et al (1999) said, in business context, loyalty is used to describe the willingness of a customer to continue patronising a firms goods and services over a long period of time and on a repeated basis and preferably exclusive basis and voluntarily recommending the firm's products to friends and associates. In their view, customers will continue to be loyal to a particular firm if they feel and realise that better value is being offered. Kotler (2000) asserted that the most important consideration to attain high customer loyalty is for firms to deliver high customer value. He maintained that it has been the practice by firms to devote much attention and effort to attracting new customers rather than maintaining existing ones, adding that traditionally firms emphasise more on making sales rather than building relationships. Customer loyalty is seen as one of the major drivers of success. This is acknowledged by Pullman and Gross (2004) when they argued that loyal customers are the key to success for many service organizations. Bowen and Shoemaker (1998) also added that a small increase in loyal customers can result in a considerable increase in profitability.

Loyalty has both an attitudinal and behavioural dimension (Dick and Basu, 1994). It is believed that customers who are behaviourally loyal to a firm display more favourable disposition towards the firm relative to competitors. Typical examples of behavioural loyalty are repeat purchase and positive word of mouth. However, numerous studies (eg. Aldlaigan and Buttle, 2005; Liljander and Roos, 2002; Reinartz and Kumar, 2002) have established that in some cases behavioural loyalty such as repeat purchase does not necessarily represent attitudinal loyalty, since other underlying [limiting] factors [such as distance and monopoly power] might serve as barriers to customer defection (Aldlaigan and Buttle, 2005; Liljander and Roos, 2002; Reinartz and Kumar, 2002).

Therefore, the link between positive firm-customer relationship and customer loyalty has been established. Reichheld and Sasser (1990) found that when a company retains just 5 percent more of its customers, profits increase by 25 percent to 125 percent. Thus, marketers are seeking information on how to build customer loyalty.

The complexity of customer loyalty is substantiated by the wide range of definitions within academic literature. According to Oliver (1997) customer loyalty is a deeply held commitment to re-buy or re-patronize a preferred product or service consistently in the future, despite situational influences and marketing efforts having the potential to cause switching behaviour. This is influenced by Relationship Marketing practices (trust, commitment, communication, and conflict handling, and competence, social and financial bonds) and mediating variables (Top management support, employee motivation and Information Technology infrastructure).

A review of current literature on relationship marketing has clearly established that trust has often been mentioned as one of the important underpinnings of relationship marketing. Morgan and Hunt (1994) conceptualised trust as a partner's confidence in an exchange partner's reliability and integrity. It is frequently argued that an abuse of this trust by a service provider will lead to customer dissatisfaction and defection (Ndubisi and Wah, 2008). Thus trust is hypothesised to have positive effect on customer loyalty.

Like trust, commitment is another important variable for understanding the strength of a marketing relationship, and it is a useful construct for measuring the likelihood of customer loyalty and predicting future purchase

frequency (Gundlach et al., 1995; Morgan and Hunt, 1994; Dwyer et al., 1987). Wilson (1995) observed that commitment was the most common dependent variable used in buyer-seller relationship studies. Since, commitment is higher among individuals who believe that they receive more value from a relationship; highly committed customers should be willing to reciprocate effort on behalf of a firm due to past benefits received. Thus, committed customers are expected to be loyal to the organisation resulting in positive relationship between this variable and customer loyalty. (Mowday et al., 1982) and highly committed firms will continue to enjoy the benefits of such reciprocity.

The role of communication in business has been demonstrated over the years to have positive effect on customer acquisition and retention of customers (Schiffman and Kanuk, 2007). The frequency of communication between the parties indicates the strength of the relationship and this is expected to have positive effect on customer loyalty.

Dwyer et al. (1987) viewed conflict handling as a suppliers ability to avoid potential conflict, solve manifest conflicts before they create problems, and discuss solutions openly when problem do arise. Poorly handled conflicts could also lead to negative word -of -mouth and eventually customer exit. Therefore conflict handling is hypothesised to have positive effect on customer loyalty.

Competence is defined as the buyer's (customer's) perception of the supplier's technological and commercial competence (Anderson and Weitz, 1989). Once the customer perceive the organisation to be competent they are more likely to stay with them. Thus it is assumed that competence as a relationship marketing construct would have positive effect on customer loyalty.

Social and financial bond refers to the 'the degree of mutual personal friendship and liking shared by the buyer and seller' (Wilson 1995). In relationship management, the root of this type of bond is derived from business-to-business literature, where it was used to indicate good personal relations (Smith, 1998; Willians et al., 1998). Lin et al. (2003) and Hseish et al. (2005) augured that organisation which exhibit good social and financial bonds are more likely to retain their customers. Thus social and financial bond is hypothesised to have positive effect on customer loyalty.

Top management commitment is an essential element for bringing an innovation online and ensuring delivery of promised benefits. Dickie (1999) warns against starting a CRM project if senior management does not fundamentally believe in re-engineering a customer-centric business model. This is because without top management commitment, such initiatives are bounds to fail with negative effect on customers. Thus top management commitment or support is expected to have positive effect on customer loyalty

Additionally, employee motivation is critical in relationship marketing programmes. This is done to reduce employee resistance (Chen and Popovich, 2003) to the implementation of CRM. Through employee motivation CRM can be successfully implemented to influence customer loyalty positively. Thus employee motivation is expected to positively influence customer loyalty.

Information technology (IT) has long been recognized as an enabler to radically redesign business processes in order to achieve dramatic improvements in organizational performance (Davenport and Short, 1990; Porter, 1987). CRM applications take full advantage of technology innovations with their ability to collect and analyze data on customer patterns, interpret customer behaviour, develop predictive models, respond with timely and effective customized communications, and deliver product and service value to individual customers. Therefore, IT infrastructure is expected to have positive effect on customer loyalty.

Methodology

This study adopted the survey strategy because is cross-sectional in nature and cross-sectional studies usually employ the survey strategy (Robson, 1993). The choice for this research design-became necessary because it has been found to be suitable for analyzing issues by considering a cross-section of the population at one point in time (Robson, 1993). Again the suitability of using the survey strategy in this study is to help the researcher

identify and explain statistically, the factors that explain the factors that influence customer loyalty within the banking sector in Ghana.

The population consists of 384 relationship managers of universal banks in Ghana. The questionnaire was sent to all of them in June 2010. A total of 247 questionnaires were returned given a response rate of 64.32%. The overall response rate is considered quite high when compared to similar research of relationship marketing (Nor and Badriyah 2009).

Data was collected through the use of fully structured questionnaires. Questionnaire consists of both open-ended and close-ended questions. The close-ended questions were developed on a five point Likert scales ranging from 5 (strongly agree) to 1 (strongly disagree).

The questionnaire was divided into two main sections. Section one was subdivided into nine parts and focused on questions relating to the various practices of relationship marketing as depicted by the conceptual framework in the banking industry. These are commitment (three positive statements), conflict handling (four positive statements), communications (five positive statements), relational bonds (social and financial) (seven positive statements), competence (four questions) and trust (five positive statements). Part seven of section one sought to find out how relationship marketing practices in section one impact on customers' decision to be loyal to their service providers and comprised six positive statements. Finally part nine examine issues on Information Technology which comprises six positive statements.

Data analysis followed a two-pronged approach by making use of both qualitative and quantitative methods. According to Kanbur (2001) there is a growing recognition that sensible combination of qualitative and quantitative methods help to solve problems that are associated with each type of method taken separately. According to Booth et al (1998) qualitative technique is often more appropriate for capturing the social and institutional context of issues and people's lives than the quantitative technique. Quantitative analysis was done to test the relationship between Customer Loyalty and customer relationship marketing constructs as well as mediating variable. The model is stated as follows:

$$Cloyal_i = \alpha + \beta_1 TR_i + \beta_2 COM_i + \beta_3 CONF_i + \beta_4 SFBON_i + \beta_5 COMMIT_i + \beta_6 COMPET_i + \beta_7 TMAN_i + \beta_8 EMPLOY_i + \beta_9 ITISSU_i + \varepsilon \quad [1]$$

Where

Cloyal is the dependent variable and is the mean of the construct use to measure the customers' loyalty for each respondent while independent variables are:

TR = Trust

COM, = Communication

CONF = Conflict handling

SFBON = Social and financial bond

COMMIT = Commitment

COMPET = Competence

TMAN = Top Management support

EMPLOY = Employee motivation

ITISSU = IT Infrastructure

ε = error term

Results and Discussions

Customer Relationship Marketing Practices Construct

A mean of approximately 4 was obtained for Trust, Communication, Conflict Handling, 'Social and Financial Bonds', Commitment and Competence. This means, on the average, the respondents "agree" that Trust, Communication, Conflict Handling, Social and Financial Bonds, Commitment and Competence are factored in the RM practices of the banks. The least standard deviation of 0.55 was obtained for Social and Financial Bonds. This means the respondents (irrespective of the bank) have the most related views as far as Social and Financial Bonds as a component of their RM practices are concerned. The highest standard deviation of 0.703 was obtained for commitment. This means the respondents have more diverse views with regard to the issue of commitment (perhaps commitment depends on the type of bank).

These instruments were found to be very reliable with Cronbach Alpha value of at least 0.70. (Table 2). This is clearly consistent with the findings of Morgan and Hunt (1994), Ndubisi and Wah (2005), Narteh (2009) and Claycom and Martins (2002).

Comparatively, the banks pay the biggest attention to Trust in RM practices. This is followed by Conflict Handling, Communication, Commitment, Competence and Social and Financial Bonds respectively. The emphasis on trust is probably due to the fact that the entire spectrum of the banker-customer relationship is governed by the banker's secrecy/confidentiality a breach of which gives rise to legal action. Since people by nature prefer to keep their financial affairs secret, trust can be derived from the assurance of confidentiality. The literature on RM even postulates that some relationship employees serve as private confidants of their customers. See Table 2.

Mediating Variables

A mean of approximately 4 was obtained for Top Management commitment or support and I.T. infrastructure. This means, on the average, the respondents "agree" that Top Management commitment and I.T infrastructure are among the mediating variables that co-exist and work with RM practices by banks in Ghana to produce customer loyalty. A mean of approximately 3 was obtained for Employee issues. This means, on the average, the respondents "are neutral" as to whether Employee issues are necessarily addressed by the various banks in the practice of RM.

The least standard deviation of 0.62 was obtained for Employee issues. This means the respondents (irrespective of the type of bank) have the most similar views as far as Employee motivation as a component of the mediating variables is concerned, thus instrument used is valid.. This is possibly due the fact that motivational packages in the banking industry tend to be determined by industry benchmarks due mainly to competition for competent staff and also labour unions are quick to collate data across industry for purposes of negotiations (Table 3).

The highest standard deviation of 0.708 was obtained for I.T. infrastructure. This means the respondents have more diverse views with regards to the issue of I.T. infrastructure (perhaps commitment depends on the type of bank). This probably explains the variations in technological intensity and sophistication among banks in Ghana. Comparatively, top management is the most important factor within the mediating variables which influence customer loyalty. The existence of hyper-competition in Ghana's banking industry could probably explain the growing emphasis on top management commitment. Hence top management's keen involvement in relationship building, appointment of senior manager to oversee and closely supervise RM issues and customer-centric ideals being emphasized as organizational core values have collectively been emphasized in the study outcome. Underlying this top management commitment is the growing realization that relationship management and service quality issues offer a competitive advantage. This is followed by I.T. infrastructure and Employee Motivation respectively. See Table 3.

Regression Results

The results of a regression model was used to determine how the six RM practices and three mediating variables impact on customers' decision to remain loyal to their banks is presented in Table 4. The results showed that there is a significant relationship between RM and customer loyalty ($F=40.106$, $p<0.05$). This means competence, communication, conflict handling, commitment, relational bonds (social and financial), and trust jointly determine customer loyalty. An R-Square of 0.563 was obtained indicating that all six relationship marketing practices jointly determine 56.3 % of customer loyalty. An attempt made to estimate how the individual variables contribute to customer loyalty revealed that, amongst all the six practices of RM, competence is the chief determinant of customer loyalty, followed by commitment, communication, 'social and financial bonds', conflict handling and trust. The findings also revealed that competence, commitment and communication have significant effects on customer loyalty with ($p<0.05$), hence they constitute the major determinants of customer loyalty in Ghana's banking industry. On the other hand, 'social and financial bonds' and conflict handling showed a positive but insignificant relationship to customer loyalty. This means their contribution to customer loyalty is to a lesser degree. Contrary to expectation, trust showed a negative relationship with customer loyalty. However, the strength of the relationship judging from the t and p -values ($t=-0.516$, $P = 0.607 > 0.05$) indicate that though the relationship is negative, it is not statistically significant as ($P > 0.05$) at 5% level of significance. This means that though trust and customer loyalty affect each other negatively, the relationship is rather insignificant.

In a recent study by Chen and Popovich (2003) top management support was identified as a key success factor for RM implementations. In this regard, it was expected that top management commitment positively mediate RM and have positive influence on customer loyalty. This was highly supported by the findings. Top management has significant partial relationships with customer loyalty with ($\beta=0.602$, $p<0.01$). The result revealed that IT infrastructure has no significant partial relationship with customer loyalty ($\beta=0.045$, $p>0.01$). However, employee motivation has significant partial relationships with customer loyalty with ($\beta=0.250$, $p<0.01$).

Mediator Test

Mediator test was conducted to evaluate the strength of mediation between the mediators, top management commitment, IT infrastructure and employee motivation on customer loyalty. The results in Table 5 indicate for each mediator the z -values of three tests, Sobel, Aroian and Goodman values with associated p -values. The results indicate strong evidence of mediation for top management and employee motivation with p -values of 0.006 and 0.000 respectively. Therefore, the association between RM and customer loyalty is significantly reduced by the inclusion of top management commitment and employee motivation in the model. In the case of IT infrastructure, the result indicates weak evidence of mediation with a p -value of about 0.500. Therefore, the association between RM and customer loyalty is significantly reduced by the inclusion of top management commitment in the model.

Concluding Remarks and Policy Implication

This study focused mainly on RM practices and customer loyalty and proceeded to establish the effect of mediating variables between RM practices and customer loyalty in the banking industry.

The theoretical implication of this research is that the study provides empirical evidence within the Ghanaian context that the six practices of RM, namely: competence, trust, commitment, communication, relational bonds, and conflict handling collectively have positive impact on customer loyalty.

The finding implies that if a bank wants to achieve a high rate of customer loyalty, then RM has to be considered as a strategy. In other words, banks must make continuous efforts to effectively manage their relationships with their customers because the manner in which they build and maintain these relationships determines customer loyalty. Specifically, banks must take the necessary steps to improve upon their competence through technical training programmes. Continuous training and investment in customer service as well as technical training are needed to ensure consistency in quality service delivery. Employees in turn must

display a desire to provide first class service to customers to win their confidence. These factors in combination lead to customer loyalty.

Trust as revealed by the findings showed a rather negative relationship with customer loyalty but the relationship is insignificant. This means that respondents do not consider trust as a primary factor in determining customer loyalty. A possible explanation to this is that banks in Ghana are generally trustworthy perhaps due to the sound regulatory framework in the country that ensures that banks adopt sound banking practices in conformity to regulatory standard; hence customers have no reasons to worry about trust.

Commitment also proved to be a strong determinant of the strength of relationship marketing and thus a useful construct for measuring customer loyalty. The practical implication to managers is that managers must place a lot more emphasis on the building and maintaining valued relationships.

Furthermore, if banks want to increase customer loyalty, they must encourage the building of strong relational bonds in the form of social bonds between their employees and customers. Employees must, therefore, regularly check on their customers, send customers' special gifts on special occasions such as surprise birthday cards and flowers.

References

- Aldlaign, A., and Buttle, F. (2005), Beyond Satisfaction: Customer attachment to retail banks, *International Journal of Bank Marketing*, Vol. 23, No. 4, pp. 349-59
- Amoako K, G, Arthur E, Bando C and Katah K.R (2012) The impact of effective customer relationship management (CRM) on repurchase: A case study of (GOLDEN TULIP) hotel (ACCRA-GHANA) *African Journal of Marketing Management* Vol. 4(1), pp. 17-29
- Anderson, E. and Weitz, B. (1992), "The use of pledges to build and sustain commitment in distribution channels", *Journal of Marketing Research*, Vol. 24, pp. 18-34
- Athanassopoulos, A., Gounaris, S. and Strathakopoulos, V. (2001), "Behavioural responses to customer satisfaction: an empirical study", *European Journal of marketing*, Vol. 35 Nos. 5/6, pp. 687-707
- Bloemer, J. & de Ruyter, K. (1998). "On the relationship between store image, store satisfaction and store loyalty". *European Journal of Marketing*, Vol. 32, No. 5/6, pp. 499-513.
- Bolton, R.N., Kannan, P.K. and Bramlett, M.D. (2000), "Implications of loyalty program membership and service experiences for customer retention and value", *Journal of the Academy of Marketing Science*, Vol. 28 No. 1, pp. 45-65
- Cadotte E.R, and Turgeon N, (1988). Key factors in guest satisfaction. *Cornell Hotel Restaur. Adm. Q.*, pp. 45-51.
- Chen, I.J and Popovich, K., (2003), Understanding Customer Relationship Management: People, Process and Technology. *Business Management Journal*, Vol.7 No.5, pp.374-386
- Chen, I.J and Popovich, K., (2003), Understanding Customer Relationship Management: People, Process and Technology. *Business Management Journal*, Vol.7 No.5, pp.374-386
- Claycomb, C. and Martin, C.L. (2002), "Building Customer Relationships: An inventory of service providers' objectives and practices, *Journal of Services Marketing*, Vol. 16, No. 7, pp. 615-635
- Colgate, M. and Hedge, R. (2001), "An investigation into the switching process in retail banking services", *International Journal of Bank Marketing*, Vol. 19 No. 5, pp. 201-12.
- Davenport, T.H. and Short, J.E. (1990), "The new industrial engineering: information technology and business process design", *Sloan Management Review*, Vol. 31 No. 4, pp. 11-27.
- Dick, A. S., & Basu, K. (1994). Customer loyalty: Toward an integrated conceptual framework. *Journal of the Academy of Marketing Science*, Vol. 22, No.2, pp. 99-113.
- Dickie, J. (1999), "Why CRM projects fail", *CRM Journal*, online article available at: <http://www.ijklo.org/volume 3/IJKLOV3po29-044> Downes. pdf.
- Dominici G, and Guzzo R (2010). Customer Satisfaction in the hotel Industry-A case study of Sicily. *Int. J. Mark. Stud.*, 2(2): 3-12.

- Dowling, G. R., & Uncles, M. (1997). Do customer loyalty programs really work? *Sloan Management Review*, Vol. 38, No.4, pp. 71-82.
- Dwyer, F. R., Schur, P.H. and Oh, S. (1987), Developing buyer-seller relationships, *Journal of marketing*, Vol. 51 No. 2, pp.11 -27
- Ennew, C.T. and Binks, M.R. (1999), "Impact of participative service relationships on quality, satisfaction and retention: an exploratory study", *Journal of Business Research*, Vol. 46 No. 2, pp. 121-32.
- Gundlach, G. and Murphy, P. (1993), "Ethical and legal foundations of relational marketing exchanges", *Journal of Marketing*, Vol. 57 No. 4, pp. 35-46.
- Hallowell, R. (1996), "The relationships of customer satisfaction, customer loyalty, and profitability: an empirical study", *International Journal of Service Industry Management*, Vol. 7 No. 4, pp. 27-42
- Hsieh, Y., Chiu, H., & Chiang, M. (2005). Maintaining a committed online customer: A study across search-experience-credence products. *Journal of Retailing*, Vol. 81, No.1, pp. 75-82 Institute, Chatsworth, CA.
- Kanbur, R. (2001). Quantitative and Qualitative Poverty Appraisal. Complementaries Tension and the Way Forward. Working Paper No. 2001-2005, Department of Applied Economics and Management. Cornell University
- Liljander, V. and Roos, I. (2002), "Customer relationship levels: from spurious to true Relationships", *Journal of Services Marketing*, Vol. 16 No. 7, pp. 593-614.
- Lin, C., Weng, J. C. M., & Hsieh, Y. (2003). Relational bonds and customer's trust and commitment - A study on the moderating effects of web site usage. *The Services Industries Journal*, Vol. 23, No.3, pp. 109-127.
- Lovelock, C. and Wirtz, j. (2007), *Services Marketing: People, Technology and Strategy*, *Management Journal*, Vol. 18 No. 3, pp. 312-27 pp. 56-69.
- Morgan, M. R., & Hunt, D. S. (1994). The commitment-trust theory of relationship marketing, *Journal of Marketing*, Vol. 58 (July), pp. 20-38.
- Mowday, R., Porter, L. And Steers, R. (1982), Organisational linkages: the psychology of commitment, *Journal of vocational behaviour*, Vol. 14, pp. 224-47.
- Narteh, B. (2009), "Relationship Marketing and Customer Satisfaction in the Ghanaian Banking Sector". *JRMMR*, Vol. 2, No. 1, pp 15-29.
- Ndubisi, N. O. and Wah J.K (2008). Relationship marketing and customer loyalty. *Marketing intelligence*, Vol. 25, No.1, pp. 98-06.
- Ndubisi, N. O. and Wah, K.W. (2005), Factorial and discriminant analyses of the underpinning of relationship marketing and customer satisfaction" *Internal journal of Bank Marketing*, Vol. 23 No. 3, pp 542-57
- Nor A K and Badriyah M. (2009) Linking CRM Strategy, Customer Performance Measures and Performance in the Hotel Industry *Int. Journal of Economics and Management* 3(2): 297 – 316 (2009)
- Nordman, C. (2004), "*Understanding customer loyalty and disloyalty – the effect of loyalty-supporting and – repressing factors*", doctoral thesis No. 125, Swedish School of Economics and Business Administration, Helsinki, Finland.
- Oliver, R. (1997), *Satisfaction: A Behavioural Perspective of the Consumer*, McGraw-Hill, New York, N.Y.
- Pont, M. and McQuilken, L. (2005), "An empirical investigation of customer satisfaction and loyalty across two divergent bank segments", *Journal of Financial Services Marketing*, Vol. 9 No. 4, pp. 344-59.
- Porter, M. (1987), "From competitive advantage to corporate strategy", *Harvard Business Review*, pp. 10-12.
- Raman, P. (1999), "Way to create loyalty", *New Straits Times*, 17 August, Kuala Lumpur.
- Reichheld, F.E. and Sasser, W.E. Jr (1990), "Zero defections: quality comes to service", *Harvard Business Review*, Vol. 68 No. 9, pp. 105-11

- Reinartz, W.J. and Kumar, V. (2002), "The mismanagement of customer loyalty", *Harvard Business Review*, Vol. 80 No. 7, pp. 4-12.
- Robson, C., 1993. Real world research: a resource for social scientists and practitioner researchers. Blakewell, Cambridge, USA, ISBN 0631176896
- Schiffman L. S and Kanuk L.L (2007), Consumer Behaviour. Pearson, Prentice Hall Edition
- Sharp, B., & Sharp, A. (1997). Loyalty programs and their impact on repeat-purchase loyalty patterns. *International Journal of Research in Marketing*, Vol. 14 No.5, pp. 473-486.
- Silvestro, R. and Cross, S. (2000), "Applying the service profit chain in a retail environment: challenging the satisfaction mirror", *International Journal of Service Industry Management*, Vol. 11 No. 3, pp. 244-68.
- Smith, B. (1998). Buyer-seller relationship: Bonds, relationship management, and sex type. *Canadian Journal of Administrative Sciences*, Vol. 15 No.1, pp. 76-92.
- Stauss, B., Schmidt, M. and Schoeler, A. (2005), "Customer frustration in loyalty programs", *International Journal of Service Industry Management*, Vol. 16 No. 3, pp. 229-52.
- Verhoef, P.C. (2003), "Understanding the effect of relationship marketing efforts on customer retention and customer share development", *Journal of Marketing*, Vol. 67 No. 4, pp. 30-45.
- Williams, J. D., Han, S., & Qualls, W. J. (1998). A conceptual model and study of cross-cultural business relationships. *Journal of Business Research*, Vol. 42 No.2, pp. 135-143.
- Wilson, D. T. (1995). An integrated model of buyer-seller relationship, *Journal of the Academy of Marketing Science*, Vol. 23 No. 4 pp. 335-45

Tables

Table 1: Growth of Banking and Non-Bank Financial System

Year	2004	2005	2006	2007	2008
Major Banks	20	21	24	24	26
Branches	360	392	450	595	640
Rural Banks	119	121	125	127	129
Agencies	-	-	-	-	486
Non-Banks	-	-	36	41	45

Source: BoG Annual Report 2008

Figure 1: Conceptual Framework

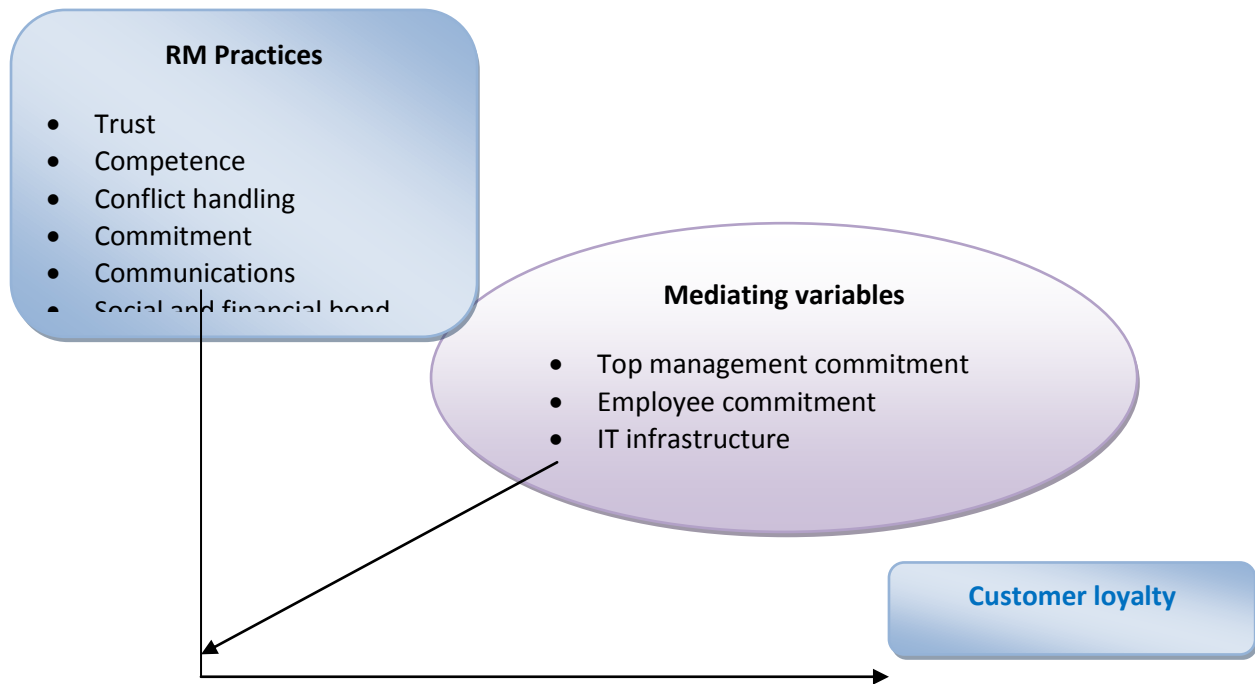


Table 2: Extent of RM Practices

RM practices	N	Cronbach Alpha	Mean	Std. De.
Trust	235	0.79	4.1515	.57426
Communication	244	0.79	3.8514	.68547
Social and Financial Bonds	229	0.75	3.6479	.55014
Conflict Handling	244	0.80	3.9139	.67531
Commitment	229	0.84	3.8046	.70343
Competence	234	0.85	3.7590	.70170

Source: Field study 2010

Table 3: Perceived state of mediating variables

practices of the antecedents	N	Cronbach Alpha	Mean	Std. Dev
I.T. Infrastructure	226	0.79	3.9991	.70842
Top Management support	226	0.79	4.0243	.63637
Employee Motivation	223	0.75	3.4234	.62076

Source: Field study 2010

Table 4: Regression results of customer loyalty and RM

	Coef.	Std. Error	t-statistics	P-Values
(Constant)	1.074	0.215	4.998	0.000
Trust	-0.035	0.069	-0.516	0.607
Communication	0.127	0.062	2.034	0.043
Social and Financial Bonds	0.077	0.066	1.166	0.245
Conflict Handling	0.055	0.053	1.036	0.301
Commitment	0.174	0.059	2.941	0.004
Competence	0.276	0.059	4.692	0.000
Top Management support	0.162	0.058	2.779	0.006
I.T. Infrastructure	0.033	0.048	0.676	0.500
Employee Motivation	0.212	0.049	4.361	0.000
R-Square	0.563			
F-Value	40.106			
P-probability	0.000			
No of observation	247			

Source: Field study 2010

Table 5: Mediation Tests Results

	Tests	Z-value	P-value
Top management commitment	Sobel	2.731	0.006
	Aroian	2.725	0.006
	Goodman	2.737	0.006
I.T. Infrastructure	Sobel	0.674	0.499
	Aroian	0.673	0.501
	Goodman	0.677	0.498
Employee motivation	Sobel	3.905	0.000
	Aroian	3.886	0.000
	Goodman	3.926	0.000

Source: Field study 2010

EXPLORING LEATHER AS ALTERNATIVE MATERIAL FOR THE PRODUCTION OF INSTRUCTIONAL MEDIA FOR PRESCHOOL EDUCATION

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The research explores the use of locally tanned leather as an alternative medium for making instructional materials to aid pre-school teaching and learning. Materials usually employed in the production of instructional materials to serve as teaching and learning aid usually, include plastic, wood, paper, clay and plaster of Paris. These materials may be too heavy as found in wood, easily perishable as found with paper, or even too expensive to import from other countries. The researcher employed qualitative research using the descriptive and experimental methods. The principal instruments designed to collect data were observation and interview. Leather was identified to be a convenient material for producing instructional media for preschool education since it has been found to be readily accessible, easily manipulated, remarkably light in weight, and attractive when scorched, painted or dyed in various colours to arouse the interest of children. Leather instructional materials produced were attractive and easy to manipulate by the pre-school children. The instructional materials produced with leather were child-friendly.

Key Words: Preschool Education; Leather; Instructional Media; Teaching and Learning

Introduction

Preschool education is considered as an aspect of education imperative to early childhood development in Ghana. It has therefore been made formal for children before they proceed to the primary school level. Sarpong (2006) explains that preschool in Ghana is the type of education which prepares children towards academic life before the actual formal school education starts at the age of six years. Categorically, preschool covers the initial stages of early childhood education, and it comprises crèches, day care centres, nurseries, and kindergartens. According to Chutima (2005), most child psychologists pay greater attention to the pre-school age because this is the most important period when human beings establish the foundation for their subsequent physical, mental, emotional, social and intellectual development as well as their personality.

It must be noted that preschool education is a very important foundation in the lives of children, particularly in today's dynamic society and in a world where more and more parents in both urban and rural areas have less time for their children due to time constraints created by their occupations. Castle (1993) has underscored that preschool education significantly is to give children the opportunity to learn to play together, to share toys, to use their hands, feet and eyes to gain self-confidence, to learn how to keep clean, how to dress and how to use their bodies. Adoption of strategic pedagogical approaches and the exploitation of various instructional materials towards knowledge impartation are therefore prerequisite. Vygotsky, (1978) states that the teaching approach goes under the acronym MAMACHOLASU MA: material; MA: manipulation; CHO: choice; LA: language and SU: support.

Instructional materials play a vital role in teaching and learning at various levels of education, especially at the preschool level where children need to build a strong foundation to ground them firmly for mainstream education. Shankar (1980) has emphasized that play has been regarded as the heart-beat of early childhood education; therefore, materials employed in the production of teaching and learning materials for educating preschool children should possess characteristics requisite to propel the teaching and learning process. According to Craig (n.d), instructional media for children should attract attention, develop interest, adjust the learning climate and promote acceptance of an idea. These characteristics and expectations can best be achieved if the materials employed are apt for the production of teaching and learning aids.

It is worth mentioning that instructional materials used in preschool education are usually made from materials that include plastic, wood, paper, clay and plaster of Paris. It has been observed that teaching and learning

materials made in plastics are usually imported into the country at high cost to the detriment of the economy of the nation. Additionally, many types of plastic materials involved are not biodegradable when they are disposed off. Wood resources may be used, but its sources (the forest) are depleted, and consequently, scarce and expensive. Metals are not conducive for instructional materials meant for preschool education because of their weight, toxicity and tendency to injure children. Paper is highly perishable and easily wears out, especially in the hands of preschool pupils. Leather on the other hand is known to possess desirable properties which render it versatile in utility, durable, pliable, bleachable and can be dyed in various colours to attract attention easily. There are various designing and decorative techniques, such as marbling, embossing, carving and scorching, that can be employed to beautify leather (Boahin, 2008).

In spite of the suitability and applicability of leather in the production of artifacts that have been empirically known, and the vast natural properties inherent the material, it is not employed in the production of instructional materials for preschool education in Ghana. It is therefore expedient to explore the feasibility of the Ghanaian local leather as alternative material for making instructional aids to assist preschool teaching and learning processes

Empirically, the World Book Encyclopedia Vol. 12 (1972) (as cited in Boahin; 2008), states that unlike synthetic material, leather is versatile in utility due to its diverse properties. It has durability, workability and beauty that enhances with age. It possesses properties which give it the ability to stretch, to be as flexible as cloth or as stiff as wood and some kinds are thick and heavy. Leather can be dyed and polished until it has a glossy finish expected. Decorative techniques such as embossment, marbling and coating can be employed to beautify its aesthetic appeal. These inherent abilities of leather give assurance of its endurance to dirt and longevity when in use.

Materials and Methods

The researchers employed the descriptive and experimental methods of qualitative research, and the target population comprised leathers, tanners, leather sellers, preschool pupils and teachers. Due to the heterogeneity nature the population, different sampling techniques were employed. Respectively, the locally tanned leathers from Aboabo cluster of indigenous tannery in Kumasi, Ashanti region of Ghana, and Hausa Zongo tannery at Tamale in the Northern region of Ghana were selected purposively for the experiments to ascertain the impact of their varied quality standards as expressed by Asubonteng (2010). Seven from each tannery were used. The convenience sampling approach was used in selecting the Kwame Nkrumah University of Science and Technology Nursery School as a preschool environment for testing the effectiveness of the instructional materials designed and produced in leather. Also, the tanners, leather sellers, classes of pupils and teachers at the KNUST Nursery School were selected randomly for the study. The sample size involved 14 leathers (2.5 square feet each in size), 2 tanners, 5 leather seller, 6 teachers and 180 preschool pupils.

Data Collection

Data collection was done by the use of observation and interview. Firstly, leather markets and tanneries in both Kumasi and Tamale were surveyed to ascertain the availability of the locally tanned leather. Interview and observation guides were designed to make the survey organised and effective. Leather tanners and sellers were interviewed to find out the rate of skin delivery, leather production, supply and sales. The tannery processes of the leather were also observed critically at the tanneries to note the chemicals employed in the production.

Leathers were then collected from Kumasi and Tamale tanneries and given refining treatment by sanding the flesh side further to remove excess flesh toward the removal of odour and impurities associated with the locally tanned leather. They were then soaked in water for 40 minutes to hydrate to become soft. The leathers were then washed, rinsed and stretched on boards (plywood) to dry under the shade and burnished. Some of the leathers were also dyed with suede dyes in bright colours. The instructional materials were designed to cover numerals, mathematical symbols, lettering, geographical shapes, fruits and vegetables, animals and objects as specified by the Ghana Preschool Educational Syllabus. With materials such as strawboard and adhesive, 40 samples of instructional materials were produced. Acrylic pigments in bright colours were used to paint the surface of some of the pieces. Also, decorative and joining techniques including embossing, pyrography (scorching) and

pointillism shading, embroidery and sewing were employed for enhancement. Wax polish, removal of excess glue and threads were done to ensure good finishing of the teaching and learning aids produced. The final presentations of the items made were paramount to ensure the children's understanding of the concepts.

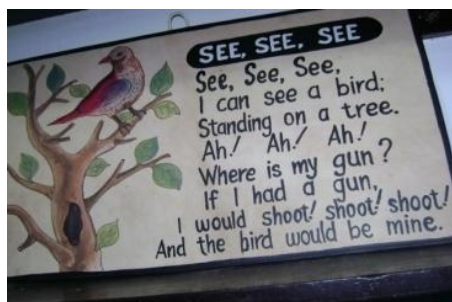
The teaching and learning materials produced in leather were subjected to test at the KNUST Nursery School to determine their usefulness and effectiveness when in usage by preschool children. The test was conducted in four different classrooms, and in each case, the teachers used the teaching and learning materials to teach while the researchers observed the reactions of the children to gather data. The teaching and some of the children were interviewed face-to-face afterwards with generally open-ended questions to elicit their views and opinions about the leather instructional materials. These teachers had had between 6 to 10 years of teaching experience in preschool institutions and their ages ranged from 30 to 50 years, and the children were mostly 3 to 5 years.

Results and Discussion

The leather instructional materials produced were tested based on the following qualities as emphasized by Craig (n.d) and Vygotsky (1978): legibility, attractiveness, manipulability, durability, safety in use and fitness for purpose. The teachers employed the teaching and learning materials in Mathematics (addition and subtraction); English Language (identification of letters of the alphabets, formation, identification and pronunciation of words, identification and filling in of missing letters in words); Environmental Science (identification of fruits and vegetables, animals and human body parts).

Legibility

The instructional materials in leather were legible enough to be identified from afar by the children in the classroom irrespective of the angle they seated. The colours used in painting the surfaces of the leather were bright enough to be seen by all the children in the classroom. The teachers had no difficulty in using the materials to teach the children of such age group. The images were clear enough for the teachers to use to communicate ideas to the children as shown in Plate 1 (a) and (b).



Plate

1(a): Picture reading and rhymes

Plate 1(b): Picture of a girl

The instructional media were found adequately bold to be seen from afar. Shapes and colours were big and clear enough to be identified, recognized and appreciated by the teacher as well as the children. The children were in love with the bright colours employed in painting on the leather to portray animals, human beings, numbers and letters of the alphabets. It was also evident, however that whenever the colour of the picture of some of objects like banana did not contrast well with the background colour of the leather, the children less appreciation such objects in the teaching and learning activities. As a result, the children could not identify the banana as readily as expected. The banana shape was re-painted with yellow and green colours and mounted on anew background leather with black inscription for the children to see it more clearly. From the cooperation the teachers experienced, the teachers commented that the images on the leather seemed to be more realistic, and they could easily register in the minds of the children during teaching.

3.2 Attractiveness

Since the level of attractiveness of the leather teaching and learning materials were tested based on their ability to be manipulated to aid the teaching and learning of different subjects such as Mathematics, English Grammar and Environmental Science, suitable and friendly themes related to the daily activities and interests of children were chosen. These themes surrounded on addition and subtraction (Mathematics); identification of letters of the alphabet, formation and pronunciation of words and filling in of missing letters in words (English Language); identification of fruits and vegetables, animals and human body parts (Environmental Science). Having observed the proceedings of the teaching and learning activities as conducted by the teachers, it was noticed that the children could assimilate and appreciate the aiding competence of the instructional media as well as the contents of the lessons and themes taught. Plate 2 portrays one of the joyful moments of the kinds ability and the ease with which they identified, picked and showed the letters of the alphabet to the class during the teaching and learning sessions at the KNUST Nursery School.

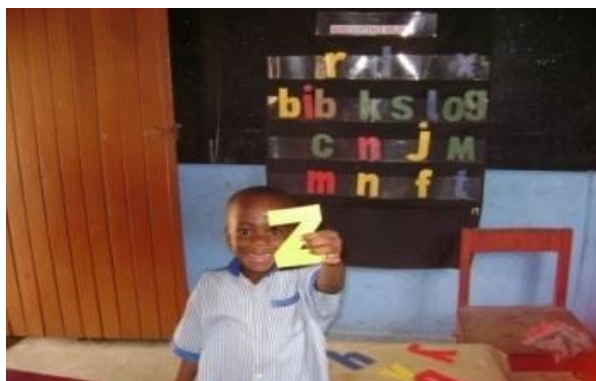


Plate 2: A happy pupil showing a letter of the alphabet to the class

Also, the pictures depicted the rhymes written on leather (*as found in Plate 1(a)*) attracted the attention of the children during the lessons. They could easily identify the pictures of the animals in the rhymes and grasped the concepts easily. It came to light that the attraction of the pictures always prompted them to recite the rhymes with or without the teacher's help.

It was observed generally that every child wanted to get hold of those that depicted a boy and a girl and claimed to be his or her photograph. During the Environmental Science lessons on "Parts of the Human Body", the teacher skillfully used the materials to communicate effectively to the children. This was possible since the teaching and learning materials made were realistic. In addition, it was glaring that the bright and childlike colours used fascinated and facilitated the pupil's ability to identify the letters, shapes, objects, words, symbols and numbers easily. The dominant colours were red, yellow, blue, orange and green. The usage of cool and warm colours were noticed to have had control on the temperament of the children. The colours also happened to stimulate those who were dull in the class to participate actively. In terms of the attraction possessed by the instructional materials produced, it can be concluded that the pictures, symbols, colours, shapes of the instructional materials were vivid enough to attract attention and arouse the children's interest.

Manipulability

Using manipulation as a measure to determine the effectiveness of the instructional materials required the employment of the various teaching aids at different positions by lifting, hanging, placing on a table or picking and displaying the items. The pupils, looking fascinated, wanted to feel each of the instructional materials by lifting them in spite of the size and shapes. The teachers on the other hand could also manipulate the letters of the alphabet to teach variety of -topics such as nouns, spellings, pick-and-say and word formation and pronunciation.



Plates 3(a) and 3(b): Depict the manipulative abilities of the leather teaching and learning aids

During the test process, it was noticed by both the teachers and the researchers that the instructional materials produced in leather were handy and could be handled by all the children, no matter their age differences. This was due to the light-weight nature of leather as compared to wood, metal, plastics and some papers. Another advantage identified was that the materials did not occupy too much space in the classroom. The teachers therefore concluded that the instructional materials made in leather could be manipulated easily, since they were handy and the children could move them around.

Durability

The durability of leather instructional materials was tested in the course of the research to find out their resistance to destruction from pressures and manipulations from teachers and children, as well as the extent of survival when using them in class.

During the test, critical attention was paid observing the survival of the materials against wear and tear, scratch, discolouration and dirt. The children had the opportunity to play with the instructional materials throughout the period of the study. It came to light that the instructional materials could withstand the rough handling by the children to prove the durability of the leather. This proved that the leather is reasonably resistant to wear and tear as confirmed by Asubonteng (2010). The acrylic paint protected the surface of the leather teaching aids from water marks and perforations. The teachers commented that due to the durable nature of the instructional materials, they could last for a long time.

Safety in Use

With the common knowledge of preschool children being curious, playful, exploitative and manipulative, to mention a few, safety measures could therefore not be taken for granted. Testing the safety of the leather teaching and learning materials was regarded paramount to determining their efficacy when being used in classroom sessions. The aim was to assess and ensure that the material leather, strawboards, colours and shapes used posed less or no harm to children of such age.

More importantly, throughout the study period, there were no reports of any damages caused to any of the children by the leather instructional materials. The teachers confirmed the child-friendly nature of the materials. Also, due to the conscious efforts exerted to curve the edges of the teaching aids, they were devoid of sharp edges to result in injuries. It is worth mentioning that since children like putting things into their mouths easily, it was ensured that the vegetable tannins used in preparing the leather could cause no threat to human health. The use of tannins, dyes, glue and polish were health-friendly. The skin of the animals, which becomes leather after tanning, is used as food in most Ghanaians homes and public food vending spots.

Fitness for Purpose

The features of the designs were created to suit the interest of the children – this ensured ergonomics in the purposes for which the instructional materials were made. The selection of the items was carefully done, and was limited to concepts, thinking and reasoning within the confines of the preschool curriculum in Ghana. This made the instructional media very cordial, prerequisite and vital to the children's educational process in areas

including: Mathematics (Number work), English (Language and Literacy), Environmental Studies, Creative Activity and Music and dance (i.e. rhymes).

Significantly, it was noted that the colours employed in the painting, dyeing and marbling of the leathers to portray the images were in conformity with the atmosphere of the classrooms as created by the colours which had been used in painting the rooms. When the items were hung on the walls of the classroom, the pupils could easily learn on their own, or with the assistance and direction of the teacher. Pictures 4 (a) and (b) depict the level of participation of the pupils as a result of the arousal caused by the use of the instructional materials used during the exercise



Plates 4 (a) and (b): Pupils responding to questions from their teachers during the exercise

The preschool children were able to recognize, identify, form, spell and pronounce any word, number, objects, within their domain that was presented with the leather instructional materials. The instructional materials could serve many purposes; hence, they were fit for use in preschool educational environment.

Conclusion

The study found out that the Ghanaian vegetable tanned leather is mostly available in the northern than the southern parts, but it is easily accessible. The quality declines from the north towards the southern indigenous tanneries. Most of the leathers used were soft and easy to manipulate to achieve the desired shapes, forms and sizes to suit the intended purpose (preschool children's educational aids)

The instructional materials produced with leather were child-friendly. The researchers employed the use of various techniques such as painting, marbling and scorching to produce the instructional materials with leather to aid teaching and learning at preschool level of education. The study successfully produced the instructional materials with leather for preschool children.

Based on the findings of the study, it can be concluded that leather, due to its diverse properties, permits itself to be used as a suitable alternative material for the production of legible, attractive, durable, manipulative and safe instructional media to aid teaching and learning at the preschool level of education.

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References

- Asubonteng, K. (2010) Improving the Quality of Ghanaian Indigenous Leatherwork; Alternative Strategies. KNUST, Kumasi: PhD Dissertation, Department of General Art Studies.

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- Atiase, E. K. (2004). *Leather as a Medium for Sculpture Works*. Kumasi: M.A. Thesis, KNUST, Kumasi: Department of Art Education.
 - Boahin, J. O. B. (2008). *Technical Problems and Solutions in the Indigenous Leather Industry: Implications for Art Education in Ghana*. PhD Dissertation, KNUST, Kumasi: Department of General Art Studies.
 - Castle, E. B. (1993). *Principles of Education for Teachers in Africa*. New York: Oxford University Press.
 - Craig, L. (n.d.). *Instructional Media: Selection and Use*. Indonesia: University of Saskatchewan.
 - Sampong, O.A. (2006). *Design and Production of Teaching Learning Materials for Pre-Schools*. M.A Thesis, KNUST, Kumasi: Department of Art Education.
 - Chutima, N. (2005). *Influence of Parenting Styles on Pre-School Children Development in Roi et Province*. MSc Thesis, Mahidol University: Faculty of Graduate Studies.
 - Shankar, M. (1980). *Audio-Visual Aids for Pre-School and Primary School Children. A Training Document Aids to Programming*, New York: UNICEF Assistance to Education.
 - Vygotsky, L. S. (1978). *Mind In Society: The Development Of Higher Psychological Processes*. Cambridge, MA: Harvard University Press.

STRATEGIC REPOSITIONING OF KOFORIDUA POLYTECHNIC

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The study sought to find out strategic changes taking place in Koforidua Polytechnic and why. The methodology used in the study is based on qualitative approaches of documentary analysis. Data was collected through a content analysis of relevant documents. The scope of the study is limited to the researcher's interpretation of the strategic changes identified and articulated in official polytechnic documents. A framework for assessing and modeling changes in strategy provided by Ginsberg (1988) was adapted to suit the higher education context and applied in the analysis. The adapted framework was used as a tool to conceptualize changes in strategy in Koforidua Polytechnic. The findings indicate significant changes in strategy in Koforidua Polytechnic. The leadership of the Polytechnic has introduced new strategic directions for the polytechnic, focusing on the provision of infrastructure facilities, improving financial resources mobilization, promoting research, strengthening collaborative partnership at home and abroad, and good governance and planning. External and internal conditions provide pressure for the shift in strategic direction. The successes of changes as evident in the paper have brought a change in the overall perception and strategic image of Koforidua Polytechnic.

Keywords: Strategy; Strategic Change; Strategic Planning; Higher Education; Koforidua

Introduction

The environment in which higher education institutions operate is changing at an unprecedented rate. For organizations to achieve their goals, they should be subject to change. There is therefore no doubt with regards to the importance of any organization of its ability to identify where it needs to be in future and how to manage the changes necessary to get there. The study and measurement of strategic change is complex given the wide variation of definitions and conceptualizations that exist in relation to it. Strategic change relates to the process of organization renewal and transformation, which is influenced by the internal and external environment. . Using the simple definition of strategic change as that of a change in strategy, this case study analyses the changes that have taken place in strategic planning within Koforidua Polytechnic since 2005.

Koforidua Polytechnic can respond to the inevitable evolution in the higher education system in two ways, these are ad hoc or strategic repositioning. Since the best way to predict the future is to invent it, this study is an attempt to find out whether or not the Polytechnic is taking conscious decisions and actions to shape its change and development. The study will find out what changes are taking place in strategy and why. What are the implications of these changes for the future of the Polytechnic? In the literature, it appears no empirical research has been conducted on the strategic changes taking place in polytechnics in Ghana, particularly Koforidua polytechnic and the contribution of this paper is to fill this knowledge gap.

Defining and Measuring Strategic Change

Scholars in the field of strategy have given different meanings to the term 'strategy'. Steiner et al (1986) describes strategy as the forging of company missions, setting objectives for the organization in the light of external and internal forces, formulating specific policies and strategies to achieve objectives and assuring their proper implementation so that the basic purposes and objective of organization will be achieved. Many definitions of strategic planning appear in the jungle of literature available on this topic. According to de Lourdes Machado et al (2004) strategic planning is "a continuous process, an externally responsive approach to an ever-changing environment that requires constant adaptation on the part of the institution" (p. 388). It is described as a way of creating the future, a process for organizational renewal and transformation which focuses on adaptive change or change motivated by the external environment.

There is no shortage of models for developing strategy in the literature making it a challenging task to get an overall picture of strategy tools and models. Ward and Rivani (2005) have attempted to describe and

systemically compare a selection of common models used. They describe the Boston Consulting Group (BCG) matrix, which dates back from the 1970's as based on the combination of two dimensions: Business Growth and Market Share. Porter's Five Forces Model (P5F) which concerns competitive strategy is described as providing an overall model to help enterprises realize the impact of external scenarios (forces) on their overall performance. The Ansoff Matrix which is concerned with market penetration, market development, product development and diversification is particularly strong in those enterprises where market pull is the predominant way of competing. The PEST analysis – Political, Economic, Social and Technological - is described by Ward and Rivani (2005) as a framework used in the assessment of the external environment in which a company operates and is based on the assumption that certain external and indirect circumstances that characterize an industry are able to influence its capacity to produce value (Ward and Rivani, 2005).

Mintzberg (1978) grouped strategic decision making into three modes: planning, adaptive and entrepreneurial. The planning mode is a well organized, integrated process where strategies are illuminated in a timely fashion by a purposeful organization. Conversely the adaptive mode describes the process in which many decision makers with contradictory goals negotiate to produce a course of incremental, incoherent decisions. Finally the entrepreneurial mode depicts a process where a powerful leader takes bold, risky decisions based on his/her vision of the organizations' future.

There exist strategies that are intended and those that are realized unintentionally (Mintzberg, 1978), making the measurement of strategic change a complex and controversial matter. Snow and Hambrick (1980, cited in Ginsberg, 1988) challenge the researcher to consider at what point an organizational response to environmental change represents a change, as opposed to an adjustment in strategy. Two schools of thought abound, the 'content' school using large samples and statistical methods to investigate the antecedents and consequences of strategic change and the 'process' school -using longitudinal case studies to examine the role of managers in the strategic change process (Rajagopalan and Sprietzer 1997).

In the literature there are many technologies, models, theories and frameworks on change strategies. In the view of the strategic change literature, Rajagopalan and Sprietzer (1997) use the perspectives of the rational learning and cognitive theoretical lenses and they discuss the theoretical and methodological contributions and limitations of each. In the rational lens perspective, strategic change is a sequential, planned search for optimal solutions for well-defined problems based on previously defined objectives. The learning and cognitive lens perspectives generally adopt the same definitions where strategic change is an evolutionary and iterative process and change is effective through a series of small adjustments in organizational and environmental conditions. While the rational lens perspective is found primarily in the content school, the learning and cognitive lens perspectives are mostly used in the process school of strategic change (p.50).

Ginsberg (1988) explains that where a strategic change occurs there is a change in certain particulars which can be described in terms of the content of the strategy and or the process of strategy making. He provides a framework for assessing and modeling changes in strategy which is employed later in the methodology of this paper. The framework involves an analysis of the factors that change when external scenarios or forces impact on overall performance.

Drivers of Organizational Change

In an effort to better understand why strategic changes occur in higher education the factors that act as catalysts for change are examined. The literature reveals that many forces are combining to drive change in contemporary higher education institutions including global, national, regional and local sources. To succeed in this highly competitive environment, which is in constant state of flux, higher education institutions need to develop management capabilities, innovation strategies and competitive advantages (de Lourdes Machado et al, 2004)

For higher education institutions, strategic planning is shaped by external factors such as the higher education environment, national higher education policy and available resources on the one hand and by internal forces such as institutional culture, mission and vision on the other (Hayward and Ncayiyana, 2003). External challenges that require higher education institutions to reposition themselves all the time if they are to survive

have been identified by Hayward and Ncayiyana (2003). They are: a shift to knowledge society; globalization; under resourcing; increased competition among institutions of higher education; the needs of a diverse and divided society; and the central role played by higher education institutions in national, regional and local development.

Skilbeck (2001) recognizes six forces that are driving change and impacting on higher education policies and practices globally: the growth in demand for higher levels of education attainment; the valuable economic return to society on investment in higher education; the power of emerging knowledge; the rapid development of information and communication technologies; economic globalization and internationalization; and the ongoing pursuit of cohesion, justice and equity in society. Among the most important of environmental changes which affect higher education missions and strategies are fast growing internationalization and supra-national regional developments (Skilbeck, 1997).

In Ghana, national, cultural, political and economic factors influence change in higher education strategies. The economic downturn which made government to adopt the neo-liberalism model of cost sharing in the higher education sector, the new polytechnic Act (745), 2007 among others have contributed to strategic change in polytechnic institutions.

Methodology

The methodology used in the study is based on qualitative approaches of documentary analysis which is appropriate for case studies (Yin, 1994). The two strategic plans of Koforidua polytechnic are examined and comparatively analyzed. Data is collected through a content analysis of relevant documents. The sources of evidence used include strategic planning documents, minutes of the Governing Council and its sub-committees, reports of Rectors and direct observation. The focus is an analysis of changes in strategy with the research being fundamentally interpretive in its approach. Although the author is an employee of the polytechnic every care was taken to analyze the documents objectively.

Although surveys and interviews are commonly used in case studies involving higher education institutions, for this report, the researcher decided to focus on analysis of documentary evidence in order to identify changes in the polytechnic's strategy over the years. While interviews or a survey may reveal individuals perceptions of what changes have taken place in the polytechnic and why, the scope of this study is limited to the researcher's interpretation of the strategic changes identified and articulated in official polytechnic documents.

The framework for assessing and modelling changes in strategy provided by Ginsberg (1988) (Appendix 1) is adapted to suit the higher education context and applied in the analysis. Ginsberg (1988) classifies the definitions of the term 'change in strategy' along two fundamental dimensions. The first dimension conceptualises strategy in terms of a position or a perspective. The second dimension conceptualises change in magnitude or pattern. This adapted framework (table 1) is used as a tool to conceptualise changes in strategy in Koforidua Polytechnic. However limitations in the scope of this study did not allow generation or analysis of data for all the factors identified in the framework. In modelling and analysing changes in strategy in Koforidua polytechnic, an attempt will be made to answer what factors influence the occurrence of various types of change? And are the performance outcomes of these various types of change positive or negative? The changes in strategy are interpreted using the framework provide by Ginsberg (1988) (figure 1). The thematic areas of Koforidua polytechnic in terms of changes in strategy also served as a framework for the analysis.

Findings and Discussions

Strategic Plan 2005-2009

This was the first strategic plan of Koforidua Polytechnic. This five-year strategic plan was to assist the Polytechnic to reposition itself as a first class tertiary institution in Information Technology Management in the Eastern Region and Ghana as a whole. As an input to achieving the institutional vision and mission, eleven thrusts (thematic areas) were envisioned to ensure that the aims and objectives of the Polytechnic are achieved.

Strategic Plan 2010-2014

This is the second strategic plan of the Polytechnic. This five-year strategy builds on the course set out in the first strategic plan. The plan sought to consolidate the gains of the first strategic plan, continue with the changing projects from the previous plan, and re-strategize the projects yet to be started to reflect the new direction of the Polytechnic. This plan is also meant to provide the broad road map for the Polytechnic in achievement of its mission and vision. Taking into consideration the strengths, weaknesses, opportunities and threats of the Polytechnic, this strategic plan is guided by eight strategic thrusts.

Comparative Analysis of Strategic Plans

A comparative analysis between the two plans show a clear change in direction with only about five of the strategic thrusts set out in the 2005-2009 Strategic Plan being reflected in the 2010-2014 Strategic Plan (fig. 2). Thus only strategic thrusts 2, 7, 8, 9 and 10 of Strategic Plan 2005-2009 reflects with Strategic Plan 2010-2014. Strategic thrusts 3, 7, and 8 of Strategic Plan 2010-2014 are new strategic directions of the Polytechnic (see fig 2).

Change in Position and Perspective

The change in position aspect of the framework for conceptualizing changes in strategy is outward looking. It is concerned with locating Koforidua Polytechnic in its external environment and looking at changes in magnitude or pattern of the various components through which its relationship to the environment is defined. The components examined for this case study include number of students, staff, academic programmes, research funding, income and expenditure. This is just a selection of the several relevant components that could have been added, but collation of all impacting factors was beyond the scope of this study. A study of the table 2 shows significant overall changes in position in the last five years.

The change in perspective aspect of the framework for conceptualizing changes in strategy is inward looking, seeking to understand the collective mind, culture, ideology and paradigm. It is concerned with integrated sets of ideas through which problems are spotted and interpreted and from which streams of decisions flow. By increasing the number of Departments and Divisions (academic and non academic) and empowering them to take decisions, this is an attempt to devolve decision making to the individual Division and Department, streamlining the process by removing unnecessary bureaucracy and administrative layers. The increase in the number of policies, meetings, committees, Divisions, Departments, and priority areas indicates a significant change in magnitude of perspective. The pattern of perspective is also changed due to the change in the structure of decision making bodies and nature of management meetings that take place.

Strategic Changes

Considering the two strategic plans in conjunction with the other documents content that were analyzed, five main changes in strategic direction emerged. These are:

1. Providing infrastructural facility to enhance teaching, learning and research
2. Improving financial resource mobilization and management
3. Promoting Research
4. Establishing collaborative partnerships at home and abroad.
5. Enhancing Good Governance and Planning.

First Strategic Change: Providing Infrastructural Facility to enhance Teaching, Learning and Research

External factors such as the growth in demand for higher level of education attainment and increased competition among institutions of higher learning have led to this strategic change. The Polytechnic is putting emphasis on infrastructural development to enhance teaching, learning and research. In 2001 a committee set up to examine Polytechnic education in Ghana described Koforidua Polytechnic as one of the least endowed Polytechnics. At that time one could talk about only a single two-storey block which houses the entire Polytechnic. With this new strategic direction, more infrastructural facilities are being provided, the Polytechnic is completing a 27- unit block of flats for Senior Members/Senior Staff, 5- storey engineering block, and 4-

storey classroom/offices block. The construction of the internal road network and other facilities has been completed. The polytechnic's strategic intent is to construct a student hostel, a maintenance/warehouse unit among others by 2014. This new strategic direction has led to a positive performance outcome. More academic programmes have been introduced and students' enrollment has increased.

Second Strategic Change: Improving Financial Resource Mobilization and Management

With this new strategic direction, the Polytechnic is making efforts to improve financial resource mobilization to meet academic objectives, for recurrent activities and strategic investment in capital and staff. Efforts are also being made to achieve significant annual cost savings improvements to take care of administrative activities, and develop the capital planning of the Polytechnic to ensure close alignment with academic priorities.

The pressure for change towards improving financial resource mobilization and management arises from the significantly changed external environment and enduring internal financial difficulties. The pressure to improve financial resource mobilization is also encouraged within national strategic goals. As the Polytechnic acknowledges its over dependence on the state for funding, its strategies have become making more effort to diversify income sources. The underlying message to the staff is to generate income internally and ensure that corporate financial management; cost saving measures and effective capital planning are put in place. This finding is consistent with research carried out by de Lourdes Machado et al (2004) who identified twelve variables that contribute to the directions an institution may take, with one of the most influential being budgetary priorities. While the cost saving programme has impacted on the staff workload and necessitated sacrifices at departmental level, so far there is little evidence of resistance to the new fiscal policies. This would indicate that the strategies taken to improve financial resource mobilization and management and to reduce dependence on the state have led to a positive performance outcome.

Third Strategic Change: Promoting Research

Research has not been given much attention since the polytechnic was established in 1997. However, from available documents, the Polytechnic has now made Research one of its priority areas. The polytechnic has instituted an annual International Applied Research Conference. The conference was instituted in 2008 and by far four (4) conferences have been organized under various themes and more than one hundred (100) papers have been presented. Each School/Division has also set up an Applied Research unit. The Polytechnic now has a Research Journal and has recently appointed a Director for Research. More staff members are participating in international conferences/workshops. The pressure to focus on research arises from both external and internal factors. Polytechnic institutions in Ghana are being urged to pay attention to research since they are supposed to play a central role in national, regional and local development. Internally, it is encouraged by efforts to make Lecturers get promotion to become Senior and Principal Lecturers. The focus on Research is also to enable the polytechnic fulfill its vision and mission. This strategic direction has met no resistance and the performance outcome has been positive. This is by way of journal publications, conference papers, books, etc. Thus the polytechnic staff has become research conscious.

Fourth Strategic Change: Strengthening Collaborative Partnership at home and abroad

The fourth change in strategic direction is the strong emphasis on strengthening collaborative partnerships at home and abroad, paying particular attention to China. The polytechnic is committed to links to the external environment through international, national and regional partnerships and collaborations with other higher education institutions and a wider range of stakeholders. This change in strategic direction is closely linked to improving financial resource mobilization and so far there have been no evidence of resistance to it.

Difficult internal and external economic conditions provide pressure for the shift in strategic direction towards collaboration and external resourcing. Stronger partnership between the polytechnic and the business communities are necessary to harness scientific and technological knowledge to drive national and regional competitiveness. Linking with business in the provision of research capacity, consultation contracts, and continuous professional development, can result in additional funding, while also enhancing the impact of Koforidua polytechnic on national innovation. Recently, the polytechnic has established close institutional

relationships with Plateau State Polytechnic of Nigeria, five Universities in China and Ghana Telecom University. These collaborations have brought several opportunities for staff exchanges and further investment and interest in Koforidua polytechnic. At present some staff members of the polytechnic are pursuing various degree programmes in China, enjoying tuition free scholarships. Two staffs of Plateau State Polytechnic have been in Koforidua polytechnic on an exchange programme and Ghana Telecom University has set up a campus at the polytechnic to run Bachelor and Master Degree programmes. The success of this strategic change as evidenced above has brought about a change in the overall strategic image of the polytechnic. It has led to a positive performance outcome.

Fifth Strategic Change: Enhancing Good Governance and Planning

With this strategy, the polytechnic's strategic intent is to monitor progress in the implementation of strategies by Departments and Schools/Divisions. Efforts are in place to raise internal communication to a level to ensure consistent information flow. The polytechnic constantly conduct programme reviews of academic decisions and develop planning of students' numbers, activities, buildings and facilities. The pressure to ensure good governance is due to internal and external factors. Among others it arises from complaints of poor internal communication and the pursuit of justice, cohesion and equity in society. The performance outcome has been positive.

Conclusion

Strategic planning is a necessary measure to respond effectively to the changing expectations, demands, needs and emerging opportunities of the higher education market. Higher rates of participation, internationalization, the growing importance of knowledge-led economies and increased global competition together with global economic crisis have inspired international and national policy changes which have deeply altered the operation of higher education institutions. Koforidua polytechnic has responded to the many pressures for change through setting out strategic thrusts (thematic areas). The polytechnic has taken the process of planning very seriously, requiring all departments to set out their own key action plans and targets.

Against the milieu of the polytechnic current and historical position, the leadership of the polytechnic, who are the architects of the change effort in the institution, introduced new strategic directions for the polytechnic focusing on the provision of infrastructure facilities, improving financial resource mobilization, promoting research, strengthening collaborative partnership at home and abroad and good governance and planning. The successes of strategic changes as evidenced in the paper have brought about a change in the overall perception and strategic image of the polytechnic. If the present trend continues, Koforidua polytechnic is likely to become one of the best polytechnics in Ghana.

The change in strategic direction by Koforidua polytechnic was caused by change in position, magnitude and pattern of perspective. Planning in Koforidua polytechnic is now cost-conscious than ever before and action plans and targets have been developed in close collaboration with the academics and administrators. The change in strategic direction is a necessary measure to ensure the future of the polytechnic. However, the challenge remains to ensure strategy implementation and the pressure to rise from the financial difficulties and to strengthen collaboration. It is vital that the polytechnic does not lose sight of the strategic goals that focus on the key functions of the polytechnic in teaching, learning and research.

The author proposes that for further research a terminal evaluation of the Strategic Plan 2010-2014 be conducted to identify its implementation challenges and to serve as input into the formulation of the third strategic plan.

References

- de Lourdes Machado, M., Farhangmehr, M. and Stover Taylor, J., 2004. The Status of Strategic Planning in Portuguese Higher Education Institutions: Trappings or Substance? *Higher Education Policy*, 17, pp.383-404.
- Ginsberg, A., 1988. Measuring and Modelling Changes in Strategy: Theoretical Foundations and Empirical Directions. *Strategic Management Journal*, 9 (6), pp.559-575

- Government of Ghana, Act 745, 2007. *Polytechnic Act, 2007*, Accra: Government Printer, Assembly Press
- Hayward, F. M., and Ncayiyana, D., 2003. *A Guide to Strategic Planning for African Higher Institutions*. Centre for Higher Education Transformation, South Africa.
- Koforidua Polytechnic, 2005, *Strategic Plan, 2005-2009*. Koforidua: Koforidua Polytechnic
- Koforidua Polytechnic, 2010, *Strategic Plan, 2010-2014*. Koforidua: Koforidua Polytechnic
- Mintzberg, H., 1978. Patterns in strategy formation. *Management Science*, 24(9), pp.934-948.
- [Accessed 2 September 2011].
- Rajagopalan, N. and Spreitzer, G. M., 1997. Toward a Theory of Strategic Change: A Multi-lens Perspective and Integrative Framework. *The Academy of Management Review*, 22 (1), pp.48 – 79.
- Steiner, G. A., Miner J. B., and Gray E. R., 1986. *Management Policy and Strategy*
- New York: MacMillan Publishing Company.
- Skilbeck, M., 1997. Higher education in a changing environment: regional, national and trans-national issues. *Tertiary Education and Management*. 3(2). pp.101 – 111.
- Skilbeck, M., 2001. *The University Challenged. A review of international trends and issues with particular reference to Ireland*. Dublin: Higher Education Authority.
- Ward, D. and Rivani, E., 2005. *An Overview of Strategy Development Models and the Ward-Rivani Model* [online]. Available from: <http://129.3.20.41/eps/get/papers/0506/0506002.pdf> [Accessed 3 September 2011].
- Yin, R. K., 1994. *Case study research: design and methods*. London: Sage.

TABLE 1

A framework for conceptualizing changes in higher education strategy (adapted from Ginsberg, 1988)

Strategy as:		
Change in:	Position (Outward looking; locating Koforidua polytechnic in its external environment)	Perspective (inward looking, seeking to understand the collective mind, culture, ideology, paradigm)
Magnitude	(a) Change in the number of academic programmes in which an institution competes, or in the intensity of its teaching and research priorities.	Change in the intensity of the norms and values that determine, and are reflected in, how and why an institution chooses its teaching programmes, research priorities, and administrative systems.
	<ul style="list-style-type: none"> - Number of students - Number of academic, non-academic staff - Number of academic programmes 	<ul style="list-style-type: none"> - Number of policies, individuals, organizations influencing decision making
	(b) Change in the intensity of an institution's resource deployments to functional areas.	<ul style="list-style-type: none"> - Number of decision makers - Number of meetings of Polytechnic Management Team, Governing Council, Academic Board, School Boards and Departments
	<ul style="list-style-type: none"> - Amount of research funding attracted - Amount of income - Amount of expenditure - Amount of funding deployed to functional areas 	<ul style="list-style-type: none"> - Number of committees - Number of priority areas (teaching, research, service)
Pattern	(a) Change in the relatedness of the education programmes in which an institution competes.	Change in the configuration of the norms and values that determine, and are reflected in, how and why an institution chooses its teaching programmes, research priorities, and administrative systems.
	<ul style="list-style-type: none"> - Type of student (Full- time students (HND), Part- time students(HND), Non- 	

<p>HND students)</p> <ul style="list-style-type: none"> - Ratio of academic to administrative staff - Programme type (distinguish by course levels and delivery mode) <p>(b) Change in the configuration of an institution's resource deployments to functional areas.</p> <ul style="list-style-type: none"> - Breakdown of research funding by discipline - Way in which funding is deployed to functional areas 	<ul style="list-style-type: none"> - Type or content of policies, individuals, organizations influencing decision making - Structure of decision making bodies - Nature of meetings of Polytechnic Management Team, Governing Council, Academic Board, School Boards, Departments - Nature of committees - Nature of priority areas (teaching, research, service)
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FIGURE 1

A framework for modelling changes in strategy

Source: Ginsberg, A (1988)

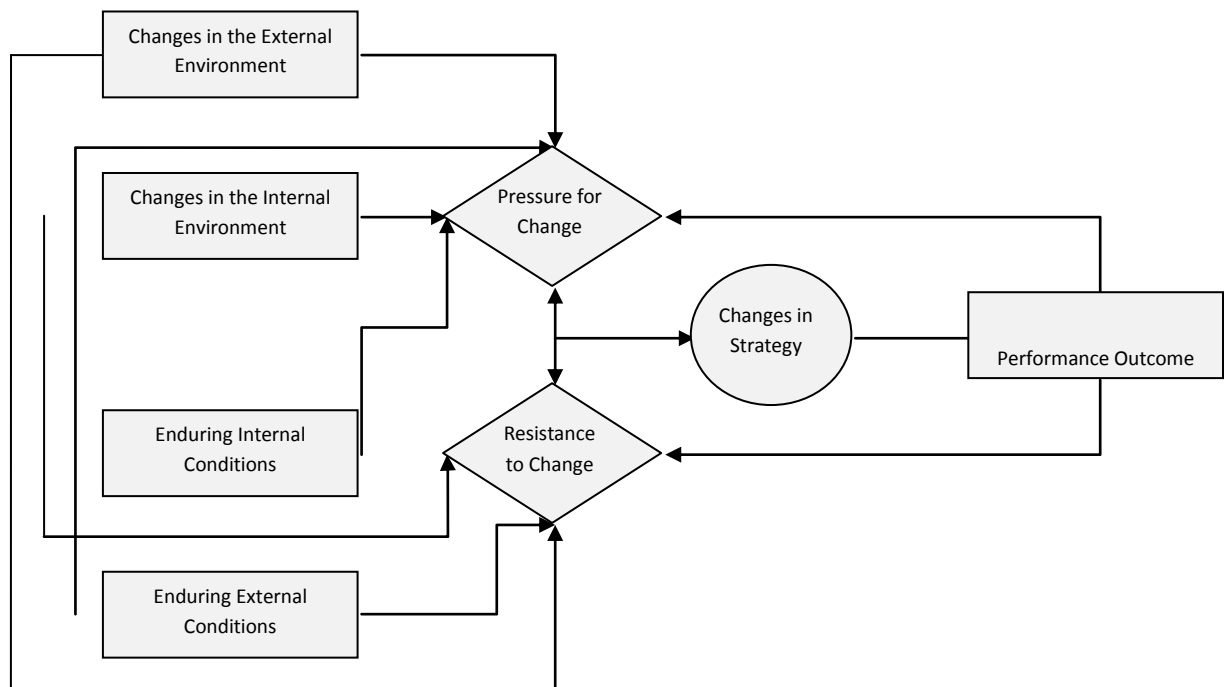


TABLE 2
Factors used to analyze change in position

	2005	2010
Students		
Total students enrolled	2208	4,539
Full Time students (HND)	1542	2379
Part-Time students (HND) Evening	189	786
Non-HND students	477	1374
Staff		
Academic	34	127
Non- Academic	129	331
Total	232	458
Academic Divisions/Schools	2	3
Academic Programmes(HND)		
Business and Management Studies	3	4
Applied Science and Technology	1	4
Engineering	0	6
Academic Programmes (Non- HND)	6	12
Total Research Funding	0	GH117,819.00
Total Income	GH¢1,538,719.26	GH¢8,485,752.69
Total Expenditure	GH¢1,048,882.75	GH¢7,220,753.13

Figure 2 Polytechnic Strategic Thrusts 2005-2009 versus Strategic Thrusts 2010-2014

Strategic Thrusts(2005-2009)		Strategic Thrusts(2010-2014)
1. Create avenues for further studies in order to provide opportunities for academic progression		1. Consolidating existing programmes and introduces new ones as a way of attracting top class and highly motivated students to the Polytechnic.
2. Develop human resource capacities to improve efficiency and effectiveness		2. Develop human resource capacities to improve efficiency and effectiveness
3. Work towards achieving ideal staff: student ratios		3. Provision of infrastructural facility to enhance teaching, learning and research
4. Diversify modes of delivery to suit different clientele		4. Harness ICT facilities for maximum efficiency and effectiveness
5. Leverage relationship with various stakeholders so as to generate greater interest in programmes		5. Improve existing facilities to enhance academic work and research
6. Strengthen the applied nature of programmes through approved research and communicating service		6. Explore avenues for internally generated income through provision of consultancy service and continuing education
7. Consolidate existing programmes as a way of attracting top class, highly motivated students to the Polytechnic		7. Improve financial resource mobilization and management
8. Harness ICT facilities for maximum effectiveness in all areas of the Polytechnic's work		8. Good governance and planning
9. Improve existing library facilities to enhance academic work and research		
10. Exploit avenues for internally generated income through provision of consultancy service and continuing education.		
11. Introduce recreational facilities to enhance extracurricular activities		

Change in:	Strategy as:	
	Position	Perspective
Magnitude	(c) Change in the number of businesses in which a firm competes, or in the intensity of its business specialization. (d) Change in the intensity of a firm's resource deployments to functional areas. 1	Change in the intensity of the norms and values that determine, and are reflected in, how and why a firm chooses its business domain, production processes, and administrative systems. 2
Pattern	(c) Change in the relatedness of the businesses in which a firm competes. (d) Change in the configuration of a firm's resource deployments to functional areas. 3	Change in the configuration of the norms and values that determine, and are reflected in, how and why a firm chooses its business domain, production processes, and administrative systems. 4

APPENDIX 1: Ginsberg's framework

A framework for conceptualizing changes in strategy (Source: taken from Ginsberg, A(1988).

MEASUREMENT OF EXHAUST GAS EMISSIONS FROM VEHICLES AT THE AUTOMOTIVE ENGINEERING WORKSHOP OF KOFORIDUA POLYTECHNIC

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This study aimed to investigate if the excess air factor (λ) of some vehicles measured fall within the Lambda window on Carbon Monoxide and Hydro Carbon. Ghana currently does not have an emission regulation standard. Emission tests are not obligatory for a vehicle to be considered road worthy unlike in the advanced countries. As a result emissions tests, which is a very important diagnostic technique, is not used in Automotive workshops. In this study CO, CO₂, HC, O₂ and emissions from sixty (60) vehicles were measured at Automotive Engineering Workshop of Koforidua Polytechnic. A four-gas Exhaust Gas Analyser was used for the emissions measurement including excess air factor. The results showed that vehicles whose excess air factor lied outside the Lambda window showed substantial HC and CO emissions. This has been the case for majority of the vehicles tested. However, vehicles that fell within the Lambda window had the lowest emissions and implications on fuel consumption seemed favorable. It is therefore recommended that Automobile Workshops provide services for customers that will include tuning of air/fuel ratio to fall within the lambda window. It is also about time that Emissions testing become an integral part of road worthy tests in Ghana.

Keywords

Exhaust emission, excess air factor, lambda, engine diagnosis, exhaust gas analyser, pollution

Introduction

To obtain the appropriate quantity of oxygen, it is necessary to mix the air and petrol in the stoichiometric (air/fuel) ratio. It is interesting to note that the quoted ratio is 14.7:1 by weight, but if the volumes of the two elements are compared, the volume of air is approximately 9500 times larger than the volume of petrol. Therefore every litre of petrol burned in an engine requires 9500 litres of air to be drawn in (assuming the stoichiometric ratio is used). If the mixture is correct, then the excess air factor is correct, which is expressed as $\lambda = 1$ (lambda = 1). If there is too much air (a weak mixture) then the excess air factor is greater than 1, which is expressed as $\lambda > 1$ (lambda is greater than 1). According to Hughes and Martz (1990) if there is too little air (a rich mixture) then the excess air factor is less than 1, which is expressed as $\lambda < 1$ (lambda is less than 1). Emissions control systems often function efficiently only when there is the appropriate amount of oxygen in the exhaust gas. The lambda window range generally quoted at a lambda value of 0.97 to 1.03, provides an indication of the air/fuel ratio corresponding to the lambda window. If the air/fuel ratio is controlled accurately so that the excess air factor is always within the lambda window, the catalytic converter will operate at optimum efficiency at all times. However, under certain engine operating conditions, it is necessary to operate with air:fuel ratios that are outside the lambda window.

Ghana has no concrete standard for evaluating emissions in private or public vehicles. The Driver and Licensing Vehicle Authority's (DVLA) sole qualification for tailpipe exhaust is that it must not obstruct or create a nuisance for other drivers,(Accra Mail.com) but since vehicle usage would continue to increase from year to year, Ghana must have a legislation on vehicle emissions. In the United States, emissions standards are managed by the Environmental Protection Agency (EPA) as well as some U.S. state governments. Some of the strictest standards in the world are formulated in California by the California Air Resources Board (CARB). Europe has its own set of standards that vehicles must meet, which includes the following tiers:

- Euro I (1992–1995)
- Euro II (1995–1999)
- Euro III (1999–2005)
- Euro IV (2005–2008)
- Euro V (2008+)

In the U.S the Clean Air Act Amendments require enhanced Inspection and Maintenance (I/M) programs. The states must submit to the EPA a **State Implementation Plan (SIP)**

for their programs (Hillier and Coombes, 2006). Each enhanced I/M program is required to include as a minimum the following items:

- Computerized emission analyzers
- Visual inspection of emission control items
- Remote on-road testing of one-half of 1% of the vehicle population
- Registration denial for vehicles not passing an I/M test
- Denial of waiver for vehicles that are under warranty or that have been tampered with
- Annual inspections
- OBD-II systems check for 1996 and newer vehicles

Visual tampering checks may be part of an I/M testing program and usually include checking for the following items:

- Catalytic converter
- Fuel tank inlet restrictor
- Exhaust gas recirculation (EGR)
- Evaporative emission system
- Air-injection reaction system (AIR)
- Positive crankcase ventilation (PCV)

If any of these systems are missing, not connected, or tampered with, the vehicle will fail the emissions test and will have to be repaired/replaced by the vehicle owner before the vehicle can pass the emission test.

One-speed and two-speed idle test measures the exhaust emissions from the tailpipe of the vehicle at idle and/or at 2500 RPM (Richard and Jeffrey, 2004). This uses stand-alone exhaust gas sampling equipment that measures the emissions in percentages. Each state chooses the standards that the vehicle has to meet in order to pass the test. The advantage to using this type of testing is that the equipment is relatively cheap and allows states to have decentralized testing programs because many facilities can afford the necessary equipment required to perform this test.

Excess Air Factor (Lambda)- λ

Excess Air Factor is the ratio of the actual air/fuel ratio to the ideal air/fuel ratio. Although the ideal air/fuel ratio is 14.7:1 ($\lambda = 1$), there is a small tolerance or window for an air/fuel ratio termed the Lambda Window, that results in low emissions and good combustion. The lambda window range is generally quoted at a lambda value of 0.97 to 1.03. The amount of oxygen contained within the exhaust gas is critical to the operation of catalytic converters and some other emission reducing devices. To ensure the correct amount of oxygen is contained within the exhaust (for efficient catalytic converter operation) it is necessary to operate the engine at the stoichiometric air/fuel or within the Lambda Window. At this ratio Carbon Monoxide (CO), Hydrocarbon (HC) and Oxygen (O₂) are in a balance so the catalytic converter can function at its most efficient and reduce pollutant levels.

Experimental Procedure

An Exhaust gas analyser enables measurement of vehicle exhaust gasses such as CO, HC and O₂ to be made. A four gas exhaust gas analyser shown in figure 1, was used for the emissions test

- i. The analyser is preheated and calibrated for some minutes, after which a leak test was performed. A failed leak test would not allow the test to continue. After the leak test a hydrocarbon residual test is done for the test to commence
- ii. A cable was connected from the analyzer to the number one spark plug high tension lead and then to the ground, this allows the analyzer to read the idling speed of the engine.

- iii. The test requires the oil dip stick be removed and a probe inserted into the engine oil. This allows the analyzer to read the temperature of the engine.
- iv. Another probe was inserted into the exhaust tail pipe to measure the exhaust gasses
- v. The analyzer then displayed results of the constituents of the exhaust gas on the screen
- vi. Measurements were carried out at a temperature above 80⁰C (thus the engines working temperature).



Figure 13 The Four-gas exhaust analyser used for the one-speed emissions test

EMISSION STANDARD	CARBON MONOXIDE % VOLUME	HYDRO CARBON VOLUME ppm
EURO 1	2.72	0.66
EURO 2	2.2	0.34
EURO 3	2.3	0.2
EURO 4	1.00	0.10

Results and Analysis

Table 1, below shows the European standards that were used to compare the results obtained in the analysis section.

Table 1. European Standard Requirements which was used to analyse the results

Hydrocarbon Emissions Measured

From figure 1, it was noted that under Euro 1, Ten (10) vehicles passed the test only one (1) vehicle failed. Under Euro 2, three (3) vehicles failed and seventeen (17) vehicles passed the test,

Under Euro 4, all the four (4) vehicles passed the test. In all 86 percent of the total vehicles passed the test while 14 percent failed the test.

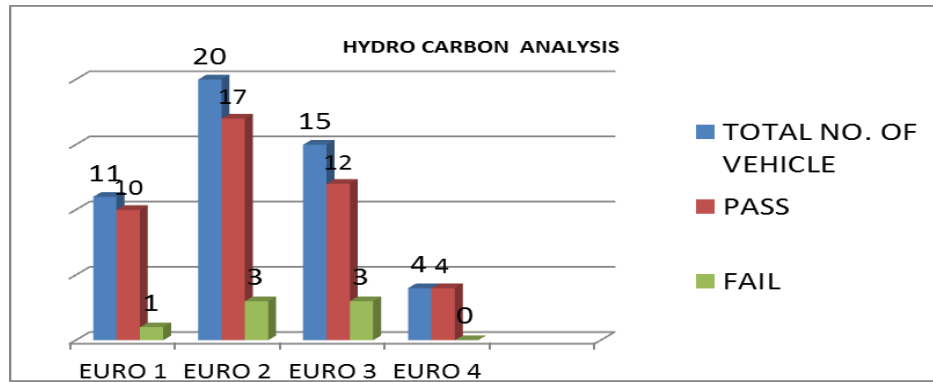


Figure 14 HC chart depicting vehicles that either passed or failed the one speed emission test

A correctly operating engine should burn (oxidize) almost all the gasoline; therefore, very little unburned gasoline should be present in the exhaust. For those vehicle that failed it could be due to excessive oil consumption caused by weak piston rings or worn valve guides. In engine diagnosis excessive HC emissions is likely to be caused by:

- Defective or worn Spark plugs
- Defective or loose Spark plug wires
- Incorrect ignition timing
- A lean air-fuel mixture can also cause a misfire. This condition is referred to as a lean misfire. A lean air-fuel mixture can be caused by low fuel pump pressure, a clogged fuel filter or a restricted fuel injector (James Halderman, 2012).

Carbon Monoxide Analysis

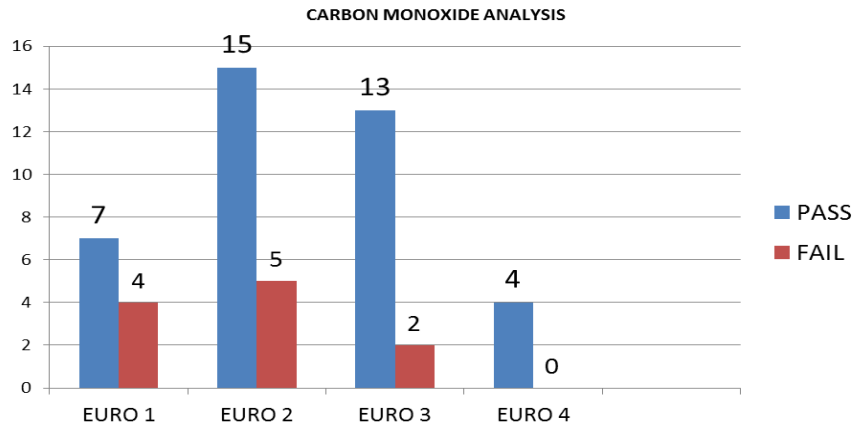


Figure 15 Carbon Monoxide Analysis Results

The presentation above in figure 2, shows that under Euro 1 seven (7) vehicles were able to pass the test, Four (4) vehicles failed. For vehicles under Euro 2, fifteen (15) of them passed while five (5) of them failed. Under Euro 3, thirteen (13) vehicles passed the test and two (2) failed. Failure of these vehicles may be due to incomplete combustion. It could be seen from the above figure that no vehicle failed under Euro 4 this may be due to the ages of these vehicles, also it was realized that the Engine Management Systems components of these vehicles have not been tampered with, and therefore performed better.

Excessive carbon monoxide is an indication of too rich an air-fuel mixture. The higher the CO reading, the richer the air-fuel mixture. High concentrations of CO indicate that not enough oxygen was available for the amount of fuel (Martyr and Plint, 2007). Common causes of high CO include:

- Too-high fuel-pump pressure
- Defective fuel-pressure regulator
- Clogged air filter or PCV valve

- Defective injectors

In all the 22% of vehicles who failed the CO emission test could have one or more of the above issues mentioned above.

Carbon Dioxide Analysis

Carbon dioxide (CO₂) is a measure of efficiency. The higher the level of CO₂ in the exhaust stream, the more efficiently the engine is operating. Levels of 12% to 15% are considered to be acceptable. Because CO₂ levels peak at an air–fuel mixture of 14.7:1, a lower level of CO₂ indicates either a too-rich or a too-lean condition.

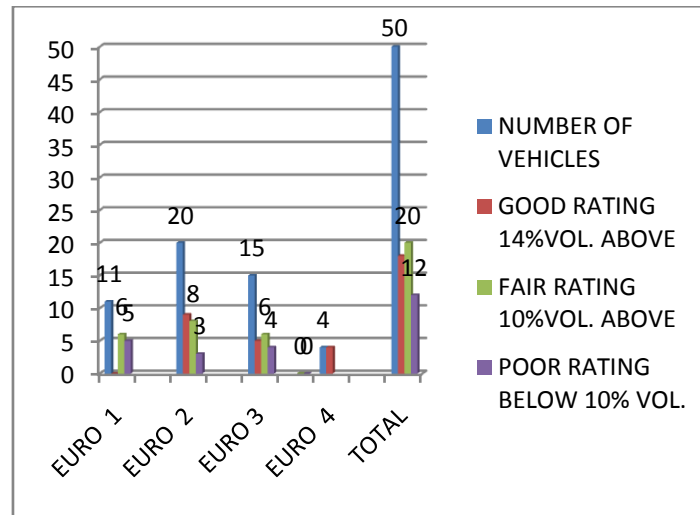


Figure 16 Carbon Dioxide Analysis Results for the 50 vehicles tested

No vehicle under Euro 1 had a Good rating, which means that most of the vehicles were burning too lean or too rich mixture. Thus more air less fuel or more fuel less air. It could also be an intake air system leakage. Vehicles that fall under the Good Rating had their CO₂ levels above 14% volume, Fair Rating above 10% volume and Poor Rating below 10% volume. It could also be seen that 24% of the total vehicles had Poor rating, 40% Fair and 36% Good. The table also showed that all vehicles under Euro 4 had Good Rating a clear indication of complete combustion.

Lambda (Excess Air Factor) Analysis

It was found during the analysis that, twenty seven (27) of the vehicles which represent 54% of the total vehicles had correct lambda values while twenty three (23) of them representing 46% failed. All the lambda values that fell within the lambda window were considered accurate and others incorrect.

Conclusion

Forty-six percent (46%) of vehicles tested failed the lambda emissions test. Twenty-four percent (24%) failed the CO₂ test while twenty-two percent (22%) failed the CO tests. For the HC test, 14% failed. If the results are anything to go by, it would be fair to say that half of the vehicles tested are not road worthy according to international standards. This will have adverse effect on fuel economy. It can be said conclusively that, newer vehicles performed much better in the emissions test. This justifies, the current legislation which taxes older vehicles much more than newer vehicles. The results depicts the Exhaust gas analyser as an important tool for modern day, vehicle diagnosis. It is also quite evident from this research that Ghana as a country does not have any emission legislation implemented to ensure vehicles are properly maintained and devoid of hazards on our roads.

Recommendations

It is recommended that vehicle emissions test be made an integral part of road worthy tests in Ghana. Government should purchase exhaust Gas Analyzers for all Driver Vehicle and Licensing Authorities (DVLA) in the country so that emission test could be included when going for vehicle Road Worthiness Certificate. It is recommended that in the purchase of vehicles, newer vehicles should be considered above older ones considering the satisfactory performance. Older vehicles however, are to be properly maintained. The research has also shown how exhaust gas emission analyser can be used to accurately diagnose bad conditions of vehicles. It can also be used to diagnose the state of the vehicle. Unfortunately, this equipment is absent in most Automotive workshops in Ghana. It is highly recommended that Automotive engineers consider training and use of this equipment.

References

- Hughes, K., Martz, L., & Denton. (1990) *the Air Resources Board's Risk* .Engineering Symposium, California USA, December 1990
- Hillier V.A.W and Peter Coombes (2006) *Fundamentals of motor vehicle technology 5th Edition* page 200-205. Nelson thornes, delta place.
- James D. Halderman (2012) *Automotive Technology, Principles, diagnosis and service, fourth edition*. Pearson education, Lake Street.
- Martyr A.J and Plint M.A (2007) *Engine testing; theory and practice, 3rd edition*. Butterworth-Heinemann, Linacre house, Jordan Hill, Oxford.
- Richard Stone and Jeffrey K. Ball (2004) *Automotive Engineering Fundamentals*. SAE international, warrendale.

AN EVALUATION OF THE QUALITY MEASURES IN THE CONDUCT OF EXAMINATION IN HO POLYTECHNIC

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The study evaluates the quality measures in the conduct of Examination in Ho Polytechnic. The structure of Ho Polytechnic, the nature of its business, operations, products, services and quality systems were discussed with particular emphasis on the conduct of Examination in the Polytechnic. Semi-structured (non-standardized) Interviews were conducted to sample size of 40 participants working in the academic affairs department with the use of simple frequency and percentages method to analyze the data. The findings revealed that the quality systems do exist in the academic affairs but with challenges. Activities towards ensuring improvement in the conduct of examination have been proposed as a means of repackaging examination rather than over dimension of examination quality.

Key Words: Quality measures; Systems; Policies; Procedures; Examination; Ho Polytechnic

Introduction

The study is to perform an evaluation of the quality measures in the conduct of Examination in Ho Polytechnic. The purpose of the study is to find out if quality measures exists, if these are being implemented, what the results are, what difficulties are there, and provide recommendations that can improve on the quality measures in order to meet the expectations of industry where students find themselves after school.

To achieve this goal, Total Quality Management (TQM) framework is used broadly to review this exercise. Industrialization, the convergence of graduates taste and other demands of today's corporate world require all institutions; no matter the nature of training they are involved in, to have a system of ethics, processes and practices that would ensure that they create value for their students as a means of attracting new employers and maintaining old ones. As pointed in Psychogios and Priporas (2007), Total Quality Management (TQM) is therefore the concept which seeks to say that quality must be measured in terms of customer (Student) wants, input quality, process efficiency and the continuous improvement of product (examination) quality. TQM encompasses the entire organization (Ho Polytechnic).

The study investigated among other things the level of understanding amongst internal conduct of examination and the academic needs of all stakeholders for managing the Polytechnic, general examination procedures and practices and where Ho Polytechnic place its examination quality emphasis. The study is limited to the management of examination which is one of the main methods of assessing students' academic achievement.

In present time, education has become a mass phenomenon in Ghana. The load on education system according to Chandra (2006) and Colby and Witt (2000) has become very high but the policies and procedures related to admission, teaching, infrastructure and examination have not been streamlined to handle this vast load.

Despite the best efforts from government, Examination bodies, Examination Laws and regulations, this have not been able to achieve much in maintaining desired quality standards of the conduct of Examination in most campuses.

Adams (2002) and Chapman (2002) believes that external interference and pressure in all aspects of education such as admission policy, teaching process, faculty selection and most importantly examination system have played vital role in deterioration of quality of educational output. In order to produce technical manpower of right quality, it is extremely important that all policies and procedures relevant to Examination are standardized and their variations from one institution to another are substantially removed (Prasad, Bhar and Srivastav 2012). Quality assurance in education deals with proactive means of ensuring quality of inputs, teaching-learning process, academic achievement of pupils and school environment before things get out of hands (Babalola, 2004). Thus, an education of high quality should have high quality students, teachers, facilities, school

curriculum and government policies as inputs. The manner in which the inputs are processed from the beginning to the final years of an educational programme and the quality of assessment of the entire teaching-learning activities, also constitute important aspects of quality assurance.

To examine somebody or something is to inspect it closely; hence, an examination is a detailed inspection or analysis of an object or person. In an academic or professional context, examinations (or exams for short) are tests which aim to determine the ability of a student or a prospective practitioner. Exams are usually written tests, although some may be practical or have practical components, and vary greatly in structure, content and difficulty depending on the subject, the age group of the tested persons and the profession.

This Exams process aims at measuring the degree of knowledge assimilated by the students during a course of study or training imparted to them. In tertiary education special emphasis is given to continuous evaluation of students' performance during a semester or academic session. Examination process has suffered great set back in achieving its objectives on account of various reasons resulting in a assessment that in many cases does not reflect the true level of knowledge acquired by the students (Prasad, Bhar and Srivastav 2012).

It has been observed by Prasad, Bhar and Srivastav (2012) that students may pass examinations securing good marks with scanty preparation. This illustrates the quality problem in policies, procedures and activities in the present examination system. Total Quality Management (TQM) approach is an effective but long term measure for transforming the minds of people engaged in examination processes towards providing quality education.

A strict and flawless examination system in an institution (Ho Polytechnic) screens out good students who have attained requisite standards of learning from the rest. In addition, it automatically creates a pressure on other subsystems and processes of education, i.e., teaching, infrastructure development, faulty performance improvement, and process of admission in case of high failure rates of the students (Candramouly MC. and Padmaja M. 2003)

It is similar to a quality control (QC) department certifying a product FIT for the market or DEFECTIVES for repair and rework. Similar is the function of Examination System in the field of Education (Mohanty P. and Lakhe RR. 2002)

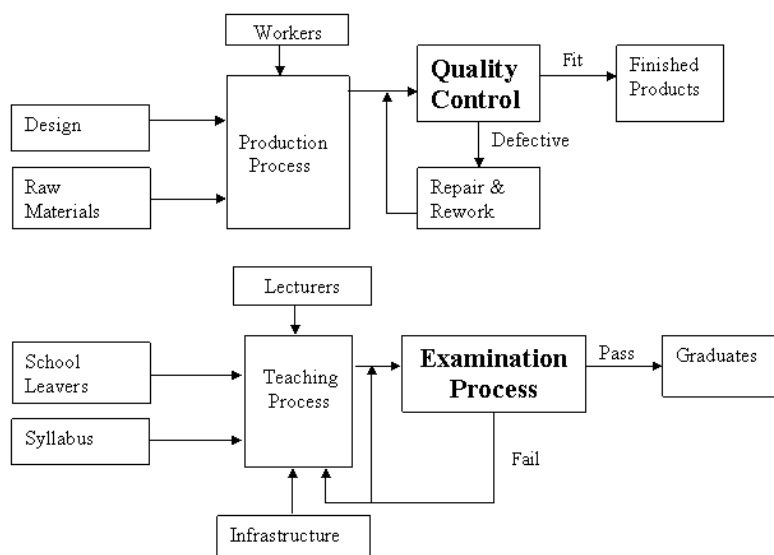


FIG 1: COMPARISION OF FACTORY MODEL WITH UNIVERSITY MODEL

There are Quality Systems, Policies, Procedures and Activities that has to be followed in achieving a successful conduct of Examination.

- Securing question papers and other examination materials
- Checking question papers
- Conditions for storing question papers in secure storage

- Preparing Time Table
- Using Calculators
- Resources for Examinations
- Examination Halls/Centers
- Invigilation Arrangements
- At The Beginning of the Examination
- Leaving the Examination Hall
- Malpractice
- Finishing the Examination
- Collecting Scripts
- After the Examination
 - Packing scripts
 - Sending scripts
 - Unused stationery

Based on the above discussions, the ultimate objectives are outlined

- To identify if Ho polytechnic has quality measures for the conduct of examinations.
- To find out if Ho polytechnic implements and manages the quality systems and measures in the conduct of examination to improve the output of graduates in the job market.
- To know if there are possible ways for the Polytechnic to improve upon the existing examination procedures towards achieving its academic objective.
- To recommend those methods to management of academic affairs department.

Methodology

Data for the study was collected via the use of a semi-structured or non-standardized interview guide study to gather necessary primary data for the study. In the view of David (2004), interviewing is the right data collection method when insightful answers are required though O'Leary (2004) argues that interviewing has its own issues and complexities, and demands its own type of rigour. The sample for the interview exercise was drawn from amongst those whose work involved the conduct of examination especially from the **Academic Affairs Department through exam centers to invigilators.** Hoyle, Harris and Judd (2002, p. 144) comment that questions have "... dual goals of motivating the respondent to give full and precise replies while avoiding biases stemming from social desirability, conformity, or other constructs of disinterest." This is supported by Gray (2004) that interview give the opportunity to probe and have high personalized data.

Participants of the conduct of examinations were targeted comprising 5 examination committee members, 9 staff working directly at the examination centers and 26 lead invigilators making a total number of 40 respondents and a simple frequency and percentages method was used to analyze the data.

Evaluation of secondary data was also conceded from student handbook, Examination malpractice manuals, Examination Committee's reports, Development Officer and Estate Officers report on the availability of exam halls.

The interview solicited information on the level of understanding amongst internal conduct of examination and the academic needs of all stakeholders for managing the Polytechnic, general examination procedures and practices and the effect of examination quality on the quality of decisions based on academic issues. The interview also found out where within the context of Garvin's dimensions of quality does Ho Polytechnic place its examination quality emphasis with attention to activities depicting the existence of willingness and ability to improve on the quality of examination in a continuously fashion and the cost that may be associated with such activities.

Results

Attempts were made to analyse data that relates directly or at least very closely to the major issues of the research, namely:

- Systems
- Policies
- Procedures and
- Activities

That relates to quality in the management of examination that is use by the Approved Academic Board and Committees listed in the Polytechnic Statutes and responsible for the actual management of academic issues of the Polytechnic.

Systems	Policies	Procedures	Activities
Storage of question papers <ul style="list-style-type: none"> • Storing question papers in printing rooms. • Late printing of question papers due to late submission from moderators and some lecturers • Inadequate space for storage. No security personnel. 	Preparing for examination <ul style="list-style-type: none"> • Most of the lectures set exam questions before the end of the semesters lecture. • Questions are submitted for moderation through the Heads of Departments • A main exam center where collection and submission of scripts take place are available as a preparatory ground for the conduct of examination. 	Time Tabling <ul style="list-style-type: none"> • <u>Most (95%) of the respondents</u> admits that draft time table comes out but corrections are never effected but sometimes changes are effected during the course of the examination and students get confused and lost over the venue for their exams. 	All actions taken before, during and after the conduct of exams fall under this category.
Examination Halls/Centers <ul style="list-style-type: none"> • <u>80% of the respondents</u> believe that exam halls are mostly prepared in advance for the start of the exams. • The polytechnic lack large exam halls • Poor seating arrangements 	Resources for Examination <ul style="list-style-type: none"> • <u>87% respondents believe that</u> some logistics (envelops, photocopier, invigilators etc) that enhances the quality and management of examination in Ho Polytechnic are inadequate. • Available resources are mostly sent to the exam centers in bits resulting to shortages. 	Invigilation Arrangement <ul style="list-style-type: none"> • Both teaching and non teaching staff do invigilation in the Polytechnic • <u>95 % of the respondents believe</u> in an increase number of invigilators for more effective work. • Lack of motivation and monitoring by most invigilators. 	
	After the Examination <ul style="list-style-type: none"> • Collected scripts are submitted immediately after the examination at the 	At the Beginning of the Examination <ul style="list-style-type: none"> • <u>Almost all the respondents (95%)</u> 	

	<p>center.</p> <ul style="list-style-type: none"> • Difficulty in submission when it rains as there are no vehicles assigned for this purpose. 	<p>pointed_out that identification of candidates are not done at the beginning of exams.</p> <ul style="list-style-type: none"> • Most research respondents who are invigilators prevent student without Identity Card from writing exams • <u>78% of the respondents also</u> raised the issue of question paper shortages due to inaccuracy of the attendance list causing delay • <u>60% of respondents</u> believes that improper seating arrangement causes delay in the start of Exams. • All the respondents say the candidates sign the attendance list during the examination. 	
	<p>Examination Malpractice</p> <ul style="list-style-type: none"> • All respondents believe everyone knows what constitute examination malpractice and students who are caught indulging in such a practice are made to face the law. 	<p>Leaving the Examination Hall</p> <ul style="list-style-type: none"> • <u>80% of the respondents</u> says most candidates don't tick against their names or sign after submission of their script • Students submit their finished answer booklet themselves whilst some are collected by the invigilators 	
		<p>Finishing and Script Packing</p> <ul style="list-style-type: none"> • Exam answer booklet are packed randomly packed and not sequentially • Unused stationary or materials left are taken back to the examination center 	

Discussion

The method and venue for storing question papers is not safe and late printing could be avoided or prevented if course lecturers submit exam question early enough to moderators. The system for exam hall preparations is perfect but the polytechnic need large exam halls with better seating arrangement to suit this purpose in order to combat these errors.

The academic calendar of the polytechnic is highly adhered to the policy of exam question submission. Exam centers are therefore created especially by the Examination committee successfully but need to regularly supply logistics to the exam centers in order to raise the exam standard in Ho Polytechnic. In view of these, the laid down rules, regulations and sanctions on Examination malpractices should continue to be strictly implemented.

The involvement of both teaching and non teaching staff for invigilation exercise is very good but need to be monitored and motivated for effective work and the procedure of leaving the exam hall should be critically looked up to so as to prevent candidates from leaving the hall without signing. This will do a great deal of good by pointing out the errors after counting the scripts. **With regards to packaging and discharge of exam scripts, vehicles need to be provided for ease of transfer of scripts during rainy times.**

Conclusions

Broadly, there is the need for every candidate or student to understand what quality examination actually means or constitute in their academic life. Some quality systems, policies and guidelines exist in Ho Polytechnic but most of such policies are written into documents and even so those documents are ambiguous because they are not being used for their purposes.

There have been some short seminars but no training programmes or activities in place to make the staff of the examining body to better understand the needs for the conduct of quality examination. The examining body attributes the inability of such organization to unavailability of fund for its organization and sometimes don't even see the need of it at all. Staff members are not given the opportunity to make constructive criticisms and contributions to make the conduct of examination of quality on Ho Polytechnic campus a success.

The poor quality performance of one semester's conduct of examination has resulted to the rewriting of exam by students before the beginning of new semester. Quality planning and organization of exams is not achieved as there is always delay in the submission of examination question papers to the head of academic division by some lecturers which has confirmed that there are totally no policies and procedures governing these activities.

The quality and quantity of material resources for examination should be sturdily looked at or attended to as these items are not mostly or readily available and human resource should not be neglected as invigilators are not well motivated.

The quality of examination hall in Ho Polytechnic campus is also bad and need urgent attention to meet the standard for examination. It is observed that the sizes of the halls are too small and seating capacity in them especially the few large ones are bad. In light of these, change of venue for some of the papers is mostly not communicated to candidates or students well or at all which has resulted to students getting frustrated and causing the exam to start late.

Recommendations

The Management and academic unit of the Polytechnic should consider building the capacity of staff and students to manage and help organize quality examination and all issues concerning academic work by providing them continuous training in all areas of academic affairs.

Such training programmes should concentrate on issues such as:

- Dimensions of Quality Teaching
- Setting of Standard Questions and Time Management
- Invigilation
- Safety and Security in Examination Halls

- Collection and Marking of Scripts
- Recording of Marks and Submission of Results
- And other related issues

This will help to ensure that formulated policies and available resources will be used to optimize the management of examination and its related activities.

The Polytechnic could also consider formulating Policies of academic management and have those policies documented. Such policies which can be drawn internally or by experts from external have to be dynamic enough to respond to the frequently changes nature of academic management. These Policies will clearly show all the direction that the institution wants to do in managing academic issues especially from setting of question and delivering of results for success, growth and competence of our products in the job market.

The capacity or strength of students in the Polytechnic is rapidly increasing, hence need very large examination halls for quality assessment. Facilities in these halls should also be improved and maintained regularly to meet the standard for quality examination. Due to the peculiarity of examination, security service is highly needed before, during and after exams. A representative of the security unit must also be on the examination committee or board to make inputs to the planning, organization and management of the exercise.

These securities should be well equipped to offer quality security assistance and be able to present a report after service.

Reference

- Achunine, R.N & Irondi, E.O (Eds) *Management and administration of secondary education: Issues, policies, realities and challenges*. Owerri: Totam Publishers Limited.
- Adams, D (2002). *Education and National Development: Priorities, Policies, and Planning*. Series "Education in Developing Asia". Manila: ADB, and Hong Kong: Comparative Education Research Centre, University of Hong Kong.
- Adegoke K.A. (2003). *Curriculum theorizing for competency*. An inaugural lecture delivered at University of Lagos-Nigeria. University of Lagos Press.
- Andrabi, T., Jishnu D, and Asim I. K (2007), "*Students Today, Teachers Tomorrow? Identifying Constraints on the Provision of Education*," mimeo.
- Babalola, J.B. (2004). *Quality assurance and child friendly strategies for improving public school effectiveness and teacher performance in a democratic Nigeria*. In E.O
- Candramouly, M.C and Padmaja, M. (2003) "*Quality in Technical Education A Critical Analysis of Governing Factors*", *The Indian Journal of Technical Education*, Vol. 26, No. 3,
- Chandra, A. (2006) "*Building a Good Institution*", *Journal of Engineering Education*
- Chapman, D.W. (2002). *Management and Efficiency in Education: Goals and Strategies*. Series "Education in Developing Asia". Manila: ADB, and Hong Kong: Comparative Education Research Centre, University of Hong Kong.
- Colby, J. and Witt M. (2000), *Defining Quality in Education*. The International Working Group on Education. The Education Section, Programme Division, UNICEF New York.
- Corbetta, P. (2003). *Social Research Theory, Methods and Techniques*. London: SAGE Publications.
- David, M. & Sutton C.D. (2004). *Social Research the Basics*. London: SAGE Publications.
- Ebenebe, R.C. (1998). *Discipline and education: The Nigerian secondary school case*. In
- Education in Nigerian Universities, held at the Faculty of Education, University of Ilorin.
- Ematarom, U.G. (2004). *Provision and management of facilities in primary schools in Nigeria- Implications for policy formulation*. In Fagbamiye, E.O., Babalola, J.B., Fabunmi, M. & Ayeni, A.O. *Management of primary and secondary education in Nigeria*. Ibadan: NAEAP pp111-120.
- Ezebor, S. (1983). Test, evaluation and performance in Nigeria. In Adesina, S., Akinyemi, K & Ajayi, K (Eds.) *Nigerian education: Trends and Issues*. Ife: University of Ife Press.
- Fagbamiye; Babalola, J.B, Fabunmi, M. & A.O.Ayeni, A.O. *Management of primary and secondary education in Nigeria*. Ibadan: NAEP pp. 303-312.

- Gray, D. E. (2004). *Doing Research in the Real World*. London: SAGE Publications.
- Hoyle, R. H., Harris, M. J. & Judd, C. M. (2002). *Research Methods in Social Relations*. London: Thomson Learning, Inc.
- Mohanty, P & Lakhe, R.R (2002) "TQM in Service Sector ", Jaico Publishing House.
- O'Leary, A. (2004). *The Essential Guide to Doing Research*. London: SAGE Publications.
- Okebukola, P. (2005). *Quality assurance in teacher education: The role of faculties of education in Nigerian universities*. A paper delivered at a meeting of Committee of Deans of pp. 240-259.
- Prasad, G., Bhar, C. and Srivastav, V. (2012). *Critical Review Of Examination Related Problems In Technical Education In India*. [Online] Accessed on 3rd March 2012 at <http://www.cce.iisc.ernet.in/iche07/52.pdf>
- Psychogios, A. G., & Priporas, C. V. (2007). *Understanding total quality management in context: Qualitative research on managers' awareness of TQM aspects in the Greek service industry*. *The Qualitative Report*, Vol. 12(1), 40-66. Retrieved [Online]. Accessed 3rd March 2012 from <http://www.nova.edu/ssss/QR/QR12-1/psychogios.pdf>
- Ramirez, F. O., Luo, X. E. Schofer, and J. W. Meyer. (2006). "Student Achievement and National Economic Growth." *American Journal of Education* 113 (1): 1–29.

PERFORMANCE APPRAISAL AND LECTURER'S PRODUCTIVITY: EVIDENCE FROM KOFORIDUA POLYTECHNIC

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The significance of performance appraisal as a major and pivotal human resource activity required for the growth, development and success of any organization can hardly be overemphasized. Unfortunately, in most of the public sector organizations, this fundamental activity is not given due importance. The ultimate corollary of this scenario appears in the shape of slow progress and lower productivity of the employees and of the organization as a whole. It is therefore important for organizations to have a performance improvement plan as a guide to *where we are now, where we want to be and how we will get there*. The study looked at the performance appraisal process, compliance by lecturers and its effects on lecturer productivity at Koforidua Polytechnic. The sample survey method was used with purposive and stratified sampling techniques adopted to allow for distinct categorization of separate strata. The results of the study revealed that the performance appraisal process in Koforidua Polytechnic is closely linked to sound policies in conformity with standards. Management commitment to and students' understanding of the appraisal program were perceived as dominant factors that could contribute to effective performance and boost output. There is therefore the need for adequate training and education for all stakeholders and the establishment of an Appraisal Review Committee. This study offers a better understanding of the factors that influence performance appraisal in enhancing lecturers' productivity in Koforidua Polytechnic.

Keywords: Performance; appraisal; productivity; employee; organization; effectiveness

Introduction

Decisions made about the value of an institution are often based on its productivity (Reingold and Stepanek, 2000). According to Mathis (2004), the more productive an institution is, the better its competitive advantage, because the cost to produce its goods or services is lower. Shresta (2005) commented that it has the major aim of bringing about lasting improvements in performance. Staff productivity will require that institutions put in place adequate motivational strategies and economic incentives (Ologunde et al. 2007). One way to review the performance and potential of staff is through a systematic appraisal of performance. It is important that members of the organization know exactly what is expected of them, and the yardsticks by which their performance and results will be measured (Terry and Franklin 2003). Administrative uses of performance appraisal are often the link between rewards employees hope to receive and their productivity. The linkage can be thought of as follows:

Productivity —————> Performance Appraisal —————> Reward

Developmentally, performance appraisal can be a source of information and feedback for employees, identifies strengths and weaknesses, recognizes performance and is a key to future growth and improvement in productivity (Mathis and Jackson, 2004)..

The purpose of this study will help identify the strengths and weaknesses of the current implementation of performance appraisal of lecturers for validity, reliability and sustainability and provide training needs of appraisers and implementers. In addition, it will provide a pathway to quality teaching in tertiary institutions; as this will ensure that targets or objectives set are accomplished by teachers in order to improve performance that meet the institution's expectation. It will enable Management to take proactive measures to ensure compliance and sustainability of performance appraisal

The Polytechnic introduced performance appraisal for teaching staff in 2006/2007 and was implemented by the Planning Department. The main challenge is the low level of compliance to these indicators and the standardized processes and procedures to be followed on performance appraisal. This has resulted in the process of conducting the performance appraisal to be ineffective. Students do not have much understanding in assessing the teaching staff objectively on their teaching performance. There is inadequate education and sensitization for students on how well to evaluate and rate lecturers' performance. A key shortfall is the inaction on feedbacks- inappropriate interviews and poor usage of appraisal results. Commitment of Management to

enforce compliance to standards on performance appraisal and provide the needed resources and training for effective appraisal system is inadequate. Therefore, the need to evaluate performance appraisal for the past four (4) years and its effect on lecturer productivity is of paramount importance to the institution's development as the Polytechnic continues to expand and grow. With these challenges, therefore, this research intends to examine academic productivity based on performance appraisal at Koforidua Polytechnic in their teaching duties.. **The objectives seek to** examine the performance appraisal process in Koforidua Polytechnic. Secondly to examine lecturer's compliance to standards on performance appraisal in Koforidua Polytechnic. and determine the effects of performance appraisal on lecturers' productivity in Koforidua Polytechnic

Performance appraisal is a process typically delivered annually by a supervisor to a subordinate designed to help employees understand their roles, objectives, expectations, and performance success. In the most basic sense, productivity is a measure of the quantity and quality of work done, considering most of the resources used (Mathis, 2004). It is simply a question of efficiency. In the academic context, productivity means effectiveness (Keirstead, 2010). Academic staff productivity has been defined as the efficiency with which the faculty or department perform their multiple responsibility of a) Learning (product of teaching), b) Knowledge and scholarship (the product of research and scholarly activities) and c) Institutional, community and professional well-being (the products of shared governance, community service and professional activities) (Kusure et al 2006)

.Performance indicators for teaching are grouped into four: Course presentation, Mode of delivery, Lecturer's bearing in class and Pedagogy. (Course presentation - identifies the course title and objectives, course outline with references, lecture notes, course content and description by teaching staff. Mode of delivery - addresses teaching staff command over the subject, effective communication during teaching, use of appropriate teaching methods and class interaction. Lecturer's bearing in class examines punctuality, regularity, responsiveness to students' question and adequate class assignments Pedagogy aligns itself to timely submission of marked assignments and discussions in class, organization of mid- semester examination and teaching staff appearance or demeanour). Each of these factors are indicated on the appraisal form, for which students assesses a lecturer, by using the five point scale ranging from 1-5.. Stakeholders include Management, Lecturers, students and Planning Department. As indicated in fig 1.1, the entire cycle begins with students' appraisal of teaching staff at the end of each semester. The graphic rating method of the trait approach is used to statistically analyzed the data. The appraisal results are then communicated to lecturers and Management with the preparation of the appraisal document. The feedback to lecturers helps to identify the areas needed for development and is also used for administrative purpose, which will intend improve performance.

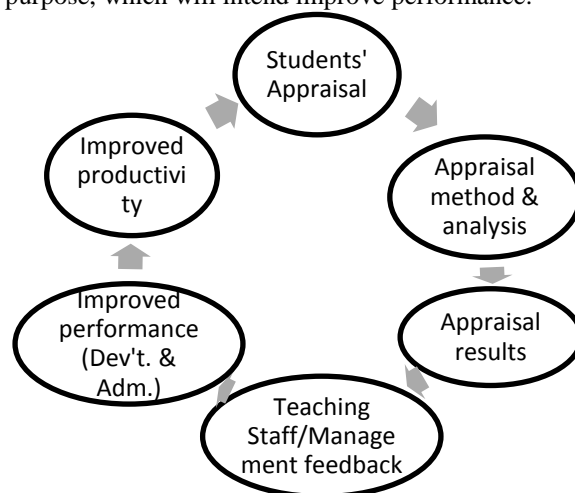


Fig 1.1 Conceptual Framework of Performance Appraisal Process of teaching staff at Koforidua Polytechnic.
Source: Author's Construct, 2011

According to Ivancevich (2004), there must be active communication between the supervisor and subordinate about performance. Formal performance appraisal programs sometimes yield disappointing results. Some of the most common problems include: inadequate preparation and training or giving feedback on the part of the

supervisor and employees are not given clear objectives at the beginning of performance period. Supervisor may not be able to observe performance or have all the information. Furthermore, unclear performance standards and inconsistency occur during appraisal among supervisors, thereby rating personality rather than performance, subjective and vague language. (Evres, Longnecker and Gioia, 2002). Carefully implemented performance appraisal process leads to sustainable growth of productivity, while poor and uncoordinated performance appraisals leads to poor feedback, and reward systems resulting in poor productivity (Beardwell and Holden 1998).

Methodology

Designing a research plan calls for decision on the research approaches, research instruments, sampling plan, data sources and contact methods (Kotler and Keller 2006). A survey strategy was employed with target population being students and staff of Koforidua Polytechnic. Teaching staff and students of Koforidua Polytechnic constitute the target population for this research. The population for students and teaching staff of Koforidua Polytechnic was 4170 and 166 respectively as at 2011 (Students' Records & Human Resource Department).

A sample size of 559 was used for the study for staff and students of Koforidua Polytechnic. The purposive sampling technique was adopted with selection of third year group from the 12 departments which was sub grouped into classes with an average class size of 40, summing up to 480 as the sample size for students. 50 teaching staff were purposively sampled from the 12 departments which represented 30%. Questionnaires were administered to Management (22), Planning staff (7), summing up to 79 as sample size for staff of Koforidua Polytechnic. Interviews were conducted for Management, teaching staff and the Planning Officer. The stratified random sampling technique was adopted as it selects sampling units from each stratum and ensures representation for all segments. The factor analysis and the descriptive statistics were used to analyze the data collected for the performance appraisal process and its effects on teacher productivity.

Results

This section deals with selected responses to the objectives of the study as well as the various research questions presented to respondents.

Table 1 Demographic Characteristic of Respondents

Position / Rank	Population	Sample size	Survey Responses	Responses (%)
Management	22	22	19	86
Lecturer	166	50	45	90
Planning Staff	7	7	6	86
Student	4170	480	323	67
Total	4365	559	393	70

Source: Field Data April, 2011

Table 1 shows the breakdown of the population, sample size , survey responses and interviews according to their positions in the study. A total of three hundred and ninety three (393) out of five hundred and fifty nine (559), representing 70%, questionnaires were collected from staff and students. This indicates a cross-section of staff and students who took part in the study.

Performance Appraisal Process by Planning Department

Evidence from the Planning Department revealed that performance appraisal is an activity undertaken semesterly to determine the extent to which lecturers perform their teaching duties effectively. An appraisal form is given to students two weeks to end of the semester to appraise lecturers on the courses taught for the semester. With the data collected from students the Planning Department analyses the data using the graphic rating scale method and the weighted average method. The feedback is given to lecturers and Management.

Challenges of the Process- some of the appraisers (students) are not cooperative, while others lack the understanding of the appraisal process. There are issues of personal bias, subjectivity and halo effect. Inaction of management, inappropriate feedback and timing pose a threat to the sustainability of the system.

Benefits of the Process- it is used to reward lecturers and for decision making by Management.

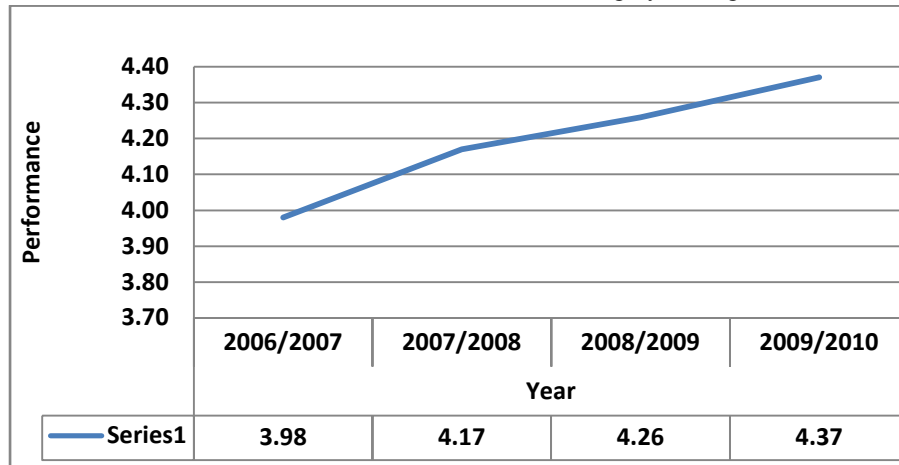


Figure 3.1 Trend analysis of performance appraisal of lecturers (2007-2010)

Source: Planning Department, Koforidua Polytechnic, 2011

The trend analysis in fig 3.1 indicates the teaching performance in the Appraisal report conducted from 2007-2010 by the Planning Department. This indicates that Lecturer's performance has been increasing gradually over the years, (3.98 - 4.37) from 2007 to 2010.

Meaning, Importance, Strengths and Weakness of Performance Appraisal by Respondents

The appraisal process from the respondents' perspective examined the meaning, importance, strengths and weakness.

Table 2 Respondents' Understanding of Performance Appraisal

Understanding of Performance Appraisal	Frequency	Percentage (%)
A formal and structured system by which management measures, evaluates and assesses an employee's job.	42	29.79

Source: Field Data (April, 2011)

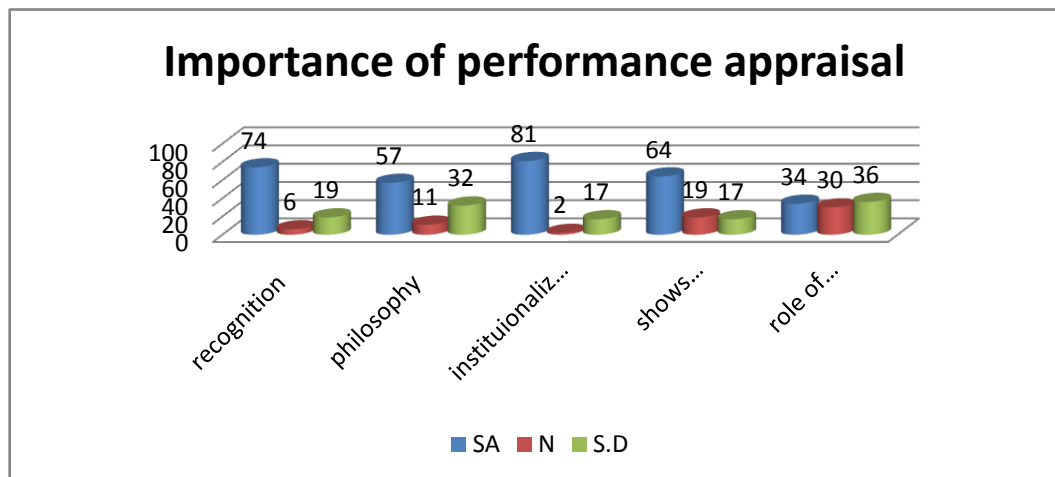


Figure 2 A bar chart showing Responses on Importance of Performance Appraisal

Source: *Field data (April, 2011)*

In table 2, 29.79 % of respondents believed that performance appraisal is a formal and structured system by which management measures, evaluates and assesses an employee's job- related attributes, behaviour and outcomes was the highest among the respondents. The main importance centred on the principles and practices of performance appraisal being institutionalized which recorded the highest percentage of 81%. In fig 4.2 the strengths highlighted on the policies of performance appraisal being known to all staff with the highest factor loading of 0.630. Weaknesses dwelt on poor understanding of performance appraisal among staff and students which recorded 84% in tables 4.3 and 4.4 as shown below.

Table 3 Factor Analysis on Strengths of Performance Appraisal

Factor Matrix	
Variables	Factor 1
Teaching staff conform to specific standards with regards to their duties of teaching and administrative roles by laid down policies	0.564992
Policies on PA should be known to all lecturers	0.630402
Top management, middle management and staff support the system	0.590127
Standardized procedures/processes are followed by Planning Department.	0.522136

Source SPSS Data Analysis on factor analysis, April, 2011

Weaknesses of Performance Appraisal	Strongly Agree / Agree (%)	Neutral (%)	Disagree/ Strongly Disagree (%)
Poor understanding of performance appraisal by staff and students may render the system ineffective	84	1	14
Lecturers perceive performance appraisal as a threat	60	20	17

Source: Field Data, April, 2011

Compliance Strategy of Lecturers

Students (appraisers) appraise the Lecturers on courses taught in the semester. Respondents commented on the four broad performance indicators used to appraise lecturers with 85 % concluding that lecturers provided Course structure , 65 % agreed to ineffective mode of delivery , 60 % supported an impressive lecturer's availability and 70 % agreed on pedagogy. However, 89% of respondent do not receive feedback and 82 % agreed to the fact that management do not adhere to their concerns raised through performance appraisal. Lecturers (appraisees) receive feedback from the appraisal, with 60 % of respondents viewing performance appraisal as a threat. Planning Department implements the appraisal for students and staff, prepares appraisal document and gives feedback to the lecturers and Management. Management supports the appraisal by approving and providing the needed resources to the Planning Department. However, inaction is taken by Management for lecturers who consistently perform poorly. It is important to note that the roles played by the stakeholders are ineffective and a good strategy requires proper coordination and education for them.

Effects of Performance Appraisal on Lecturer Productivity

Table 5 Position *Performance Appraisal Enhancing Lecturer Productivity - Cross Tabulation

Position	Effects of performance appraisal on Lecturer productivity		Total
	Yes	No	
Management	12 (17%)	7 (10%)	19 (27%)
Lecturer	24 (34%)	21 (30%)	45 (64%)
Planning Staff	5 (7%)	1 (2%)	6 (9%)
Total	41 (58%)	29 (42 %)	70 (100%)

Source:Field Data (April, 2011)

Table 6 Opinion of Students on Effects of Performance Appraisal on Lecturer Productivity

Variables	Response		No	
	Yes		No	
	Frequency	Percent	Frequency	Percent
Is performance appraisal enhancing teaching and learning?	145	45	178	55
Does management adhere to your concerns raised through performance appraisal?	59	18	260	82
Do you receive feedback from the appraisal exercise	34	11	289	89

Source: Field Data (April, 2011)

In table 5, 58% of staff agreed that there is a positive effect of performance appraisal on lecturer productivity as against 42 %. Opinion of students from table 4.6 showed a negative effect of performance appraisal on lecturer productivity at the Polytechnic, with 45% of students agreeing to this assertion while 55 % were of the counter view. This implies that a greater number of students do not realize the effect of performance appraisal on lecturer's productivity.

Discussion

Analysis so far has shown that performance appraisal in Koforidua Polytechnic has not had much impact on lecturer's productivity, due to the inconsistency of students in appraising lecturers. The opinion of students on effects of performance appraisal enhancing lecturers' productivity is in contrast with the appraisal reports from the Planning Department over the years, where performance has been increasing. It was realized from the findings that the performance indicators, especially lecturer's bearing in class as low among the number of respondents. Inaction by Management and poor feedbacks to students of the appraisal has contributed to the weakness of the system., where students become reluctant in rating the lecturers.

Conclusion and Recommendations

Conclusion

The research includes the appraisal process which encompasses the understanding, importance, strengths and weakness of the system which requires continuous improvement and review to enhance productivity. It was also revealed that a greater number of respondents agreed to an effective course presentation. Furthermore, there was two opposing views on the opinion of staff and that of students on performance appraisal in enhancing lecturer's productivity, with majority of students agreeing that performance appraisal is not enhancing teaching and learning while staff think otherwise. Feedback to students and concerns raised through performance appraisal are not adhered to by Management..

Recommendations

Institutionalization of the practices and principles of performance appraisal is recognized as key in enhancing productivity of staff of the Polytechnic. It is, therefore, recommended that continuous education, workshops and training be given to all stakeholders and a performance appraisal handbook developed by the Polytechnic. For stakeholders to be effective there must be proper coordination and this therefore calls for an Appraisal Review Committee for a more transparent, fair and objective system. Benchmark best practices that pertain in other sister Polytechnics and Universities should be adopted. Motivational packages should be awarded to deserving staff while consistently poor performing lecturers need disciplinary action or are discharged. From these two opposing views of performance appraisal enhancing productivity it is recommended that Management bridge the gap between the perceptions and the realities provided by the results of the appraisal to enhance consistency in the assessment by students that will help track performance of lecturers and improve productivity.

References

- Archer North and Associates (2010) Performance Appraisal System, www. Performance appraisal.com
- Evres P., Longnecker C and Gioia D. (2002) Problems to avoid during performance appraisal, Air Conditioning, Heating & Refrigeration News, 216, no. 16: 24-26.
- Ivancevich J.M. 2004 Human Resources Management, 9th Edition New York. N.Y. McGraw Hill.
- Keirstead J. 2010 Management of Environmental Quality: An international Journal Volume 21, issue 1, Publisher: Loughborough University, Yages: 6-19
- Kotler P., Keller K. *Marketing Management* 12th Edition 2006. Prentice Hall. PC.
- Kusure et al. (2006) Academic staff professional development for optimal productivity. (<http://www.babcockuni.edu.ng>)
- List of Registered Students, (2009-2011) Students' Records, Koforidua Polytechnic
- Mathis, R.L. and Jackson J.H.,(2004), Human Resource Management, 10th Edition, International Students Edition, South Western, Thomson Learning.
- Ologunde et al (2007) Academic staff professional development for optimal productivity. ([Http://www.docstoc.com.2010](http://www.docstoc.com.2010)).
- Reingold J. and Stepanek, M. "Why production revolution will spread", *Business week*, Feb. 14 2000 pp 112-118.
- Shresta S., (2005) Academic staff Professional development for optimal productivity.
- Snell S and Bohlander G.,(2007), Human Resource Management, International Students Edition, Thomson Higher Education, USA
- Terry G. and Franklin S.G. 2003. Principles of Management, 8th ed., AITBS Publishers, Delhi India, p-386.

VOID FRACTION MEASUREMENT USING GAMMA RAYS FROM CAESIUM-137

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Abstract

It is difficult to study void fraction experimentally due to the complex nature of gas-liquid two-phase flow system. As such this parameter is most often analysed by authors and researchers using empirical correlations. In this study, gamma rays from caesium-137 were used to measure void fraction in vertical air-water two-phase flow system. The purpose is to highlight the application of gamma rays in determining void fraction experimentally as an alternative to the analytical and empirical correlation methods. The study was carried out using a water flow rig made of PVC pipes of diameter 2.54cm. The gamma ray counts were measured using NaI scintillation detector for the cases where the pipe contained only air, only water, and air-water two-phase flow mixture and the void fraction calculated. In the case of the air-water two-phase flow mixture, the water flow rate was varied from 6L/min to 16L/min, at a constant air flow rate and the calculated void fraction values varied from 0.151 to 0.027 respectively. The experimental results were tested against those obtained from the use of the model of Premoli et al to determine the error margins. The error margins were in the range of 0.2% – 3.8%.

Keywords: air-water; gamma rays; void fraction

Introduction

Two-phase flow is the flow situation in which a mixture consisting of two states of matter flow together at the same time through a conduit. In gas-liquid flow, the two-phase mixture may arise from two different components (e.g., air and water mixture, oil and water mixture) or a single substance, in the event of phase change due to evaporation and condensation of a single fluid as are commonly encountered in refrigeration and other heat transfer equipment (Ghajar and Tang, 2010). Two-phase flow is encountered in many industrial processes. Typically, gas-liquid two-phase flow has various applications in such areas as industrial boilers, chemical processing plants, petroleum engineering using gas-lift pumps, refrigeration, medical applications using micro-bubbles and nuclear reactor cooling systems (Kuwahara and Yamaguchi, 2007).

Flow Patterns in Gas-Liquid Two-Phase System

When gas and liquid flow simultaneously through a pipe, the different phases may take various geometric shapes and distributions within the flow field. These shapes and distributions depend primarily on the velocities of the phases. The various geometric distributions are referred to as ‘flow pattern’ or ‘flow regime’. A number of different flow patterns, with different fluid dynamic features may arise in gas-liquid two-phase flow. The flow patterns may be described as bubble (or bubbly) flow, slug (or plug flow), churn flow, annular flow and wispy-annular depending on the shape and configuration of the gaseous phase. These flow patterns decide the parameters that govern the two-phase flow. Apart from the flow rate of each phase and its physical properties, the orientation of the flow (vertical, inclined or horizontal) as well as the size of the pipe influences the flow pattern of the mixture. Vertical flow could be upward or downward. Vertical upward and horizontal flows are the focus of many authors and investigators because they are those that are usually encountered in engineering problems and industrial applications (Roston et al., 2008). This study considered vertical upward flow. Experimental observations and analysis of gas-liquid two-phase flow are difficult. This is because of the complex interactions that occur in the flow field. The bubbles could coalesce, break-up, interact with the conduit wall, and these make the flow configuration very unstable (Rahman et al, 2007). One of the key parameters in studying gas-liquid two-phase flow is void fraction.

Void Fraction

Void fraction (α) is the ratio of the flow area occupied by the gaseous phase to the total flow area. The various flow patterns are identified and described according to the void shape, size, distribution and dynamics. It is important to have a fair knowledge of the phase configuration and their distributions when predicting the performance processes and energy transfer systems. Knowledge of void fraction in particular is required to predict other important parameters such as the two-phase mixture density, viscosity, pressure gradient, heat transfer coefficient and flow pattern transition. It is also important in predicting the behaviour of a nuclear reactor primary heat transfer system, and for monitoring many industrial process plants in which gas-liquid two-phase flow occurs (Cremaschi, 2004; Ghajar et al, 2007).

Many methods including radiation application methods have been applied in measuring void fraction. Gamma ray attenuation method has a number of advantages over other radiation application methods. It is simple and easy to operate. It is less expensive than neutron attenuation techniques. It also provides single-energy gamma rays without intensity fluctuations. The method of application of radiation, especially beta, gamma and x-ray in the study of void fraction measurement is usually referred to as densitometry (Abro and Johansen, 1999; Roitberg et al, 2007; Shehata and Aljohani, 2007; Stahl and von Rohr, 2004).

Gamma densitometry has been used by many researchers including Abro and Johansen (1999), Kern (2006), Zhibiaoe et al (2007) and Stahl and von Rohr (2004) in studying void fraction. In this study, gamma rays from caesium-137 were used to measure void fraction in air-water vertical upward two-phase flow system at ambient temperature. The purpose is of twofold; firstly, to assess the test rig whether it could be modified into a facility for studying void fraction, and secondly highlight on application of gamma rays in determination of void fraction experimentally as alternative to the analytical and empirical correlation methods.

Void Fraction Models

It is difficult to measure void fraction from the input parameters for a given pipe in gas-liquid two-phase flow. This is because in addition to the instability of the phase configurations there are other complexities that characterised the flow field as mentioned earlier. There is therefore insufficient understanding of the basic underlying physics of gas-liquid two-phase flow, hence the phenomena is mostly analysed by using empirical correlations (Woldeamayyat and Ghajar, 2007).

Those void fraction models and correlations that performed well in air-water two-phase flow system in a vertical channel at ambient temperature received commendation from many researchers and authors. Prominent among those models are that of Premoli et al (Butterworth and Hewitt, 1978; Woldeamayyat and Ghajar, 2007) and the model of Chisholm (Thome, 2009; Woldeamayyat and Ghajar, 2007). The model of Chisholm is expressed as:

$$\alpha_{Ch} = \frac{1}{1 + \frac{\rho_G}{\rho_L} \left(\frac{1-x}{x} \right) \left[1 - x \left(1 - \frac{\rho_L}{\rho_G} \right) \right]^{\frac{1}{2}}} \quad (1)$$

ρ_G and ρ_L are gas and liquid phase densities respectively

The flow quality, x , is the ratio of mass flow rate of the gas to the total mass flow rate.

The model of Premoli et al is expressed as:

$$\alpha_{Pr} = \frac{1}{1 + K \left(\frac{1-x}{x} \right) \frac{\rho_G}{\rho_L}} \quad (2)$$

$$\text{Where } K = 1 + Q \left(\frac{Y}{1+YC} - YC \right)^{\frac{1}{2}} \quad (3)$$

$$Y = \left(\frac{x}{1-x} \right) \frac{\rho_L}{\rho_G} \quad (4)$$

$$Q = 1.578 \text{Re}_L^{-0.19} \left(\frac{\rho_L}{\rho_G} \right)^{0.22} \quad (5)$$

$$C = 0.0273 \text{We}_L \text{Re}_L^{-0.51} \left(\frac{\rho_L}{\rho_G} \right)^{-0.08} \quad (6)$$

$$\text{Re}_L = \frac{GD_h}{\mu_L} = \frac{\rho_L u_L D_h}{\mu_L} \quad (7)$$

$$\text{We}_L = \frac{G^2 D_h}{\sigma \rho_L} = \frac{(\rho_L u_L)^2 D_h}{\sigma \rho_L} = \frac{\rho_L u_L^2 D_h}{\sigma} \quad (8)$$

Re_L = Liquid Reynolds number

We_L = liquid Weber number

D_h = hydraulic (or equivalent) diameter

$$D_h = \frac{\text{four times the cross - sectional area of the fluid}}{\text{wetted perimeter}}$$

$$\Rightarrow D_h = \frac{4A}{P} = \text{flow channel diameter for a circular pipe}$$

μ_L = liquid dynamic viscosity

σ = surface tension of liquid

A = cross-sectional area of the pipe

P = perimeter of the pipe

Measurement Principle

When gamma rays interact with matter, they are attenuated and their intensity reduces. The extent of attenuation in solids is higher than that in liquids which is also higher than that in gases. The intensity of the emanating radiation as it traverses matter is therefore a means to conclude on the phase of the matter. The detector commonly used for counting gamma rays is the thallium-activated sodium iodide (NaI(Tl)) detector due to its good detection efficiency (IAEA, 2008). The intensity of single-energy gamma rays can be inferred from gamma photon counts per unit time since the two are directly proportional to each other (Roitberg et al, 2007).

$$N = \frac{A_{Det} I}{E_\gamma} \quad (9)$$

N = counts per unit time

I = intensity of the emanating radiation

A_{Det} = detection area of the scintillator

E_γ = energy of gamma ray

The extent of attenuation of gamma rays depends on the density and composition of the material as well as the distance the rays travel through the material. The attenuation of a narrow beam of single-energy gamma rays penetrating a homogeneous material of good geometry follows the Lambert-Beer's exponential attenuation law (Stahl and von Rohr, 2004).

$$I = I_o \exp(-\mu x) \quad (10)$$

I_o = initial intensity of the gamma-ray incident on a target material ($\gamma/\text{cm}^2\text{s}$)

x = thickness of target material (cm)

μ = linear attenuation coefficient of target material (cm^{-1}).

I = intensity of gamma ray that emanates from the target material ($\gamma/\text{cm}^2\text{s}$)

By determining the intensity of the radiation that emanates from the test section when the pipe is filled with gas only, (I_G), when filled with water only, (I_w), and when filled with a mixture of water and gas, (I_{tp}), the void fraction (α) can be calculated using the following equation:

$$\alpha = \frac{\ln\left(\frac{I_{tp}}{I_w}\right)}{\ln\left(\frac{I_G}{I_w}\right)} \quad (11)$$

Methodology

The Experimental Facility

Figure 1 shows the experimental facility on which the study was conducted. The facility is located in the Radiotracer laboratory of Ghana Atomic Energy Commission. The facility is made of polyvinylchloride pipe of internal diameter of 2.54cm. The test section is made of transparent tubing to aid visual monitoring of the fluid flow. Two containers connected in series and each of capacity 0.02686m^3 were used as water reservoirs from which a pump of capacity 0.373kW circulated water through the system. The flow meter on the test facility also regulates the flow rate from a minimum value of 0.5L/min to 26L/min maximum.



Figure 1: The experimental facility

Equipment

The equipment used for data collection is shown in Fig. 2. The gamma source used in the study was caesium-137 of activity 30mCi. The radiation detector used was thallium-activated sodium iodide scintillation detector. It

was connected to the data acquisition system by a BNC-type connecting cable. The data acquisition system consists of a single channel analyser, a lap top and data acquisition software.

Experimental Procedure

Fig. 3 shows the gamma source and NaI (TI) detector mounted on the test section. All the radiation counts recorded in the experiment were taken for five minutes with recycling time of 10 seconds. The detector was connected to the laptop via the single channel analyser and the background count taken before the radiation source was brought into the laboratory. The radiation source was then mounted at the test section diametrically opposite the detector. At first, the counts were taken under static conditions when the pipe contains only air and when only water was introduced into the setup. When air-water mixture was introduced into the setup, the flow rate was first set to 6L/min and the counts were taken. The flow rate was then increased in step of 2L/min at a time to 16L/min (giving six different flow rates of 6, 8, 10, 12, 14 and 16L/min) and the counts for each flow rate was taken using the same counting time described above. This counting time strategy was adopted in order to minimize error which may arise from small fluctuations in the voids during the period of measurement (Eberle et al., 1995). The entire experiment was conducted at room temperature.

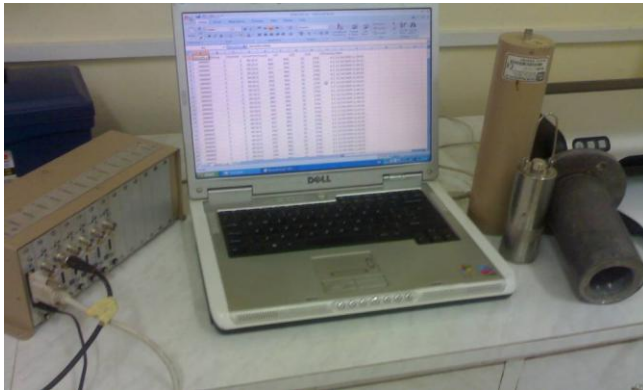


Figure 2: Equipment used for data collection



Figure 3: Gamma source and NaI(Tl) detector mounted on the test section

Results

Experimental Void Fraction

The average value for the background counts was first calculated. Similarly, the average values for the static calibration counts for air only in the pipe, I_G , and water only in the pipe, I_W , were also separately computed. The average background count was then used to make background correction for the counts obtained for each flow rate. Background corrections were also made for the static calibration counts, I_G , and I_W . The corrected counts were then used in Equation (11) to calculate 30 void fraction (α) values from the 30 data points obtained for

each of the six flow rates used. The average void fraction was then computed for each flow rate to obtain six average void fraction values corresponding to the six different flow rates used in the experiment.

Theoretical (Analytical or Correlated) Void Fraction

The input parameters used in evaluation of the theoretical (analytical or correlated) void fraction models are presented in Table 1.

Table 1: **Input parameters**

PARAMETERS (Temperature range: 20°C – 25°C)		
CONSTANTS		VALUE
Density of water (kg/m^3)		998.5
Density of air (kg/m^3)		1.2928
Surface tension of water (N/m)		0.0721
Viscosity of water (Ns/m^2)		896.6×10^{-6}
MEASURED	CALCULATED	ESTIMATED
Water flow rate, (L/min)	Water velocity, u_{SL} (m/s)	Air velocity, u_{SG} (m/s).
6.0	0.19733	0.04933
8.0	0.26310	
10.0	0.32888	
12.0	0.39465	
14.0	0.46043	
16.0	0.52621	

The water flow rates were converted to velocities and used in the void fraction models (Eqns. (1) and (2)) to obtain theoretical void fraction values. The experimental void fraction values and those obtained from the use of the void fraction models were compared graphically, analysed and discussed. By so doing, the accuracy and reliability of the experimental void fraction values could be inferred in order to draw meaningful conclusions.

Fig. 4 shows the graphical presentation of the results. The graph is plotted at varying water velocity (0.2 to 0.5 m/s) and constant air velocity (0.05m/s). Except the curve for the experimental void fraction the others depend on the air velocity. In order to fairly assess the experimental void fraction, it was necessary to use at least two different void fraction models. Using void fraction values calculated from one model would be misleading because the void fraction models which are supposed to be “standards” do not agree well among themselves. This might be because they were derived based on different sets of assumptions.

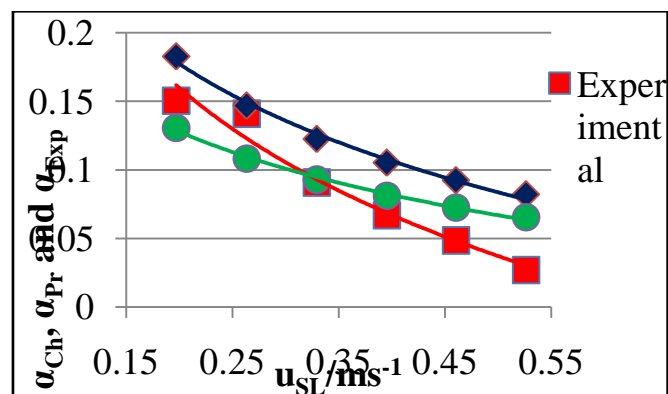


Fig. 4: Void fraction against water velocity

Discussion

As the water flow rate (or velocity) increases, at constant air flow rate, the void fraction values decrease as shown in Fig. 4. This trend is expected because increasing the amount of water in the system means decreasing the volume fraction of the air and hence the void fraction values will decrease. The three curves in Fig. 4 show similar trends, which should be the case since they are quantifying the same parameter under the same conditions. It is however clear from the graph that, the experimental void fraction values (ranged from 0.151 to 0.027) are quite close to those obtained from the model of Premoli et al (ranged from 0.131 to 0.065) than those from the model of Chisholm (ranged from 0.183 to 0.082). Though the experimental void fractions cannot be numerically the same as those obtained from the use of the models, they ought to be close enough to be acceptable. From Fig. 4, the curve for the experimental void fraction is quite close to that of the model of Premoli et al, indicating that their void fraction values are closer. The closeness of the experimental results to those obtained from the use of the models (which serve as the “standards” in this study) indicates that, with good experimental design and careful experimentation, gamma densitometry could complement and serve as alternative to the analytical and empirical correlation methods for determining void fraction.

The same input data was used in evaluating the two void fraction models, but there is much variation in their void fraction values as depicted by Fig. 4. This observation supports the point that the models might be developed under different assumptions and hence their void fraction values could not be the same. More work therefore need to be done to get models that agree well among themselves under the same conditions to enable more progress be made in studying void fraction and hence gas-liquid two-phase flow. In order to put the meaningfulness and the reliability of any experimental result, in a better perspective, error analysis needs to be done on it, and this is the subject of the next section.

Error Assessment

The experimental results were tested, verified and validated against the results obtained from the model of Premoli et al (Eqn. (2)). The model of Premoli et al was chosen because the experimental void fractions compared more favourably with this model. The statistical parameters used in testing the results were the mean deviation and the standard deviation. The error in the experimental results is said to be small when these statistical parameters are small (Bluman, 2001; Gadiner, 1997). Mean deviation range of 1% - 2.5% was reported but it is possible to achieve better results with a careful experimental design (Roston et al, 2008)

The summary of the values of these statistical indicators are presented in Table 2.

Table 2: Error margins of the experimental void fraction.

WFLR (L/min)	\overline{D}_{ev} %	SD%
6	+2.0007	2.6144
8	+3.2558	3.3177
10	-0.2438	0.3364
12	-1.4335	1.4705
14	-2.1446	2.4634
16	-3.8485	3.9188

WFLR = water flow rate

Conclusions

Void fraction was measured in vertical air-water two-phase flow system at ambient temperature using gamma ray attenuation technique. The trend of the experimental results compare well with known trends. The void fraction values obtained compare well with those obtained using the model of Premoli et al. The mean deviations of the experimental void fractions from those obtained from the use of the model of Premoli et al ranged from 0.2% for the water flow rate of 10L/min to 3.8% for water flow rate of 16L/min. The standard deviations also ranged from 0.3% to 3.9% for water flow rates of 10L/min and 16L/min respectively. It appears gamma densitometry is worth considering for studying void fraction as alternative to the analytical and

empirical correlation methods if more work is done to bring out technicalities that need to be observed for improved results. This is because the values of the statistical parameters gave a good account of the experimental results.

References

- Abro E. And Johansen G. A. (1999). *Improved Void Fraction Determination By Means Of Multi-Beam Gamma-Ray Attenuation Measurements. Flow Measurement And Instrumentation*. Vol. 10, Pp. 99–108.
- Bluman A. G. (2001). *Elementary Statistics: A Step By Step Approach (4th Ed.)*, McGraw-Hill Inc, Boston,
- Butterworth D. And Hewitt G.F. (Eds.) (1978). *Two-Phase Flow And Heat Transfer*. University Press Oxford, Oxford, Pp. 4,19-26, 42, 78-82, 92-93
- Cremaschi, L. (2004). *Experimental And Theoretical Investigation Of Oil Retention In Vapor Compression Systems*. Phd Thesis, Department Of Mechanical Engineering, University Of Maryland, Pp 186-189.
- Eberle C.S., Leung W.H., Wu Q., Ueno T. And Ishii, M. (1995). Quantitative Characterisation Of Phasic Structure Developments By Local Measurement Methods In Two-Phase Flow. *Proceedings Of 2nd International Multiphase Flow Conference*. Kyoto, Japan, 3rd -7th April, 1995
- Gadiner W. P. (1997). *Statistical Analysis Methods For Chemists: A Software-Based Approach*. The Royal Society Of Chemists, Gateshead,
- Ghajar A., Kim J., And Tang C. (2007). *Two-Phase Flow Heat Transfer Measurement And Correlation For The Entire Flow Map In Horizontal Pipes*. School Of Mechanical And Aerospace Engineering, Oklahoma State University, Stillwater,
- Ghajar, A. J. And Tang, C. C. (2010). Void Fraction And Flow Patterns Of Two-Phase Gas-Liquid Flow In Various Pipe Inclinations. *Proceedings Of The 7th International Conference On Heat Transfer, Fluid Mechanics And Thermodynamics*, Antalya, Turkey, 19th – 21st July 2010
- IAEA (2008). *Radiotracer Residence Time Distribution Method For Industrial And Environmental Applications*. Material For Education And On-The-Job Training For Practitioners Of Radiotracer Technology. Training Course Series No. 31, Vienna.
- Kern B. (2006). *Experimental Investigation Of The Hydrodynamics Of A Plunging Two-Phase Plane Jet*. M. Sc. Thesis, Georgia Institute Of Technology, Pp. 6-9, 30-32
- Kuwahara T. And Yamaguchi H. (2007). *Void Fraction Measurement Of Gas-Liquid Two-Phase Flow Using Magnetic Fluid*. *Journal Of Thermophysics And Heat Transfer*. Vol. 21, No. 1, Pp 99–108.
- Rahman M. A., Amirfazli A., Heidrick T. And Fleck B. A. (2007). A Review On Advanced Two-Phase Gas/Liquid Flow Measurement Techniques. *Proceedings Of The International Conference On Mechanical Engineering*. Dhaka, Bangladesh, 29th – 31st December 2007.
- Roitberg, E., Shemer, L. And Barnea, D. (2007). *Measurements Of Cross-Sectional Instantaneous Phase Distribution In Gas-Liquid Pipe Flow*. *Experimental Thermal And Fluid Science*. Vol. 31, Pp. 867–875

- Roston G. B., Ascheri M. E., Martín M. C. And Pizarro R. (2008). *Void Fraction Fluctuations in Two Phase Flow: Theoretical Models*. WSEAS Transactions On Fluid Mechanic. Vol. 3, No. 4, Pp. 369 – 379.
- Shehata A. H. And Aljohani M.S. (2007). A Review of Nuclear Non-Intrusive Visualization Methods In Industry: Computed Tomography And Particle Tracking. *Fourth Middle East NDT Conference and Exhibition, Kingdom Of Bahrain*. Dec 2007.
- Stahl P. And Von Rohr P. R. (2004). *On The Accuracy Of Void Fraction Measurements By Single-Beam Gamma-Densitometry For Gas-Liquid Two-Phase Flows In Pipes*. *Experimental Thermal And Fluid Science*. Vol. 28, Pp. 533–544.
- Thome J.R. (2009). *Wolverine Engineering Data Book III*. Faculty Of Engineering Science And Technology. Swiss Federal Institute Of Technology Lausanne (EPFL), Lausanne, Switzerland, Pp. 10-11
- Woldesemayat M. A. And Ghajar A. J. (2007). *Comparison Of Void Fraction Correlations For Different Flow Patterns In Horizontal And Upward Inclined Pipes*. *International Journal Of Multiphase Flow*. Vol. 33, Pp. 347–370
- Zhibiaoe L. I., Yingxiang W.U. And Donghui L. I. (2007). *Gamma-Ray Attenuation Technique For Measuring Void Fraction In Horizontal Gas-Liquid Two-Phase Flow*. *Nuclear Science And Techniques*, Vol.18, No. 2, Pp. 73-76

CURBING EXAMINATION MALPRACTICE IN GHANA: A COMPARATIVE STUDY OF ACCRA AND KOFORIDUA POLYTECHNICS

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The study sought to find out the extent of knowledge of examination policies in Accra and Koforidua Polytechnics, implementation of examination policies, the trend of examination malpractice, examination offences and punishments, and the challenges in curbing the incidence of examination malpractice in both Polytechnics. Data was collected from staff and students of both Polytechnics using questionnaires. In addition, secondary data from the examination offices of the two institutions was utilized. Data was analyzed using SPSS (version 16) and Microsoft Excel software. The findings suggest that respondents of both institutions are aware of examination policies in their institutions. The trend of examination malpractice is also decreasing in both institutions. Furthermore, examination regulations and associated sanctions are fully implemented in both polytechnics. A major challenge in curbing the incidence of examination malpractice in both institutions is students' quest to attain better grades at all cost. To curb the canker, the authors recommend invigilator strictness, institutional immediate response to examination malpractice cases and stricter sanctions to offenders.

Keywords: Examination malpractice; curbing examination malpractice; Polytechnics in Ghana; Accra Polytechnic; Koforidua Polytechnic

Introduction

The main objective of higher education is to equip students with the requisite knowledge and skills to enable them to contribute effectively to the national development effort. Examinations are processes that are used to assess the extent to which education has taken place in the individual. Examinations form an important activity in the academic community which falls within the scope of the concept of curriculum. There comes a stage in the teaching-learning process that learners are required to face a set of tasks which are designed to test their knowledge, skills or abilities in written or oral forms, or in laboratory/workshop practicals. Every examination is expected to be guided by code of conduct or ethics of the institution, government or the examination bodies. Examination therefore remains important aspect of the education process, although some have argued or queried its use as a true test of knowledge/ability (Oluwatelure, 2008).

Examination Malpractice (EM) has variously been described as an act from which the examinee derives illicit advantage over and above other candidates in an examination

Statement of the Problem

The quest by educational institutions is to ensure high standards in all of its operations. However, there seems to be lack of commitment by Educational Management to deal seriously with this negative trend of examination malpractice. Such issues are quietly dealt with and the perpetrators are not severely sanctioned with the excuse that it will tarnish the reputation of the institution. Moreover, the ever growing numbers in the rate of examination malpractices has often raised questions about the impact of laid down policies to curb this canker. The recent spree of examination leakages in some tertiary institutions has awakened the questioning minds of many Ghanaians about the caliber of graduates coming out from our public universities. Examination leakages are not restricted to the universities alone (Adomako, 2005), polytechnic institutions are also involved. The various stakeholders in the educational sector including the polytechnics have seemingly not been involved in discussing and looking for stringent ways of dealing with this canker. Furthermore, the lack of team spirit and effective coordination among decision-makers most often results in examination policy failures or in some cases financial loss to such institutions.

Research objectives

The following will constitute the objectives of the study:

1. To find out the extent of knowledge of examination policies in Accra and Koforidua Polytechnics.
2. To find out the extent of implementation of examination policies in both polytechnics.

3. To find out the trend of examination malpractices in both Polytechnics.
4. To compare the common examination offences and its associated sanctions in the two polytechnics.
5. To identify the challenges in curbing the incidence of examination malpractices.

Research Questions

The following research questions were formulated to guide the study:

- i. What are the examination are examination policies?
- ii. What is the extent of knowledge of examination policies in Accra and Koforidua Polytechnics?
- iii. What is the extent of implementation of examination policies in both polytechnics?
- iv. What is the trend of examination malpractices in both Polytechnics?
- v. What factors make it difficult to reduce examination malpractices in the polytechnics?

Significance of Study

The study is expected to make two contributions to the higher education quality literature. The tendency to cheat in examinations by students has often bedeviled academic institutions for some decades now. However, very little empirical literature exists on the forms of examination malpractice especially in Ghana. The study will enrich the literature in this novel area. Secondly, the study will provide guidelines that will assist Rectors, Vice Chancellors and Registrars on how to control examination malpractice and improve overall academic quality in Ghana.

The paper is structured as follows. The first section will provide a brief background on Polytechnic education in Ghana in order to provide the context of the study. The paper then continues with the review of the pertinent literature to guide the study. The methodology for the study was also addressed, followed by a presentation of the main findings and discussions. The last section deals with the implication of the study, possible limitations and directions for future studies.

Literature Review

This section provides the literature review for the study. It begins with the concept of examination malpractice

Concept of Examination Malpractice

Examination malpractice is a misconduct or improper practice before, during or after any examination by the examinees or others with a view, to obtaining good results, by fraudulent means (Obe, 1998). The Centre for Academic Integrity (1999) defines academic dishonesty as dishonest behaviour related to academic achievement including cheating, plagiarism, lying, deception and any other form of advantage unfairly obtained by one student over others.

The spate of the malpractice has taken a more global trend and is a familiar practice in most countries sub of the Sahara. For example, in 2003, the Examination Ethics Project reported that out of 929,294 candidates that sat for the May/June WAEC O' level in Nigeria in that year, 111,969 representing 12.05 percent were caught cheating in the examination. The following year, 2004, the Examination Malpractice Index (EMI) had increased to 16.9 percent. This means, for every 100 candidates in the examination, 16 -17 of them were caught cheating. Most cases are not even recorded and reported. According to West African Examination Council (WAEC) Reports, in Nigeria, between May/June 1996 and May/June 2005, a total of 14,408,336 candidates sat for WAEC examination and 1,367,726 of them, representing 9.4% over that period were involved in examination malpractice. This means for every 100 candidates that took the examination, about 10 of them cheated (Daily Sun, 2006).

In Ghana these malpractices occur from basic through to tertiary institutions. Some common forms of examination malpractices include, copying from neighbours through "girraffing", use of prepared materials, notebooks, textbooks, magazines, asking questions from fellow candidates, using the back side of question papers, using handkerchiefs, underwear's to write answers, use of cell phones within the hall with stored answers to receive and send text message to their friends outside examination halls among others. In order to address these malpractices, institutional policies have been developed which will form the discussions in the next section.

Institutional Policies:

Aaron (1992) found over ninety percent (90%) of community colleges in a national sample have academic integrity policies and almost ninety-eight percent (98%) have procedures for dealing with student misconduct. Effective communication of policies and increased student awareness of penalties and enforcement tend to reduce dishonest behavior.

The National Board for Professional and Technical Examinations (NABPTEX), the regulatory body responsible for examination and certification in the polytechnics, has a Student Guide which outlines modalities for the conduct of all HND examinations in Ghana. It deals with issues such as qualifications awarded at various progressive levels, assessments, grading of assessments, guidelines on the conduct of examinations, examination malpractice and penalties. The examination malpractices contained in the guide are dealt with in accordance with the provisions stipulated in Part III of NABPTEX Act 492, 1994 and the Criminal code of 1960, Acts 29 and 30, as well as the approved internal examination regulation of the institutions (NABPTEX Guide, 2006). According to Kan-Dapaah (2005), the government would be ruthless with anyone caught engaged in examination malpractices, as it is destroying the image of the nation. Examination leakages and malpractices damaged the credibility of certificates awarded to deserving students' context. The West African Examinations Council (WAEC) in Ghana embraces the use of all legal means to clamp down on examination malpractices to protect the credibility of its certificates. It includes implementing innovative measures aimed at monitoring, reporting and exposing perpetrators of examination malpractices. In addition to publication of the names and photographs of candidates who engaged in examination malpractices in order to "name and shame" perpetrators to discourage the act (Teye-Cudjoe, 2010).

Factors Influencing Examination Malpractices

The desire to achieve is a very constant pressure in the lives of all students. Whether the source of the pressure is internal, parental, peer, or even teacher, most students want good grades. Contrary to some of the published studies (Anderman & Midgley, 2004; Jensen, Arnett, Feldman, & Cauffman, 2002), a study done by Taylor, Pogrebin, and Dodge (2003) found that a significant number of students with very high grade point averages utilize dishonest academic behaviors in order to maintain high grades. Invigilators need to do their work very well at the various examination centres; they ought to have in mind that a lax attitude during invigilation do no good to the students. Invigilators, teachers, students, parents, school authorities and the media should be involved in the fight. We need public-spirited people in the society to curb examination malpractice (Teye-Cudjoe, 2010).

Zimmerman (1999) aggregated two groups of students to study negative cheating attitudes of students and its effect on the prevalence of cheating. The negative cheating attitudes, such as institutions' inconsistent responses to student cheating and the lack of instructor diligence at catching cheaters, were significantly correlated with cheating prevalence. The detachment of students from the university system may be a result of misperceptions about student cheating by the faculty and administration or an unspoken conflict between student and institutional views of the severity of academic dishonesty on an ethical level. Additionally, the lack of student involvement in leadership and code implementation may play a role in the prevalence of student cheating. Another dimension according to a study by McCabe and Treviño (1997) is that cheating tends to be more prevalent in institutions with larger campuses. Ivowi (1997) revealed that the lack of confidence as a result of inadequate preparation, peer influence, societal influence, parental support and poor facilities in schools are some of the factors responsible for examination malpractices.

Examination as Tool for Assessment

Adomako (2005) argues that although examinations are not the only instrument for assessing and evaluating knowledge, it has emerged as the most established yardstick and the most practical way of assessment in Ghana. Imagine one lecturer taking a class of about three hundred students. How can one expect such a lecturer to give separate assignment to each student and supervise as is done in project work? So examination has become the only reliable and available tool. This has caused over-dependence on certificate as the key to employment leading to a crazy rush by most people to try and acquire certificates either legitimately or illegitimately. A critical study into Ghana's educational system reveals that it is much focused on examinations. An engineering

student who fails all his/her semester papers, despite the fact that he can construct a miniature car, will still be dismissed. This student must pass examination by all means available.

Cheating is a widespread problem in higher education. Cheating in examination, plagiarizing, falsifying bibliographies, turning in work done by someone else, receiving improper assistance on assignments, and intentionally facilitating cheating on the part of others are common place in higher education. All of these behaviors comprise academic dishonesty, a widespread problem at colleges and universities (Burke, 1997; McCabe and Trevino, 1997).

Annan (2010), expressed worry at the amazing level of examination malpractice we have in our schools today. It has become institutionalized. It involves students, lecturers, and non-academic staff and has become a business operated by a mafia. Unfortunately, our schools are living in a state of denial. Furthermore, these examination malpractices have affected the quality of the products of the schools and made Ghana non-competitive in the global market where a high caliber of human resource was essential for development. Ghana needed to take its rightful place in Africa and the world as a place where highly skilled human resources are produced as it was in the past. The University of Ghana, Legon, formerly one of the best universities in Africa, for example, had no business being ranked 25th in Africa and 1,727 in the world (http://www.webometrics.info/top100_continent.asp?cont=africa). The proliferation of accredited private tertiary institutions which provided low quality education (Annan, 2010).

Human Rights Factors

According to Suhini (2011), the publication of names and photographs of the candidates alleged to have been involved in various forms of malpractices during WASSCE Nov-Dec examinations were flawed and cruel. According to him WAEC's stance is unreasonable since some of the candidates could eventually be exonerated. Some of these sanctions are quite harsh and especially considering that one will not be in the position to tell whether indeed he/she was engaged in such acts. He suggested that before such pictures are published, due diligence must be done and even incase they are found guilty. Despite several criticisms from human rights activists, WAEC maintains that right to publish identities of the candidates.

The publication was unfortunate because it has caused irreparable damage to the young ones (Suhini, 2011). On the contrary, other stakeholders such as the Parliamentary Select Committee on Education had commended the West African Examinations Council for publishing the names of candidates who engaged in examination malpractices (Teye-Cudjoe, 2010)

Methodology

Population and Sample Size

The staff and students of Accra and Koforidua Polytechnics constituted the population for this research. Accra Polytechnic has a staff strength of about seven hundred (700) and a student population of about twelve thousand (12,000) while Koforidua Polytechnic has five hundred and seventy-five (575) as its staff population and a student population of five thousand, two hundred and three (5,203). The sample size was 250 respondents, made up of 150 and 100 staff (made up of invigilators and examination staff) and students from Koforidua and Accra Polytechnics respectively. The total response rate was however 86.4%, which will not necessarily alter the general conclusions on the study. The stratified sampling technique and the simple random sampling were used in the selection of respondents for the study. Stratified sampling technique was used in the selection of students whilst simple random sampling technique was used to select staff.

Data Gathering

The open and closed-ended questionnaires were designed for the respondents. The design was guided by the material acquired for the literature review in this study. The questionnaires were divided into various sections to capture the critical success areas spelt out in the objectives for the study. In addition to the primary data, secondary data on examination malpractices from both institutions was also utilized. The primary data was analyzed using SPSS (version 16) and Microsoft Excel software.

Major Results

The result of the survey as revealed in the profile of the respondents shows that the respective respondents are directly involved with examination issues and can provide a balanced appreciation of knowledge on examination malpractices as per the thematic areas captured in the questionnaires. A total of two hundred and sixteen (216) respondents which forms 86.4% response rate took part in the study. A total of twenty (20) staff members (examination staff and invigilators) from both institutions disaggregated into 8 (40%) from Accra Polytechnic and 12 (60%) from Koforidua Polytechnic undertook the exercise. In addition, 91 (46.4%) and 105 (53.6%) students from Accra and Koforidua Polytechnic respectively formed part of the study (Table 1).

Table 1: Disaggregation of Respondents

Respondents	Accra Polytechnic	Koforidua Polytechnic	Total
Students	91(46.4%)	105(53.6%)	196(100%)
Examination officers/ Invigilators	8(40%)	12(60%)	20(100%)

Source: Field Survey, 2011

Knowledge of Examination Policies

The knowledge of the respondents was tested on whether they were aware of a policy document that guided examinations in the polytechnic. A total of 86 (43.9%) and 99 (50.5%) student respondents from Accra and Koforidua Polytechnics claimed they were aware of such a policy and added that it was the NABPTEX guide while 5 (2.6%) and 6 (3.0%) said they were not aware of such a policy document guiding examinations. All the examination officers and invigilators from the two institutions admitted that they knew of the policy guiding the organization of examinations in the polytechnics (Table 2).

Table 2: Awareness of Policy Guiding Examination

Respondents	Accra Polytechnic		Koforidua Polytechnic		Total
	Yes	No	Yes	No	
Students	86(43.9%)	5(2.6%)	99(50.5%)	6(3.0%)	196(100%)
Examination officers/ Invigilators	8(40%)	0(0%)	12(60%)	0(0%)	20(100%)

Source: Field Survey, 2011

When asked if the respondents could explain what the policy entailed with respect to examinations and malpractices, 73 (37.2%) and 93 (47.5%) respectively of student respondents from Accra and Koforidua Polytechnics claimed they could explain. In addition, 18 (9.2%) and 12 (6.1%) said they could not. They explained that although they had copies of the guide they seldomly studied it. In all, 8 (40%) and 11 (55%) of staff respondents from both institutions could explain what the policy on examinations and malpractice entailed, however only 1 (5%) respondent could not explain the details of the policy although they knew of the existence of the policy (Table 3).

Table 3: Knowledge of the Details of the Examination Policy

Respondents	Accra Polytechnic		Koforidua Polytechnic		Total
	Yes	No	Yes	No	
Students	73(37.2%)	18(9.2%)	93(47.5%)	12(6.1%)	196(100%)
Exam officers/ Invigilators	8(40%)	0(0%)	11(55%)	1(5%)	20(100%)

Source: Field Survey, 2011

Extent of implementation of examination policies

Table 4 Implementation of NABPTEX Regulation on Examination

Does your institution fully implement the NABPTEX Regulation?							
Accra Polytechnic				Koforidua Polytechnic		Total	
Respondents	S.A	A	NAD	S.A	A	NAD	
Students	11(5.6%)	64(32.7%)	16(8.2%)	57(29%)	48(24.5%)	0(0%)	96(100%)
Exam officers/ Invigilators	3(15%)	4(20%)	1(5%)	9(45%)	3(15%)	0(0%)	20(100%)

Source: Field Survey, 2011

The findings show that when the respondents were asked to rate the extent to which their respective institutions fully implemented the various modalities/regulations set out in the NABPTEX guide, 11 (5.6%) and 57 (29%) of student respondents from Accra and Koforidua polytechnics respectively strongly agreed to it, 64 (32.7%) and 48 (24.5%) agreed to the statement while a paltry 16 (8.2%) from Accra Polytechnic could neither agree nor disagree. None was found at Koforidua Polytechnic to have objected to it. Besides, 1 (5%) staff respondent from Accra Polytechnic claimed that he neither agrees nor disagrees with the full implementation of the policy, 3 (15%) and 9 (45%) strongly agreed to it, another 4 (20%) and 3 (15%) staff participants from Accra and Koforidua agreed respectively (Table 4).

Trend of Examination Malpractice

According to 59 (30.1%) of student respondents in Accra Polytechnic, the trend of examination malpractices had decreased in the polytechnic over the past two years, while their counterparts in Koforidua who formed 74 (37.8%) confirmed that a similar trend was occurring on their campus. On the contrary, 32 (16.3%) student respondents from Accra and 31 (15.8%) from Koforidua were of the view that the trend had increased. A total of 8 (40%) staff respondents in Accra and Koforidua Polytechnics equally agreed that the spate of examination malpractice had increased while 4 (20%) and 8 (40%) from Accra and Koforidua said the trend had decreased (Table 5).

Table 5: Trend of Examination Malpractice in the Past Two Years

Respondents	Accra Polytechnic		Koforidua Polytechnic		Total
	Increased	Decreased	Increased	Decreased	
Student	32(16.3%)	59(30.1%)	31(15.8%)	74(37.8%)	196(199%)
Exam officer/ Invigilator	4(20%)	4(20%)	4(20%)	8(40%)	20(100%)

Source: Field Survey, 2011

Comparison of examination offences and associated sanctions

Table 6 Breakdown of Examination Offences and Corresponding Punishments in the Two Institutions

S/N	EXAMINATION OFFENCES	PUNISHMENTS	
		ACCRA POLYTECHNIC	KOFORIDUA POLYTECHNIC
1.	Possession of Foreign material	Withdrawal	Withdrawal
2.	Impersonation	Withdrawal	-
3.	Verbal Assault on Invigilator (Insult)	Withdrawal	Rustication
4.	Possession of mobile phone in Examination hall	Caution	Caution/Warning letter and Payment of fine (highest Gh¢100.00)
5.	Exchange of question papers	-	-
6.	Copying from prepared script	Withdrawal	Withdrawal
7.	Communication with another contingent in examination hall	Caution/written warning	Cancellation of paper/Reprimand and Bond of Good behavior
8.	Found at wrong venue	Caution/written warning	-
9.	Possession of calculator written on cover	Caution/written warning	Rustication and bond of good behavior
10.	Possession of calculator with Formula	Cancellation of paper	Rustication and Bond of Good behavior
11.	Removal of leaflets in answer booklet	Caution	-
12.	Rude attitude of Candidate Invigilator	Cancellation/Rustication	Rustication
13.	Destroying Foreign Material	Withdrawal	-
14.	Copying from inscriptions on arm/palm	Withdrawal	-
15.	Browsing with phone in examination hall	Withdrawal	-
16.	ATM card holder with written notes in it	-	Withdrawal
17.	Notes in handkerchief	-	Withdrawal
18.	“Shadow” copying of notes behind MIS sheet	-	Withdrawal
19.	Written inscriptions in inner part of shirt	-	Withdrawal
20.	Student leaving examination hall to wash room without permission	-	Written warning/Bond of Good behavior

Source: Examination Malpractice Notice (Accra and Koforidua Polytechnics for 2009/2010 Academic year (Sem. I & II) to 2010 Academic year (Sem. I))

A review of offences and punishments revealed that a student who assaults an invigilator verbally (insults) in Accra Polytechnic will be withdrawn but will be rusticated at Koforidua Polytechnic.

In addition, possession of mobile phone in the examination hall will lead to the student receiving a written caution in Accra Polytechnic but at Koforidua Polytechnic a student will be fined Gh¢100.00 in addition to the written caution.

Communication in the examination hall with a colleague during examination will result in a written caution at Accra Polytechnic; however a similar offence will attract the cancellation of the student(s) paper or be reprimanded in addition to signing a bond of good behavior at Koforidua Polytechnic.

Generally, it could be concluded that at Koforidua Polytechnic punishments for examination offences are harsher than in Accra Polytechnic. Respondents interviewed at Koforidua Polytechnic claimed that apart from the NABPTEX guide on examinations, the institution has its own examination guide. This guide is handed to every student in addition to the NABPTEX guide during matriculation ceremonies.

Challenges in Curbing Malpractices

The respondents comment on the challenges that made it impossible to curb examination malpractices revealed that most student respondents i.e. 121 (62.0%) attributed the quest to attain good grades as the most dominant factor that make them cheat. Another 52 (26.5%) of them attributed it to poor preparation towards examinations which led them with no other option than to cheat and 23 (11.7%) blamed invigilators inattentiveness in the examination halls as encouraging them to cheat. This confirms studies by Teye-Cudjoe (2010) which attributed the lax attitude of invigilators as a factor contributing to cheating in examinations.

On the side of the invigilators/exam officials, 8 (40%) blamed the recurrence of these malpractices to the institution's inconsistencies in expediting action on exam malpractice cases. Another 7 (35%) claimed that the sanctions meted out to offenders were not punitive enough while a paltry 5 (25%) responded that students over engaged in social activities at the expense of their studies even during revision week so they make up study time by cheating to ensure that they pass their examinations.

Conclusions and implications

There is no single approach in curbing the spate of examination malpractice within educational institutions. Most respondents are aware of the examination policies and its contents. The trend of examination malpractice is decreasing over the past two years why?and examination regulations and its associated sanctions are fully implemented in the two institutions. Invigilator strictness, institutional immediate response to malpractice cases and stricter sanctions to offenders are recommended to help curb exam malpractices.

Limitations and directions for future study

This research would be limited by time to critically carry out on a wider target group however this may not necessarily affect the outcome. In addition as a suggestion for future research other variables should be tested quantitatively and qualitatively to draw respective relationships which will be significant in helping to bring this trend under control.

References

- Aaron, R. M. (1992). Student academic dishonesty: Are collegiate institutions addressing the issue? NASPA journal 29(2), 107-113. (EJ442669).
- Adomako, A.K. (2005), Examination Malpractices: Universities' Shame, Students' Burden, www.ModernGhana.com.htm
- Anderman, E. M., & Midgley, C. (2004). Changes in self-reported academic cheating across the transition from middle school to high school. *Contemporary educational psychology*, 29, 499-517.
- Annan, J. (2010), *Exam malpractice not good for national development*, posted on www.ghananewsnow.com, May 31, 2010 under Education category_ extracted from Daily Graphic
- Burke, J. L. (1997). Faculty perceptions of and attitudes toward academic dishonesty at a two year college. Unpublished dissertation. (ED 431 486).
- DAILY SUN, newspaper of Nigeria, Education article, August, 29, 2006).
- Dishonesty: A multicampus investigation. *Research in Higher Education*, 38(3), 379-396. (EJ Issue? NASPA journal 29(2), 107-113. (EJ442669).
- Ivowi, U. M. O. (1997). Examination malpractices: profile, causes, warning signs, case studies, prevention and detection strategies in Onyechere, I. *Promoting Examination Ethics: the challenges of a collective responsibility*, Lagos: Potomac Books.
- Jensen, L. A., Arnett, J. J., Feldman, S. S., & Cauffman, E. (2002). It's wrong, but everybody does it: academic dishonesty among high school and college students. *Contemporary Educational Psychology*, 27, 209-228.
- Joshua, M. T. (2008a). *Examination malpractice: The monster in our midst*. Paper presented at Intervention Workshop for Teachers of English Language, Mathematics and science subjects in AkwaIbom State held in September- November.
- Joshua, M. T. (2008b). *Intervention strategies in curbing examination malpractice in schools: The role of government and teachers*. Paper presented at Stakeholders Forum on Examination Malpractice, organized by Cross River State Ministry of Education, Calabar on December 16.
- Kan-Dapaah, A (2005), Examination malpractices is destroying Ghana's image, GNA, General News of Monday, 30 May 2005, Article 82561
- McCabe, D. L., & Trevino, L. K. (1997). Individual and contextual influences on academic
- McCabe, D. L., & Treviño, L. K. (1997). Individual and contextual influences on academic dishonesty: A multicampus investigation. *Research in Higher Education*, 38, 379-396.
- Obe, E.O (1998). *An appraisal of continuous assessment and national examinations in Nigerian schools*. Inaugural Lectures Series. Lagos: University of Lagos Press.
- Obo, F. E. (2008). *Education stakeholders' attitudes towards examination malpractice and their preferred intervention strategies in Cross River State secondary schools system, Nigeria*. Unpublished Ph.D thesis, Faculty of Education, University of Calabar.
- Olutayo, R. A. (2008). Checking the menace of examination malpractice: A call for more teaching and learning in schools. *Education and Leadership Journal*, 7(2), 34-45.
- Taylor, L., Pogrebin, M., & Dodge, M. (2003). Advanced placement - Advanced pressures: Academic dishonesty among elite high school students. *Educational Studies*, 33, 403-419.
- Teye-Cudjoe, A.N. (2010), "WAEC to use legal action to check examination malpractice", GNA, General News, 5th November 2010
- www.myjoyonline.com
- www.alta-vista.org
- www.ghanaweb.com
- www.biz/ed.org
- www.citifmonline.com (September 16th, 2011; [Exam fraudsters: NUGS slam WAEC for publication](http://www.citifmonline.com)", [Education, Your campus today](http://www.citifmonline.com))
- [http://www.shvoong.com/books/795518-curbing-examination-malpractice counseling/#ixzz1xb78VuF3](http://www.shvoong.com/books/795518-curbing-examination-malpractice-counseling/#ixzz1xb78VuF3)
- http://www.webometrics.info/top100_continent.asp?cont=africa

MULTIPLE REGRESSION ANALYSIS OF THE IMPACT OF SENIOR SECONDARY SCHOOL CERTIFICATE EXAMINATION SCORES ON THE FINAL CUMULATIVE GRADE POINT AVERAGE OF STUDENTS OF TERTIARY INSTITUTION.

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Senior Secondary School Certificate Examinations (SSSCE) play an increasingly important role in tertiary institutions' admissions. People's belief is that students' performance in senior secondary school certificate examination is directly related to the final cumulative grade point average (FCGPA). The purpose of the research is to determine if SSCE scores, session and sex of students imparts negatively or positively on each student FCGPA score at the Koforidua polytechnic. Data were compiled from the student records of various departments in a Tertiary Institution. The information sought were on gender, the session (morning or evening), the cumulative grade points average and the SSCE scores of the 2006 to 2009 year group of students. The multiple linear regression with interaction was used to analyse the data. It was found out that students who to attend the morning session on the average obtain higher FCGPA than their evening counterparts. It was also found out that there is no relation between a student's sex and his or her cumulative grade points average (FCGPA) at 5% significance level.

Keywords: Multiple linear regression; FCGPA; Performance; SSCE scores

Introduction

In Ghana the SSCE is required for admission into the Tertiary Institutions. This examination has played an increasingly important role in admissions not only into the Universities in Ghana but also into the country's ten Polytechnics.

Since 1998, the West African Examination's Council (WAEC) has administered SSCE exam to students applying to either the Universities or Polytechnics. A motivation for the introduction of this test was not only to democratize the admissions process but also synchronize Ghana's educational system to that of the United States of America. Requiring scores from all applicants sought to enhance the role meritocracy in the admissions process, while diminishing the roles of nepotism and patronage.

Roughly over 95% of Koforidua Polytechnic students are admitted using their SSCE. Two main streams of students are admitted, those that attend the morning session and those that attend evening session. It is needless to say that Koforidua polytechnic students like any other group of students are from diverse socio-economic and environmental backgrounds, with different psychological problems.

The main objective of this study was to determine whether or not there is a "causal" effect of SSCE scores on FCGPA in tertiary Institutions. The study also answers the following questions:

The population of the study comprises students who completed the polytechnic in the year 2006. The data used for this study were mainly secondary. Data were compiled from the student records of various departments. The data consists of information on the gender, the session (morning or evening), the cumulative grade point average and the Senior Secondary School Examination (S.S.S.E) of the 2006 year group students. In total six hundred and eighty six (686) data points were used in this study.

Review of Literature

Academic performance was hypothesized to be determined by a host of factors, which included individual and household characteristics such as student ability, motivation, the quality of secondary education obtained as well as the gender of the student. Dayioglu and Turut-Asik(), asserted that childhood training and experience, differences in attitudes, parental and teacher expectations and behaviour, differences in courses pursued and biological differences are all instrumental in giving rise to gender differences in achievement. Beyond gender, studies within the Caribbean have also attempted to identify other factors that impact on student performance, but they have used primarily qualitative research methods. Jacobs (2002) for example, assessed the unique non-cognitive factors that are related to the successful academic performance of Grenadian students who matriculate into medical programmes of St. George's University in Grenada. The research concluded that non-cognitive

factors do relate to the academic success and retention of Grenadian students in the medical programmes at St. George's University. From the analysis, for example, it was evident that finances have a significant effect on the performance of students in the university. Grenadian students are predominantly supported by means of a scholarship. Financial problems, it was found, led to stress and anxiety for students which in turn had a negative impact on the academic performance of some of these students. In addition to the challenges associated with meeting tuition payments, many students do not have sufficient funds to afford adequate housing and to live in their preferred place of residence. Grenadian students who do not receive scholarships are unable to afford to live on campus. The study's conclusions suggested that once the housing of the Grenadian medical students improves, then their focus will be more directed towards academic study and less on distressing themselves about a place to live and complicated travel schedules. Another factor the literature points to as having an impact on student performance is enrolment status, with part-time students requiring particular focus in their academic efforts because of the challenges they face in juggling academic and other responsibilities (Bourner & Race, 1990). Hoskins et al, in their assessment of the performance of students studying at the University of Plymouth, identified the key variables affecting student performance to be age, gender, prior qualifications and discipline studied (Hoskins et al, 1997). Although attention has been paid to factors affecting student performance in a Caribbean context, we are not aware of any study on academic performance in higher education in the Caribbean that seeks to assess student performance against a range of possible predictors, such as gender, age, matriculation status, residence, enrolment status and discipline studied, and that assesses this information systematically through use of a quantitative research methodology, although such studies have been conducted in other regions (Simmons et al, 2005; Hoskins et al, 1997).

Statistical Methods

Multiple Linear Regression (MLR) is the appropriate method of analysis when the research problem involves a single metric dependent variable presumed to be related to two or more metric independent variables. Multiple linear regression is useful for testing theories about relationships between two or more variables.

Several assumptions about the relationships between the dependent and independent variables that affect the statistical procedure used for multiple linear regression are made. The assumptions to be examined are:

- (i) Linearity of the phenomenon measured. The linearity of the relationship between dependent and independent variables represent the degree to which the change in the dependent variable is associated with the independent variable. The concept of correlation is based on a linear relationship. Corrective actions can be taken if the linearity assumption is violated. For example, transforming the data values (logarithm, square root etc) of one or more independent variables to achieve linearity. Directly including the nonlinear relationships in the regression model, such as through the creation of polynomial terms.
- (ii) Constant variance of the error terms. The presence of unequal variances (heteroscedasticity) is one of the most common assumption violations. Diagnosis is made with residual plots or simple statistical tests.
- (iii) Independence of the error terms. It is assumed in regression analysis that each predicted value is independent, which means that the predicted value is not related to any other prediction. Data transformations, such as first differences in a time series model, inclusion of indicator variables, or specially formulated regression models can address violation if it occurs.
- (iv) Normality of the error term distribution. The assumption violation is non-normality of the independent or dependent variable or both. Normal probability plots can be used to remedy the assumption violation.

Formally, the dependent variable is y and the independent variables are x_1, x_2, \dots, x_k , then the multiple linear regression model is of the form:

$E(Y) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_k$, where $\beta_0, \beta_1, \dots, \beta_k$ are the regression coefficients which must be estimated from sample data.

In the case of three independent variables (i.e. $k = 3$), the least squares estimates, b_0, b_1, b_2 and

In multiple regression, it is possible to compute a matrix of all possible pair wise correlation coefficient between y and each x_i ($i = 1, 2, \dots, k$); and among the x_i 's. Such a matrix is called the correlation matrix.

If we denote the correlation coefficient between y and x_i by r_{YX_i} and that between x_i and x_j by $r_{x_i x_j}$, then the correlation matrix for the data on the dependent variable Y and k independent variables, x_1, x_2, \dots, x_k is written in a matrix form.

Coefficient of Determination

The coefficient of determination is the proportion of the total variation in the dependent variable, Y that is explained by the dependent variable, X_1, X_2, \dots, X_k . The coefficient of determination is usually denoted by R^2 and is given by

$$R^2 = \frac{SS_{yy} - SSE}{SS_{yy}},$$

where

$$SS_{yy} = \sum_{i=1}^n y_i^2 - \frac{\left(\sum_{i=1}^n y_i \right)^2}{n}$$

and

$$SSE = \sum_{i=1}^n (y_i - \hat{y}_i)^2$$

By definition, R^2 lies between 0 and 1 or between 0% and 100%. A high value of R^2 indicates a reliable regression equation for prediction.

If the independent variables are mutually uncorrelated, then

$$R^2 = r_{YX_1}^2 + r_{YX_2}^2 + \dots + r_{YX_k}^2$$

On the other hand, if the independent variables are correlated or collinear, then the contribution of X_i 's to the variation of Y is such that:

$$R^2 < r_{YX_1}^2 + r_{YX_2}^2 + \dots + r_{YX_k}^2$$

Thus, collinearity is not a desirable property in regression because it makes it difficult to separate the contribution of each (collinear) variable to the variation in the dependent variable.

Making Inference in Multiple Linear Regression Analysis: The Standard Error

The multiple standard error of estimate is given by

$$s = \sqrt{\frac{\sum_{i=1}^n (y_i - \hat{y}_i)^2}{n - k - 1}}$$

The standard error is needed to find confidence intervals on regression coefficients, perform hypothesis tests for these coefficients as well as to make inferences concerning $E(Y)$ and Y .

Confidence Intervals on Regression Coefficients.

A $100(1 - \alpha)\%$ confidence interval on the regression coefficient β_j , is given by

$$b_j \pm t_{\alpha/2} s,$$

where b_j is the estimated value of β_j ; $t_{\alpha/2}$ has a t -value with degrees of freedom $(n - k - 1)$ and s is the standard error.

Tests for Individual Regression Coefficients

The dependence of Y on X_j can be assessed testing the significance of β_j . The hypotheses are

$$H_0 : \beta_j = 0$$

$$H_1 : \beta_j \neq 0 \text{ (or } \beta_j > 0 \text{ or } \beta_j < 0)$$

The test statistic is

$$t = \frac{\hat{\beta}_j}{\sqrt{\beta}},$$

which has student t distribution with $(n - k - 1)$ degrees of freedom.

If H_0 is rejected, it means that X_j significantly explains the variation in Y and so it has to be maintained in the equation. On the other hand, if we fail to reject H_0 , then X_j does not significantly contribute to Y and so it is unimportant.

Test for a Set of Regression Coefficients

The overall ability of a set of independent variables (or all the independent variables) to explain the variation in the dependent variable can be tested simultaneously. Suppose in the model

$$E(y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k$$

we wish to test whether $X_{g+1}, X_{g+2}, \dots, X_k$ ($k > g$) significantly contribute to the variation in Y . This is equivalent to testing whether the associated regression coefficients, $\beta_{g+1}, \beta_{g+2}, \dots, \beta_k$, are equal to 0.

The hypothesis, therefore, are:

$$H_0 : \beta_{g+1} = \beta_{g+2} = \dots = \beta_k = 0$$

$$H_0 : \text{At least one of the } \beta \text{ s is not equal to 0.}$$

The test statistics is F , given by

$$F = \frac{[SS_E(\text{Reduced Model}) - SS_E(\text{Full Model})] / g}{SS_E(\text{Full Model}) / (n - k - 1)},$$

and F has degrees of freedom g and $(n - k - 1)$.

The term SS_E denotes the error sum of squares. Thus SS_E (Full model) denotes the error sum of square of the full model

$$E(y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k$$

and SS_E (Reduced model) denotes the error sum of squares of the reduced model

$$E(y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_g X_g$$

Note that $k - g$ is the number of coefficients equated to zero in the null hypothesis, k the number of independent variables and n the number of observations.

Dummy Variables in Regression Analysis

Suppose data on Y and X_j ($j = 1, 2, \dots, k$), are obtained from q different sources, then by introducing variables Z_1, Z_2, \dots, Z_{q-1} ,

Where

$$Z_i = \begin{cases} 1, & \text{if from source } S_i \\ 0, & \text{otherwise} \end{cases}$$

A single equation can be written rather than q different equations for the q source. Z_i is called a dummy variable. Generally, a dummy variable is a qualitative variable that assumes the value of 0 or 1. Further, if there are q categories of variable then there will be $(q - 1)$ dummy variables to be defined. Dummy variables representing different categories can be used in a single equation.

Data Collection, Analysis and Results

The data used for this study were mainly secondary. Data were compiled from the student records of various departments of Koforidua Polytechnic. The data consists of information on the gender, the session (morning or evening), the cumulative grade point average (C.G.P.A) and the Senior Secondary School Examination (S.S.S.E) of the 2006 year group students. In total 686 data points were used in this study. A simple random sampling was used to select five departments out of thirteen. Information was gathered from students from these five departments who successfully completed in the year 2009.

In this section the analysis and results of the study are discussed.

Table 1: Distribution of the sex of the 2006 year group

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid F	209	30.5	30.5	30.5
M	477	69.5	69.5	100.0
Total	686	100.0	100.0	

The table 1 represents the total number of students who successfully completed Koforidua polytechnic in the year 2006. It can be observed from Table 1 that male students (69.5%) are more than female students (30.5%).

Table 2: Distribution of the “Session”of the attendance of the 2006 year group

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid F	99	14.4	14.4	14.4
M	587	85.6	85.6	100.0
Total	686	100.0	100.0	

Table 2 represents the distribution of students by session (morning or evening). It can be observed from Table 2 that majority of the students (85.6%) attend morning session and minority of the students (14.4%) attend the evening session.

Table 3: Estimated Model

Parameter	Estimate	Standard Error	t Value	Pr > t
intercepts	5.373017482	0.29233067	18.38	<.0001
ssce	-0.134852056	0.01560956	-8.64	<.0001
SEX	-0.227491610	0.22537258	-1.01	0.3131
session 1	-0.547266894	0.27685247	-1.98	0.0485
ssce *sex	0.010373141	0.01136616	0.91	0.3618
ssce*session 1	0.034574177	0.01461658	2.37	0.0183
sex*session 1	0.002869375	0.09108131	0.03	0.9749

Table 3 present the regression results. The results indicate that Senior Secondary Certificate Examination (SSCE) score is associated with the cumulative grade point average (FCGPA) at 1% significance level. That is students who enter Koforidua polytechnic with the “good” SSCE score tend to obtain the good cumulative grade point average . There appears to be no relation between a student’s sex and his or her cumulative grade point average at 5% significance level.

However there is some significant relationship between session and FCGPA that is students who attend the morning session tend to have higher FCGPA than their evening counterparts.

From Table 3, the estimated multiple linear regression model with interaction may be written as:

$$y = 5.373017482 - 0.134852056x_1 - 0.547266894 x_3 + 0.03454177x_1 * x_3 \dots\dots (3)$$

Where y: Cumulative Grade Point Average

x_1 : Senior Secondary Certificate Examination

x_3 : Session (Morning or Evening)

Since SSCE score is a continuous variable, it is differentiable. Note that x_3 is a dummy variable defined by

$$(X_3) = \begin{cases} 1 & \text{If a student attends morning session} \\ 0 & \text{otherwise} \end{cases}$$

Differentiating y with respect to X_1 gives $\frac{\partial y}{\partial x_1} = \beta_1 + \beta_3 x_3$

$$\text{Now } \frac{\partial y}{\partial x_1} \Big|_{x_3=0} = \beta_1 = -0.134852056$$

Thus, $\beta_1 = -0.134852056$ measures the impact of the student SSCE score of each evening student on their final C.G.P.A.

$$\text{Now } \frac{\partial y}{\partial x_1} \Big|_{x_3=1} = \beta_1 + \beta_3 = -0.134852056 + 0.03454177 = -0.1$$

Again, here $\beta_1 + \beta_3 = -0.1$ measures the impact of the student SSCE score of each Morning student on their final C.G.P.A. The model can be written as follows using the conditional expectations

$$E(Y|_{x_1, x_3}) = \beta_0 + \beta_1 x_1 + \beta_2 x_3 + \beta_3 x_1 x_3$$

$$\text{Thus; } E(Y|_{x_1, x_3=0}) = \beta_0 + \beta_1 x_1$$

$$\text{And; } E(Y|_{x_1, x_3=1}) = \beta_0 + \beta_1 x_1 + \beta_2 + \beta_3 x_1$$

$$\begin{aligned} \text{Hence, } E(Y|_{x_1, x_3=1}) - E(Y|_{x_1, x_3=0}) &= \beta_0 + \beta_1 x_1 + \beta_2 + \beta_3 x_1 - (\beta_0 + \beta_1 x_1) \\ &= \beta_2 + \beta_3 x_1 \end{aligned}$$

Where

$$E(Y|_{x_1, x_3=0}) = \beta_0 + \beta_1 x_1 \text{ is the expected C.G.P.A score giving that the student is in the}$$

Evening Session.

$$E(Y|_{x_1, x_3=1}) = \beta_0 + \beta_1 x_1 + \beta_2 + \beta_3 x_1 \text{ is the expected C.G.P.A score giving that the}$$

student is in the Morning Session.

$$E(Y|_{x_1, x_3=1}) - E(Y|_{x_1, x_3=0}) = \beta_2 + \beta_3 x_1$$

Now if $x_1 = 0$, it means that a student's SSCE score is equal to zero which obviously cannot be possible. It implies that β_3 is equal to -0.547266894 has no practical interpretation.

Findings

It was revealed that SSCE score is associated with the cumulative grade point average at 1% significant level, thus a student who enters Koforidua polytechnic with good SSCE score tend to obtain the good cumulative grade point average.

The estimated multiple linear regression with interaction, $y = 5.373017482 - 0.134852056x_1 - 0.547266894x_3 + 0.03454177x_1 * x_3$ shows that a unit decrease in SSCE score tend to be related with an increment of FCGPA

of – 0.13485, all other variables remaining constants. The study also revealed that students who attend the morning session tend to have better average obtain higher FCGPA than their evening counterparts.

Summary

The FCGPA of a student depends on a number of socio – economic, cultural, educational factors. In this study SSCE scores and “session” were found to be significantly related to students final cumulative grade point average (FCGPA). There may be other factors which may have direct effect on student FCGPA. This requires an elaborate study of the FCGPA of the students with multiple socio – economic factors by application of multiple regression analysis as suggested by Bickel (2007).

References

- Bournier, T. and Phile R. (1990.): *How to Win as a Part – time Student: A study Skills Guide*. (London: Inform Publishing Services Ltd,
- Dayioglu, M and Serap, T.(2004): “Gender Differences in Academic Performance in a large public University in Turkey.” ERC Working Papers in economics 04/17(December 2004)
<http://www.erc.metu.edu.tr/menu/series04/0417.pdf>
- Gordor B.K. and Howard N.K.(2000), *Element of Statistical Analysis*, (Accra; the city printers services limited,
- Hoskins, S. L, Newstead, S. E & Dennis, I. (1997): “Degree Performance as a function of age, gender, prior qualifications and discipline studied,” *Assessment & Evaluation in Higher Education in Higher Education*, 22,3.
- Glen, J. (2002): “Non – Academic Factors Affecting the Academic Success of Grenadian students at St. George’s University (SGU)”

CASSAVA AS A FEEDSTOCK FOR BIOETHANOL PRODUCTION IN GHANA

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The consumption of petrol from the transportation sector in Ghana increased from 606 thousand cubic metres in 1999 to 929 thousand cubic metres in 2009. With the growing demand for petrol there is a need to identify alternative sources of fuel to augment the current supply in this sector. Even though GHG emissions emitted from Ghana's transport sector is insignificant compared to those in developed countries, identification and development of renewable energy resource that are environmentally friendly, clean, and readily available is imperative. Fortunately, Ghana has identified bioethanol one of the potential biofuels in her energy mix and subsequently set targets in her Strategic National Energy Plan (SNEP). This paper suggests that cassava can be adopted as a potential feedstock for bioethanol production and further argues that net surplus of cassava produced in Ghana is enough to support the biofuel targets.

Keywords: Bioethanol; Ghana; Cassava; Net surplus; transport sector

Introduction

Biofuels technology is one of the technologies proven to address climate change. It has been reported that 51% of carbon savings was achieved by substituting 3.33% of UK's total road transport fuel by biofuels [1]. It has been reported that 2.1 Gt of CO₂ emissions could be avoided annually if biofuel is used as transport fuel [2]. Among the burgeoning importance of biofuels, it can be adopted as a tool by developing countries such as Ghana to support rural development through agriculture, however, Ghana has not taken advantage of its enormous biofuels resources. Major feedstocks that are available in Ghana that can be used for bioethanol production are cassava, sorghum, maize, e.t.c. Production and processing of cassava have received the needed attention through Presidential Special Initiative (PSI) to expand cassava production and also to revamp starch processing plants in Ghana. In addition it has been found that cassava can be cultivated on marginal land [3] and also Ghana is one of leading producers of cassava according to FAO statistics.

Unfortunately, some pundits have disagreed on the use of available land for the production of energy crops instead of food and have suggested that the production of energy crops in this manner can potentially increase in CO₂ emissions. As a result, it was recommended that a slowdown in the growth of biofuels was needed in order to address agricultural land use for energy crops and CO₂ emissions that emanate as a result of this activity [4]. However, another school of thought believes that biofuels technologies must be accelerated in order to meet 50% reduction of CO₂ by 2050 through 2nd generation of biofuels deployment which do not compete with land usage [2]. Fortunately, Ghana has a vast arable land which can sustain the production of energy crops and in addition this study will suggest the available feedstocks in Ghana that can suitably support biofuels policy.

There is enormous potential in biofuels technology if adopted Ghana can use to improve its economy and in order to achieve such benefits Ghana can learn from Brazil and the USA which are world leaders of biofuel production and also enjoying the benefits from biofuels technology. In order to adopt biofuels technology, energy crops that available in Ghana must be identified and assessed to enable a sustained production of biofuel. In view of the biofuel policy as stipulated in the SNEP document, energy crops available in Ghana are identified and examined. The quantities of the feedstocks are assessed in order to predict the sustainability of ethanol production in Ghana and it is very important to address bioethanol potential in Ghana to guide policies on biofuel.

Petrol Consumption and Bioethanol Potential Estimation

Petrol Consumption and Biofuel Policy

Crude oil was discovered in commercial quantities in 2007 and its first oil share of 995,259 barrels was lifted in 2011 and an average of 35,374 barrels per day oil was produced it was expected to reach the maximum of 120,000 bbl/d by the end of 2011 [5]. However, all the crude oil consumed domestically is imported from Nigeria and Equatorial Guinea which means that Ghana still depends on other countries for crude oil to run Ghana's economy. As part of the biofuel policy, B5 and E10 was to be introduced in 2008, the introduction of B10 and

E20 into the oil market in 2012, introduce E85 and make B5, B10 and E10 mandatory in 2020 [6]. The amount petrol consumed from 1999 to 2009 was adapted from National Petroleum Authority (NPA) and base on biofuel policy, 10%, 20% and 85% of petrol consumption was calculated and used for this study. Additionally, the projected petrol consumption in 2012 and 2020 was adopted from SNEP document. Petrol consumption is summarized in Table 1 and as can be seen 472, 532 tonnes of petrol was consumed in 1999, however, it increased to 738,561 tonnes in 2009. In order to implement the E10 and E20 policy, about 53,721 tonnes and 107,442 of ethanol would be needed respectively to replace the amount of petrol consumed in 2008. The projected amount of petrol that would be consumed in 2015 and 2020 would be 970,000 and 1,200,000 tonnes respectively. In order to introduce E85 in 2020, about 1,020,000 would be needed replace 85% of petrol that would be consumed.

Table 2: Petrol consumption and ethanol replacement scenarios (tonnes) [7]

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2012	2015	2020
A	472,532	552,146	563,454	600,415	505,254	606,128	566,299	539,063	573,077	537,212	738,561	825,000	970,000	1,200,000
B	47,253	55,215	56,345	60,042	50,525	60,613	56,630	53,906	57,308	53,721	73,856	82,500	97,000	120,000
C	94,506	110,429	112,691	120,083	101,051	121,226	113,260	107,813	114,615	107,442	147,712	165,000	194,000	240,000
D	401,652	469,324	478,936	510,353	429,466	515,209	481,354	458,204	487,115	456,630	627,777	701,250	824,500	1,020,000

A=Petrol consumption, B=10% replacement scenario, C=20% replacement scenario, D=85% replacement scenario

Potential Feedstocks Production

The process of producing ethanol can be classified into first generation or second generation.

The production of ethanol from fermentable sugars which are extracted from food sources-mainly starchy feedstocks or sugar feedstocks- is termed as first generation while the production of ethanol from lignocellulosic feedstocks such as barley straw, corn stover, bagasse, wheat straw, rice straw, e.t.c., is termed second generation. However there is an emerging technique of producing alcohol from algae. The production of ethanol from lignocellulosic feedstocks and algae are still at development stages and are not economically competitive. This study will focus on first generation since Ghana has no technological 'know how' for the second and third generations in addition it is important to note that first generation of ethanol is recommended for developing countries [2, 8] since it is likely to support rural development and also the feedstocks for producing first generation ethanol are in abundant in Ghana. In identifying major the crops in Ghana, the statistics on production of major crops grown in Ghana from 1999 to 2009 adapted from Ministry of Food and Agriculture were used for this study. The production of potential energy crops that are grown in Ghana are summarized in Table 2. The total production of major crops grown in Ghana were 16,660,000 MT in 1999 but increased to 25,919,000 MT in 2009 representing an increment of 55.6%.

Table 4: Productions of major crops grown in Ghana ('000 MT)[9]

Crop	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Maize	1,015	1,013	938	1,400	1,289	1,158	1,171	1,189	1,220	1,470	1,620
Millet	160	169	134	159	176	144	185	165	113	194	246
Rice (paddy)	210	215	253	280	239	242	237	250	185	302	391
Rice (milled)	126	129	152	168	143	145	142	150	111	181	235
Sorghum	302	280	280	316	338	287	305	315	155	331	351
Cassava	7,845	8,107	8,966	9,731	10,239	9,739	9,567	9,638	10,218	11,351	12,231
Cocoyam	1,707	1,625	1,688	1,860	1,805	1,716	1,686	1,660	1,690	1,688	1,504
Plantain	2,046	1,932	2,074	2,279	2,329	2,381	2,792	2,900	3,234	3,338	3,563
Yam	3,249	3,363	3,547	3,900	3,813	3,892	3,923	4,288	4,376	4,895	5,778
Total	16,660	16,833	18,032	20,093	20,371	19,704	20,008	20,555	21,302	23,750	25,919

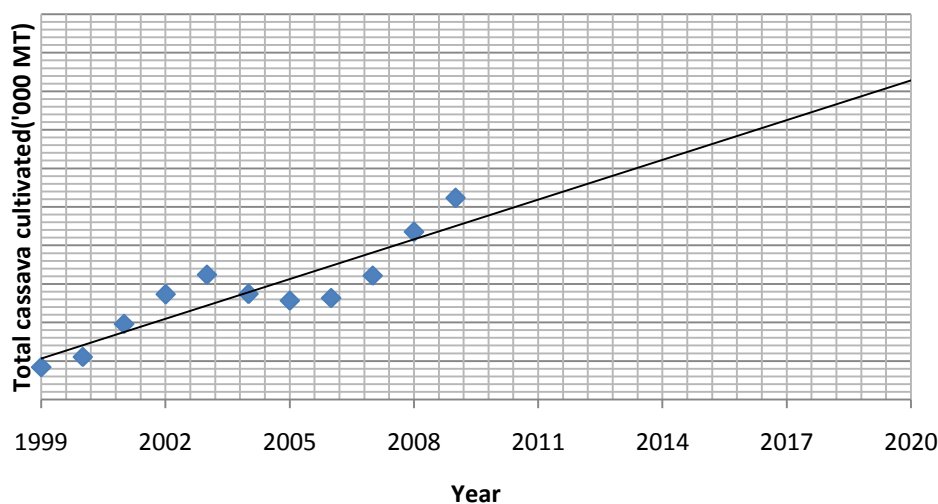


Figure 17: Total cassava cultivated from 1999 to 2009 and projected cassava cultivated

Fig 1 depicts cassava cultivated from 1999 to 2009 based on the MOFA statistics. In order to predict the future cultivated cassava, a linear curve fit was developed. The model developed has a R^2 (coefficient of determination) value of 0.804 which indicates that the model has 80% reliability of predicting the future production of cassava. Based on this model, cassava production will be about 12,534,000 MT, 13,565,000 MT and 15,283,000 MT in 2012, 2015 and 2020 respectively.

$$C_p = 343(\text{year} - 1999) + 8,066; R^2 = 0.804$$

(1)

Where C_p is the production of cassava ('000 MT)

Estimation of Ethanol Potential

The process of producing first generation ethanol includes preparation stage, liquefaction, fermentation, distillation and dehydration as depicted in Figure 2 below.

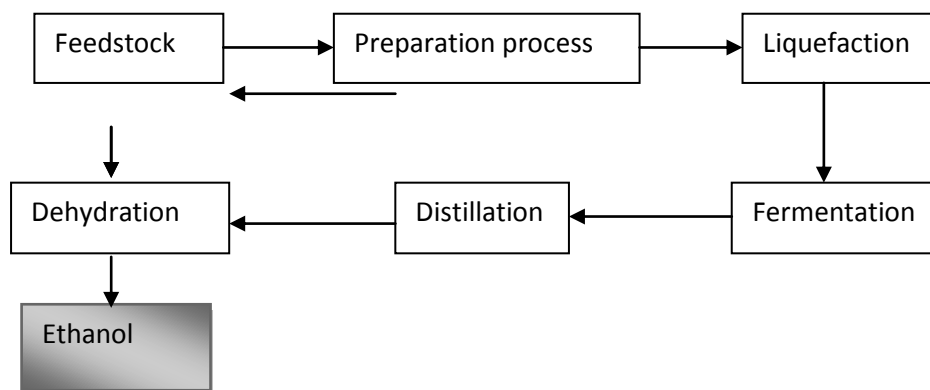
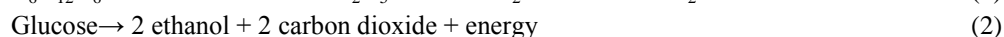
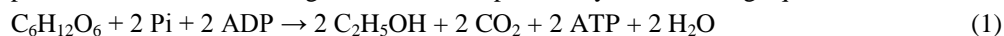


Figure 18: Ethanol production process

In principle ethanol can be produced from fermentable sugars extracted from energy crops and in the simplest form, production of ethanol from glucose can be expressed by the following equations:



It means that from equation 2, it can be calculated that the theoretical yield is 0.511 g ethanol produced per gram of glucose consumed and upon hydrolysis and 1 g of starch produces 1.11 g of glucose. This yield can never be realized in practice since not all of the glucose consumed is converted to ethanol but part of it is used for cell mass synthesis, cell maintenance, and production of by-products such as glycerol, acetic acid, lactic acid, and succinic acid [10]. Under ideal conditions, however, 90 to 95 percent of the theoretical yield can be achieved [11]. In calculating the amount of ethanol that can be produced from a certain feedstock, the parameters used are summarized in Table 3.

Table 4: Properties of some potential energy crops in Ghana

	Starch content (%)	Ethanol yield (kg/kg feedstock)
Cassava	22[10]	0.125
Yam	19[12]	0.108
Maize	61.7[13]	0.35

Results and Discussions

Feedstocks Available in Ghana

In order to embark on the production of ethanol it is very critical to identify the feedstocks and their quantities available to make bioethanol production sustainable. Figure 2 shows the total cumulative production of major crops between 1999 and 2009. As can be seen, the highest production was that of cassava with 48% of the total production of major crops followed by yam with 20% and plantain with 13% of cumulative production. The obvious and prudent feedstock of choice for producing ethanol is cassava. This is an indication showing that cassava is mostly cultivated compared to other major crops in Ghana and this is due to the fact that cassava has received the needed attention through the introduction of Presidential Special Initiatives that was implemented in 2002[14] and have resulted in high levels of cassava production.

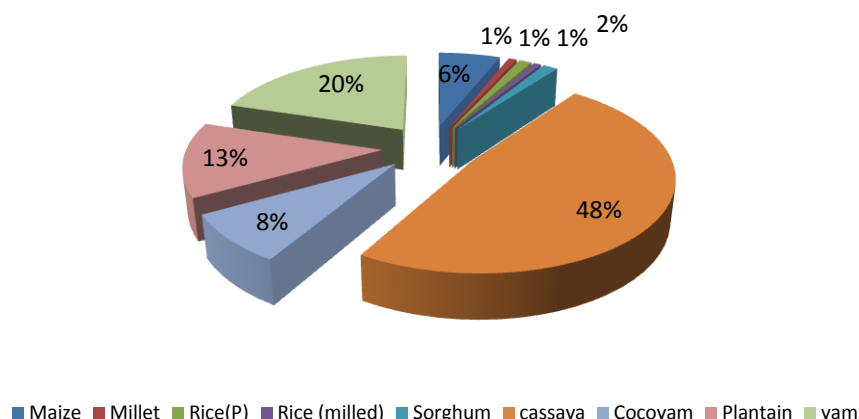


Figure 19: Cumulative production of major crops from 1999 to 2009 in Ghana

The major concern about first generation ethanol is the competition with food [15], however, based on food statistics from MOFA it was reported that the net surplus of cassava was 2,433,000 MT in 2002 [16] and this increased to 4,889,087 MT in 2009 [17] representing 25% and 40% of the total cassava production respectively while the amount of cassava that was consumed as food represents an average of 45% of the total production between 2000 and 2007 [18]. However, the amount of yam that was consumed as food was about 66% of the total production within the same period. This shows that bulk of yam produced is consumed as food and this could hamper food

security if yam is considered as a feedstock for producing ethanol if care is not taken. Similar situation could occur if maize is considered because maize is in short supply compared to other major crops and also in 2002, about 213,000 MT maize was imported into Ghana [16] but this decreased 34,000 MT in 2009 [17]. In order to increase yam and maize production to support bioethanol production, there is a need for government to intervene through agricultural policies to increase the yield of yam and maize and also best farming practices must be investigated and be introduced to farmers for implementation.

Bioethanol Potential and Petrol Replacement Scenarios

Based on the biofuel policy, the estimated amount of petrol needed to be replaced by ethanol for the different scenarios is shown in Table 1. The ethanol equivalent of petrol needed to replace 10%, 20% and 85% is shown in Figure 4. As shown in Figure 4, about 88,103 tonnes and 176,205 tonnes would be needed to respectively replace 10% and 20% of petrol consumed in 2008. However, it will increase to about 135,000 tonnes and 270,600 tonnes respectively for 10% and 20% of petrol consumed in 2012 and further increase to 196,800 tonnes and 393,600 tonnes of ethanol respectively in 2020 when E10 and E20 will be mandatory. However, the introduction of E85 in 2020 will require an amount of 1,672,800 tonnes of ethanol.

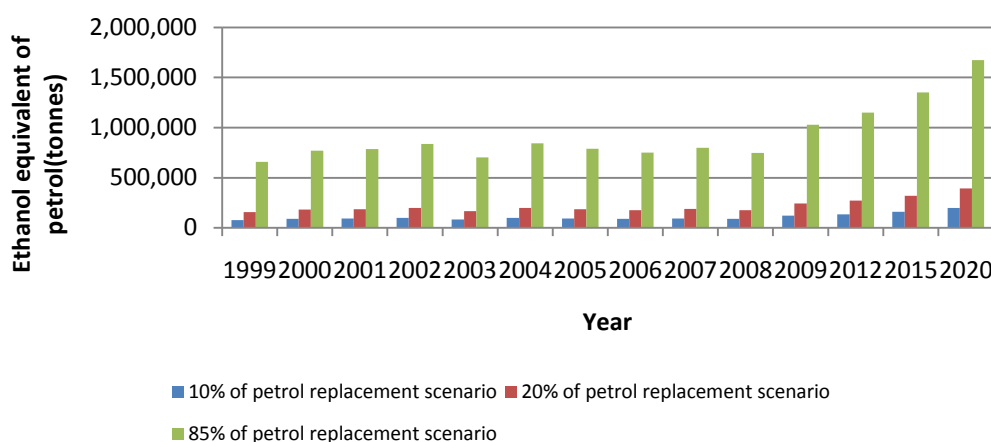


Figure 20: Petrol consumption replacement scenarios

The amount of ethanol needed to replace the various percentages might look available, however, the quantity of cassava needed to support ethanol production in order to meet the stipulated targets will play key role in terms of sustainability. Figure 5 shows the percentage of cassava to produce the needed ethanol that will replace 10%, 20% and 85% of petrol consumptions. About 6.2% and 12.4% of the total cassava produced in 2008 would be needed to meet E10 and E20. Furthermore, this will increase to 8.6% and 17.3% respectively for E10 and E20 in 2012. About 10.3% and 20.6% of the total cassava that will be produced in 2020, however, a gigantic quantity that correspond to 86.7% of the total cassava will be produced will be needed to meet E85 in the year of its introduction to the market. Clearly, the introduction of E85 into the oil market will compete with food and this will be unacceptable since this will cause this price of this commodity to shoot up. The amount of cassava needed for ethanol production to meet E10 and E20 seems sustainable and Ghana as a developing country can fully implement the stipulated targets, however, E85 seems ambitious and must be reconsidered.

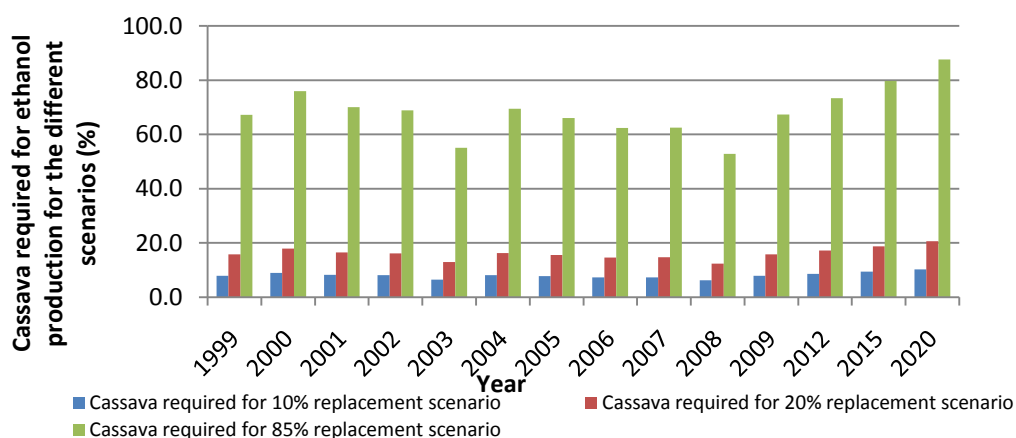


Figure 21: Cassava needed for Ethanol Production

Cassava as a feedstock for ethanol production will not hamper food security in Ghana. The net surpluses according to MOFA statistics in 2002, 2009 and 2010 are 2,433,000 MT, 4,889,087 MT and 5,749,164 MT [19] respectively and representing 25%, 40% and 43% of the total cassava productions respectively. Obviously in order to meet the set targets encapsulated in the biofuel policy, the net surpluses of cassava can sufficiently support the needed ethanol production.

Subsidy plays an important role in bioethanol production, for instance, bioethanol is produced in Brazil and the US by subsidies. More than \$6 billion per year is subsidized for ethanol production in the US. The subsidy per gallon of ethanol in the US is 60 times higher than the subsidies per gallon of gasoline [20]. This is done deliberately to promote the production of ethanol locally. This potential increases ethanol production and also reduces dependence of oil import. Fortunately, steps in that direction have been taken in Ghana to promote the production of ethanol and also creates the demand for bioethanol [21]. The rationale of adopting of biofuels as transport fuels differs from one country to another country but collectively is adopted to ensure energy security, reduction in over dependence on imported oil, decreasing the oil import bill and ultimately mitigate climate change. The focus of Ghana implementing biofuel policy is to support its energy needs, decrease its oil import bill and also provide supports for rural folks through agriculture, however, it can help reduce global CO₂ emissions in a small way.

Conclusion

Ghana must find alternative fuels to support the transport sector even though the volumes of petrol consumed in Ghana are not that substantial, however, in order to meet the future growth in demand of petrol consumption which will be inevitable alternative fuels such as ethanol will play a key role in socio-economic developments.

The three major crops that were identified were cassava, yam and maize, however, cassava looks promising since it is widely grown in Ghana in large quantities compared to yam and maize. In addition to avoid the competition of cassava usage for energy against food, the net surpluses of cassava must be the basis of producing ethanol. Based on the analysis, the net surpluses are more than enough to produce ethanol needed to introduce E10, E20 and make them mandatory.

However, the introduction of E85 in the oil market in 2020 will hamper food security and hence increase the price of cassava. For Ghana to meet E85 cassava of higher starch content must be cultivated and also improve farm management to increase yield of cassava per hectare of land. Ghana can also increase feedstocks base for ethanol production by considering other feedstocks such as yam, maize and sugar.

References

- Renewable Fuel Agency. Biofuels data highlights industry successes and shortcoming. Renewable Fuel Digest ,July 2010 issue

- IEA. Technology Roadmap Biofuels for Transport, International Energy Agency (IEA), Paris; 2011
- Dai D, Hu Z, Pu G, Li H and Wang C. Energy efficiency and potentials of cassava fuel ethanol in Guangxi region of China. *Energy Conversion and Management*; 2006, 47(13-14): 1686–1699
- Renewable Fuels Agency. The Gallagher Review of the indirect effects of biofuels production [cited 02.03.12]. Renewable Fuels Agency (RFA); July 2008 Available at:
http://www.unido.org/fileadmin/user_media/UNIDO_Header_Site/Subsites/Green_Industry_Asia_Conference_Maanila_GC13/Gallagher_Report.pdf.
- Ghana Energy Commission. 2011 Energy (Supply and Demand) Outlook for Ghana [cited 03.03.12].; April 2011. Available at: <http://new.energycom.gov.gh/downloads/2011Energy%20Outlook.pdf>
- Strategic National Energy Plan (SNEP). 2006-2020 and Ghana energy policy. Ghana: Ghana Energy Commission; 2006.
- NPA. NATIONAL CONSUMPTION 1999 – 2009. National Petroleum Authority [Cited: 03.03.2012]. Available at: http://www.npa.gov.gh/npa_new/index.php
- Howes P, Bates J, Jamieson C, O'Brien S, Webb J, Barker N, Sajwaj T, Pridmore A, Wiggins S, Leturque H, Dale N. Biofuels Research Gap Analysis, Atomic Energy Agency (AEA); July 2009
- Statistical, Research and Information Directorate. Agriculture in Ghana Facts and Figures (2009)[Cited:03.03.2012], MOFA, December 2010 Available at:
<http://foodsecurityghana.com/wpcontent/uploads/2011/03/AGRICULTURE-IN-GHANA-2009.pdf>.
- Drapcho C M, Nhua P N. Walker T H. Biofuels Engineering Process Technology. 1st ed. McGraw Hill, New York; 2008
- Thomas, K. C., S. H. Hynes, and W. M. Ingledew. 1996. Practical and theoretical considerations in the production of high concentrations of alcohol by fermentation.” *Process Biochem.* 31:321–331
- Chukwu G O, Ezenwa M I S, Osunde A, Asiedu R and Ogbogu N J. Qualities of yam tubers grown on typic paleudults: hybrid yam and fertilizer effects. *Scientific Research and Essay*; 2007, 2(12):508-511
- International Starch Institute [cited 04.03.12]. Available at: <http://www.starch.dk/isi/starch/maize.asp>
- Ennin S A, Otoo E and Tetteh F M. Ridging, a Mechanized Alternative to Mounding for Yam and Cassava Production. *West Africa Journal of Applied Ecology*; 2009, 15(1)
- Crosse J. The Challenge of Biofuels. *Ricardo Quarterly Review*; Q1, 2008
- Asante A. Assessment of food import and food aid against support for Agricultural Development. Ministry of Food and Agriculture (MOFA); 2004.
- Statistics, Research and Information Directorate, Agriculture in Ghana: Facts and Figures (2009). Ministry of Food and Agriculture (MOFA); 2010.
- FAO. Production [cited 06.03.12].FAOSTAT, Statistics Division, Food and Agriculture Organization of the UN www.fao.org; 2012. Available at: <http://faostat.fao.org/site/339/default.aspx>. ; 2012.
- Statistics, Research and Information Directorate, Agriculture in Ghana: Facts and Figures (2010). Ministry of Food and Agriculture (MOFA); 2011.
- Balat M, Balat H, Oz C. Progress in bioethanol processing. *Progress in Energy and Combustion Science* ; 2008, 34(5):551-573
- Ghana Energy Commission. Bioenergy policy for Ghana [cited 07.03.12].; August 2010, Available at: <http://new.energycom.gov.gh/downloads/BIOENERGY.pdf>.

ASSESSING THE EFFECTS OF PACKAGING MATERIALS ON THE MOISTURE CONTENT AND SURFACE FINISH OF PACKAGED FURNITURE PRODUCTS

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The study investigated the effects of packaging materials on moisture content and surface finish of Furniture products. Unfinished, semi-finished, and finished furniture parts were packaged for two, four and six weeks using five different packaging materials. Four hundred and fifty (450) strips were prepared from Iroko (*millicia excelsia*). Five different packaging materials were selected for the three levels of furniture parts after which a change in moisture contents and colour were determined. The mean moisture content (%) changes determined on unfinished furniture parts with plastic, cardboard, metallic, plastic plus cardboard (PC) and plastic plus cardboard and metallic (PCM) showed a rise in MC with plastic and cardboard showing highest(2.26%) and lowest(0.37%) respectively while in semi-finished furniture parts, PC and metallic recorded the highest and least of 1.72% and 0.65% respectively. However, cardboard recorded 0.12% upon the initial moisture content whiles metallic and cardboard packaging recorded the highest and the least rise in MC of 2.21% and 0.14% respectively for finished furniture parts. It was concluded that cardboard is the superior packaging material with the lowest MC increase throughout the three time levels.

Keywords: Packaging; Furniture; Plastic; Cardboard; Metallic Materials.

Introduction

The Furniture Industry in Ghana

In recent times, there has been a rapid development in the processing of furniture in Ghana as a result of increase development in technology. A typical example is the American technology for processing small diameter logs from both natural forests and plantations with wood mizer mills (Okai, 2002) that is gaining popularity in the country. In Ashanti and Brong Ahafo Regions, wood mizer mills have been purchased and installed in most companies. These companies stand the chance of turning lumber into finished products such as furniture for domestic and export markets.

In addition, the use of computer-aided design of furniture is catching up with most furniture producing companies in the country. According to the International Tropical Timber Organization (ITTO) there are about 600 small to medium scale furniture producers in the country with the bulk in Kumasi (ITTO, 2004). Most of the workers of these companies received their training from the numerous Technical Institutions, Polytechnics, Intermediate Technology Transfer Units and the informal apprenticeship training centres in the country.

Regrettably, there has been a considerable decline in the export of timber products including furniture. In the 1970s there was a sharp decline in the output of furniture exports which was attributed to the general poor state of the economy in the 1970s and early 1980s, obsolescence and continuous breakdown of logging and processing equipment, poor packaging, the over-valued exchange rate, inadequate transport and poor state of rail and harbour facilities, (Baidoe,1987).

Since 1989, the export performance of furniture industry has not been encouraging. Furniture export statistics for 1990 indicates that Ghana earned USD 3,620,379.00 showing 1.86% increase on the 1989 furniture export earning of USD 3,554,270.00 (Appiah, 1990).

The international furniture trade is valued at \$67 billion and is expected to grow in future because of the encouraging retail market prospects from the USA and Europe, the two largest furniture markets (Ratnasingam, 1998). Unfortunately, the export volume of furniture in 2000 was decreased as against the past performance. The export volume dropped by 8.13% from 2720m³ in 1999 to 2499m³ in 2000.

Data available from the Timber Industry Development Division (TIDD) of the Forestry Commission indicates that contracts for a volume of 2,475 pieces of furniture parts were processed and approved for export during the fourth quarter of 2009. There was a sharp increase in furniture parts export as a result of two major parts shipments for the Togolese market undertaken by Portal Limited, a Takoradi based timber firm. The TIDD report indicates that Mim Scanstyle Ltd, once the major furniture parts exporter, submitted almost no contracts for export approval during the same period (TIDD, 2009).

The poor export performance of the furniture industry since 1989 to the present shows that the industry is still facing serious problems. Among the numerous problems identified was difficulty in packaging the furniture. Traditionally, the primary function of packaging is to contain and protect the product (Kotler, 1984). Improving packaging is often limited by a perceived increase in packaging material purchase costs

Furniture is inherently predisposed to damage during transit and delivery. Damaged goods are unacceptable to consumers and the producer must therefore either scrap the items or undertake costly and time-consuming repairs which lead to high losses to the industry.

The purpose of this study was to investigate the effects of five packaging materials on the moisture content and the surface finish of the packaged furniture and to make recommendations on the most appropriate materials and method for packaging furniture.

Information gathered from interviews and questionnaires administered to the furniture companies that export furniture revealed that they are faced with problems associated with packaging such as moisture changes and discolouration of the surface finish. In this respect, the study when undertaken successfully will help to achieve this ultimate goal by way of prescribing improved methods and materials for packaging furniture by the industries.

The research will also lead to the reduction of the number of damages experienced by furniture exporters in order to reduce the amount of compensations paid on defective goods and thereby maximizing their profit. Moreover, the study will help bring about sustainable utilization of our limited forest resources.

Furniture Produced in Ghana

Page (1973) states that the bulk of furniture produced by all sector in the import-substituting sector of the industry consists of wooden and upholstered furnishings, designed for domestic and commercial use. According to Prempeh (1993), furniture is fully assembled, finished and upholstered before sale on the local market; for the large firms in the export market, like Scanstyle Mim Limited, produce knocked down furniture also called demountable or packaged furniture (Gloag, 1969) and the range consists of garden chairs of all kinds, indoor chairs and occasional furniture.

Knocked down processing allows for better-packed and less breakage in transit. It also promotes compact storage in the warehouse, making handling very easy and increasing the strength of the joint. Unfortunately, the nature of knocked down processing allows firms to avoid the use of heavily protected and locally produced inputs such as primary paints, lacquers and fabrics.

Packaging of Furniture

Human beings have always protected food and drink in containers, using skins, leaves, and gourds, and then baskets, pottery, as early as 1500 BC (Covell, 2002). According to Willinston (1988), proprietary products such as panels and furniture parts for the shoulder trade were also packed in individual cartons. The trend of packaging and branding will continue in the foreseeable future.

Packaging is the technology used to contain, protect, and preserve products throughout their distribution, storage and handling, and at the same time to identify them, provide instructions for their use, and promote them (Covell, 2002).

Packaging may include the product's primary package or container, secondary package and the tertiary or shipping package. Recently, labelling and printed information appearing on the package is also part of packaging.

Materials for Packaging Furniture

A wide range of materials from "tamperproof" to "waterproof" devices is in use as packaging materials. Common ones in use are cellophane (plastic film), polyethylene, plywood, solid wood, shredded paper, wood wool, cellulose wadding, corrugated cardboard, foam, polystyrene (Styrofoam), natural and synthetic papers, plastic and metallic containers. Some of these materials act as accessories to the main pack.

Sawn wood or lumber has a wide range of different end uses. The various end uses are from construction to repairs, packaging, furniture, etc (Amoako, 1993). Wood intended for furniture production must be kiln dried to a very low moisture content of about 8 to 12 % (Rietz 1957). A few of the more important reasons according to Rietz are that seasoning reduces imparts dimensional stability, increases most strength properties etc.

Most of the small and medium scale furniture manufacturing industries all over the country use air seasoned lumber. Some companies even use processed timber with high moisture content and in fact, some finished products in the form of furniture, doors and windows are being processed from the green lumber. However, green timber may contain a sizeable amount of moisture. So far, only the large scale furniture companies like SCANSTYLE Mim Ltd and DUPAUL employ the use of kiln in drying the timber for furniture construction

Cardboard is one of the widely used packaging materials in the world. According to Pröyry (2003), the exportation of paper and paperboard from the North America and Europe to the other parts of the world is high and it will continue to increase till the year 2015. Unfortunately paper based (board) packaging components are subject to deterioration and reduced performance through ingress of moisture. Corrugated and board sheet material should be stored flat if kept for prolonged periods (FIET, 2001).

Plastic packaging materials come in the form of cellophane, foam, polystyrene and polyethylene. These can be thermoplastic or thermosetting. The thermoplastic such as the polyethylene is the most common. They are described as linear polymers, straight chained -though may branch occasionally and crystalline. This is why they soften if the plastic is heated (Metcalf *et al*, 1966). But some like the polystyrene are amorphous which makes it not having a sharp melting point. According to Ashby and Jones (1998), polyethylene and the polystyrene are the common plastics in use in the packaging industry. Plastics have a mechanical property of being less stiff, lower density, lower strength and with less hardness. These properties may deteriorate rapidly with quite small increase in temperature (Bolton 1988). According to FIET (2001), plastic packaging materials and components are less affected by ambient environment, temperature and humidity fluctuations, but they should be dry before use.

The basic metallic materials used in the packaging industry are aluminium and steel. Metallic container is advantageous in exportation of furniture as it is locked against pilfering and sealed against the weather, usual packing requirements are relaxed, and the freight is billed as a volume shipment. Damage claims on container cargo have been found to be much lower, and pilfering has been almost eliminated (Covell, 2002).

Forms of Damage

Breakage is a common form of damage to furniture legs, cornices, doors, glass panels, and chair arms. Breakage is mostly caused by impacts either by shock or by drop; if products are consistently damaged in this way during transport and storage, more cushioning should be applied to the vulnerable component or alternative product delivery options

Bruising is also the result of impact, probably a less severe impact than would cause component breakage. Bruising is generally the result of inadequate cushioned coverage, particularly along the edges, around the corners, and over the flat panel surfaces of the furniture unit.

Scratching occurs when a packaged piece of furniture comes into contact with a sharp edge or point. This may be a protruding bolt inside a vehicle, a door handle in the warehouse or factory, or the handle of another piece of furniture, which is inadequately protected. Scratching is also caused within knocked-down furniture by dust and dirt, loose fittings, screws, handles or other components which are allowed to move about within the pack during transport and handling. Scratching can also happen when a package is being opened by customers or their agents. Corrugated cases are often sealed by pressure-sensitive tape, and anyone trying to open these cases is tempted to use a knife or other sharp blade to slit the tape, unaware that a vulnerable finished surface lies just beneath. A piece of stout board underneath the taped joint can help.

Abrasion is a particular problem in packages containing knocked-down furniture. It occurs whenever finished timber comes into contact with an unsuitable packaging material or with another abrasive component within the same package. It may also be caused by sudden shocks, vibrations, effects of changes in moisture content and temperature.

Discolouration

Natural wood surfaces, both solid and veneers, are liable to change colour when exposed to natural light. The stronger the light, the greater the colour change. (Kellogg and Meyer, 1982). This may not be a problem if the whole unit or panel is exposed, because when the article is in use it will age naturally. However, if only part of the unit is exposed, the colour variations between the exposed and unexposed portions may prove unacceptable to the purchaser, despite the fact that in time the colour differences will disappear.

Climatic conditions have detrimental effects on the surface finish of the packaged furniture products. Moisture, dehydration and temperature damage can take a variety of forms. High temperatures can cause softening of adhesives (Kollman and Côte, 1984) and lacquers. It is easy for lacquers to mark if they become soft whilst in contact with even the least abrasive packaging material, and harder packaging materials, such as single-faced or double-faced corrugated fibreboard, may cause severe marking.

Furniture makers have little control over the environment in which their products will be transported or stored, so it is important to make the package as weather resistant as possible. Enclosing the article in a plastic (polyethylene) bag can help.

Methodology

The materials which were used for the study were plastic sheets for waterproofing, corrugated paperboard for shock and vibration proof metallic container for tamper proofing, electronic moisture meter, samples of *Millicia excelsia* (Iroko), sellotape and a marker. The electronic moisturemeter (capacitance type) was used to measure the moisture content of the wood samples.

Kiln dried samples of *Millicia excelsia* (Iroko) were selected for the study. Sellotape was also used to seal the plastic and cardboard packs. The waterproof marker was used to mark all selected samples to ensure easy identification.

The study was carried out at two different sites – Scanstyle Mim Company Limited and Bibiani Logs and Lumber Company (BLLC). Mim was selected because it is one of the biggest mills in the country and also the leading exporter of furniture. BLLC was also selected because of its large concession in *Millicia excelsia* (Iroko) predominant forest district of the country. It also has a modern computerised kiln.

Feasibility studies carried out at the mills also indicated that availability of logs for processing was not a problem and the companies had enough selected species for the study. The two companies were also ready to release information and samples for the study. The Faculty of Renewable Natural Resources' Workshop of Kwame Nkrumah University of Science and technology, Kumasi was used for the execution of the project.

Millicia excelsia (Iroko) was selected for the study because the initial survey of the company revealed that contracts for immediate processing demanded this species and was the leading species in the exportation of furniture in the country. In addition, the logs were available in sufficient quantities to ensure easy access to the material.

Kiln dried samples of *Millicia excelsia* (Iroko) were planed and sawn into dimensions of $20 \times 20 \times 100$ mm strips. Four hundred and fifty (450) strips were prepared and sanded. These were divided into three groups: unfinished, semi-finished and finished furniture parts of one hundred and fifty (150) strips each.

The unfinished furniture was made up of smoothly sanded strips without any protective coating. Sanding sealer was applied to the semi-finished furniture and the finished furniture received both sanding sealer and lacquer. After preparation, specimens were marked using waterproof ink to identify them.

Five different packaging materials were selected based on their use by the furniture companies and their availability. These were plastic sheet (P), cardboard (C), metallic container (M), a combination of plastic and cardboard (PC) and a combination of plastic, cardboard and metallic container (PCM).

These materials were thoroughly checked for any perforations and defects. They were later cut to size to suit the volume of samples to be packaged.

After preparing the specimens, the initial moisture content was taken with the capacitance type moisturemeter at room temperature (25°C). The average prevailing temperature and relative humidity at the workshop during the period of the experiment were 27.9°C and 73.6% respectively. Every specimen was tested and photographed with a digital camera to ascertain the initial colour, after which they were immediately packaged.

Each group was made up ten (10) replicates for each packaging method. For instance, a pack containing ten specimens (replicates) of unfinished furniture parts was packaged in plastic sheet. This was repeated for other packages.

The set-ups were then stored for periods of two (2), four (4) and six (6) weeks under the then prevailing weather conditions. These three time levels were selected based on the length of time that products usually remain in the pack. A product for local consumption stays in the pack for a maximum of two weeks before they are unwrapped. The four week time level was also based on the maximum period it takes for shipping a product to the international market. Finally, a product upon reaching their destinations takes a maximum of six weeks before they are unwrapped.

After each period, the specimens were unwrapped and the moisture content quickly taken to determine the moisture content differences. Photographs were also taken at each period with the same digital camera and used to compare with the initial colour to determine any change in colour of the surface finish based on colour constancy.

The means and standard deviations of the data were determined. Descriptive analysis was used to discuss all the results and a comparative analysis was used to describe the differences in colour of the surface finish.

The experimental design used was split plot in complete randomized design (CRD). The data was subjected to the analysis of variance (ANOVA); and F-test at 1% and 5% significance were used to find out if there were significant differences in mean moisture changes in the five different packaging materials, time and the interaction between packaging materials and time.

Regression analysis was also carried out to determine the correlation between the time of packaging and the change in moisture content of furniture parts packaged using the various packaging materials.

Colour chart was also used to aid in the visual comparison of colours of the initial and final surface finish of the furniture parts.

Results

Effect of packaging materials on the moisture content of furniture parts

The results of the effect of packaging materials on the moisture content(MC%) of furniture parts from Iroko (*Milicia excelsia*) within the three different time levels of 2, 4 and 6 weeks were obtained as shown with the example below:

Table 1: Effect of plastic material on the moisture content of an unfinished furniture parts

Duration		Replications										Mean		SD	
(Weeks)		1	2	3	4	5	6	7	8	9	10				
2	A	8.8	10.3	10.4	9.8	9.5	8.7	9.8	9.5	9.2	10.1				
	B	10.1	12.4	11.4	11.8	11.8	10	10.7	10.9	11	11.1				
	C	1.3	2.1	1	2	2.3	1.3	0.9	1.4	1.8	1	1.15	0.504315		
4	A	9.5	10.1	9.9	10.3	10.1	9.8	9.8	10.1	9.5	9.4				
	B	10.8	11.1	10.7	11.1	11.1	11.1	10.9	11.1	10.8	10.7				
	C	1.3	1	0.8	0.8	1	1.3	1.1	1	1.3	1.3	1.09	0.202485		
6	A	9.1	9.2	9.8	9.2	9.8	9.4	9.4	9.2	9.2	9.1				
	B	10	10.7	10.6	10.1	10.3	10.3	10.5	10.3	10.4	10.8				
	C	0.9	1.5	0.8	0.9	0.5	0.9	1.1	1.1	1.2	1.7	1.06	0.347051		

A=MC (%) after packaging; B=MC(%) before packaging; C=change in MC(%); Positive values=rise in MC(%)

The results obtained from the effects of the five different packaging materials on the moisture content of unfinished furniture parts from Iroko (*Milicia excelsia*) indicates that all samples recorded higher MC as compared to MC before packaging except metallic(3.33%) and PCM (13.33%) packaging that recorded a drop in moisture content. The standard deviation (SD) also showed a high variability in the MC of specimens that went through all the five packaging materials.

It was also realised that a higher mean MC was recorded for two weeks packaging with plastic (1.51%) and metallic(1.53%) packaging while cardboard, PC and PCM recorded higher moisture contents at the six weeks packaging (0.98%,1.79% and1.14% respectively). Plastic and metallic packaging recorded the least mean moisture contents of 1.06% and 0.74% respectively in the week six while cardboard, PC and PCM recorded least mean MCs of 0.84%, 1.13% and 0.72% respectively in the fourth week.

In the case of semi-finished furniture parts, a higher mean MC was recorded for the samples that underwent two and four weeks packaging with plastic (1.88%) and cardboard (1.45%) materials respectively while metallic, PC and PCM recorded higher MC at the six weeks packaging (2.21%, 1.86% and 1.57% respectively). of cardboard, metallic and PC packaging respectively that recorded a drop in MC. The SD also showed a high variability in the MC of specimens that went through all the five packaging materials. plastic and cardboard packaging recorded the least mean MC of 0.88% and 0.14% respectively in the six weeks while PC recorded least mean MC of 0.65% and metallic and PMC, 0.65% and 1.09% respectively in the fourth week.

The results obtained from the effects of the five different packaging material on the MC of finished furniture parts also showed a higher mean MC recorded for the samples that underwent two weeks packaging with plastic (2.26%) and cardboard (0.37%), metallic (2.02%) and PC (1.9%) materials while PCM recorded higher mean MC of 2.07 in the sixth week. However, plastic and PC packaging recorded the least mean MC of 0.88% and 0.14% respectively in the six week, while cardboard, metallic packaging also recorded least MC of 0.12% and 0.65%respectively in the week four, and PMC recorded least MC of 1.16% in week two.

Discussions

Effect of Packaging Materials on Moisture Content of Unfinished Furniture Parts.

In the experiment conducted in this study, the plastic packaging showed a significant increase in moisture content of the unfinished furniture parts with time as shown in Figure 1. The general practice in many of the industries is to wrap their unfinished furniture parts with plastic sheets with the view of protecting them from moisture absorption in the course of transit or at the warehouse. Unfortunately, pressure build-ups in the plastic wrapped cases, and can easily cause the furniture to absorb the little moisture in the enclosed air.

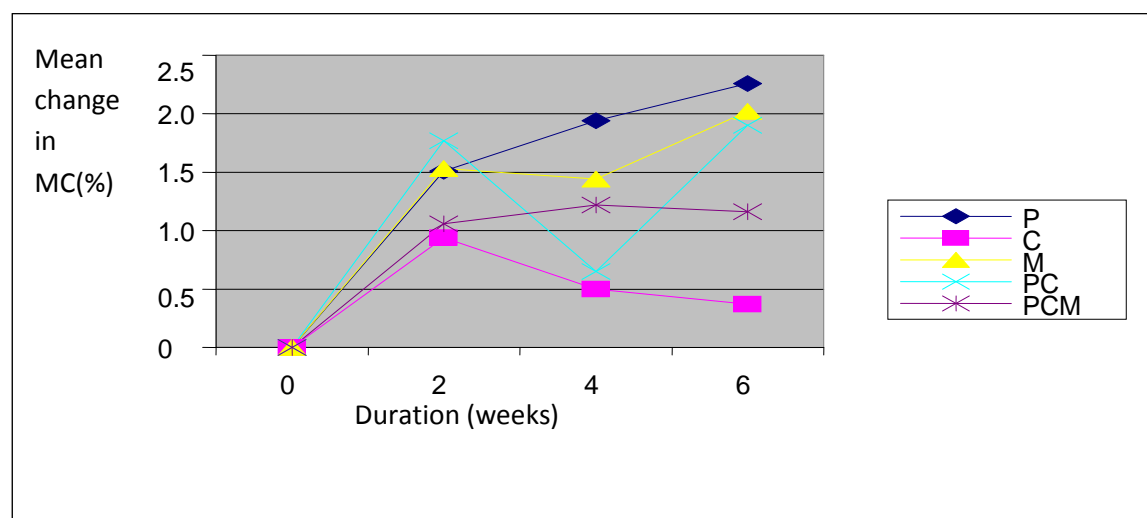


Figure 5.1 Effect of packaging materials on moisture content of unfinished

Kollman and Côte (1984) emphasised that wood is likely to absorb or expel moisture depending on the moisture content of the wood until equilibrium is attained. It was also noticed that, after the wood had taken up the moisture in the surrounding air after the first period (two weeks), it started releasing it. This depicted a slight decrease in moisture contents by 0.42% in week four with a further drop of about 0.03% in week six.

The cardboard packaging also recorded an increased (0.94%) in moisture content after the second week and dropped by 0.1% in week four and rose again in week six by 0.14%. Metallic packaging also showed similar trend of a rise and a continual drop after week two while Plastic plus cardboard packaging and PCM also showed a clear trend of rise and fall manner in moisture content with the three different time levels studied. This trend is partly due to fluctuating temperature that caused the fluctuating humidity as shown in figure 4 to affect the cardboard and in effect affecting the moisture content.

Effect of packaging materials on moisture content of semi-finished furniture parts

Effect of packaging materials on the moisture content of semi-finished furniture parts revealed general increase in the first two weeks. The highest and lowest moisture contents increase were 1.7% and 0.5% for plastic and cardboard respectively as shown in figure 2. The trend is due to the inability of the moisture to escape from the plastic pack, while in the case of the cardboard packaging, the cardboard increased in weight marginally which indicates that it has absorbed some of the moisture, which was to have been taken up by the furniture parts.

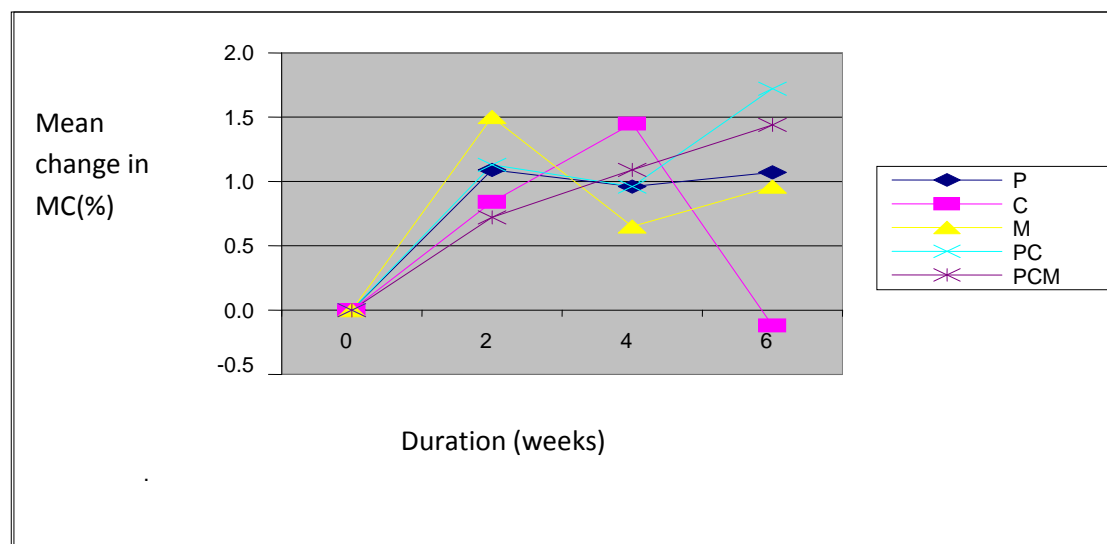


Figure 2. Effects of packaging materials on moisture content of semi-finished furniture

The fourth week duration revealed a different case, where all the materials that recorded high increase in MC rather gave low moisture content and vice-versa. Moisture content of furniture parts with plastic packaging dropped by 0.92%. This may be due to the fluctuating temperature and humidity during the fourth week period as shown in figure 4. However, it could also be seen that the change in temperature and humidity was too low to effect much change in the moisture contents of the packaged furniture parts.

Cardboard packaging recorded a lower increase in moisture content as compared to metallic, which gave a higher MC increase of 2.21%. Apart from plastic, that also showed a decrease in the four-week period, all the other three packaging methods with metallic parts recorded an increase in the four-week period as shown in figure 2. This is attributed to the fact that the accumulated air in the corrugation prevents the moisture from travelling across causing

the inner layer of the cardboard to absorb the moisture in the pack since paper is hygroscopic material (taken and transferred humidity).

Effect of Packaging Materials on Moisture Content of Finished Furniture Parts

The test conducted on the finished furniture parts to determine the effect revealed that plastic packaging recorded higher MC after the two weeks period and started dropping until it recoded a mean MC below the initial moisture content of the samples by the sixth week.

Cardboard that recorded low mean MC through out all the three time levels also recorded a drop in MC as against the initial MC of the samples. This indicates that finished furniture parts that are to be packaged for a period of about six weeks must be packaged with cardboard. The metallic packaging also kept on dropping from 2% to 0.7% as indicated in figure 3.

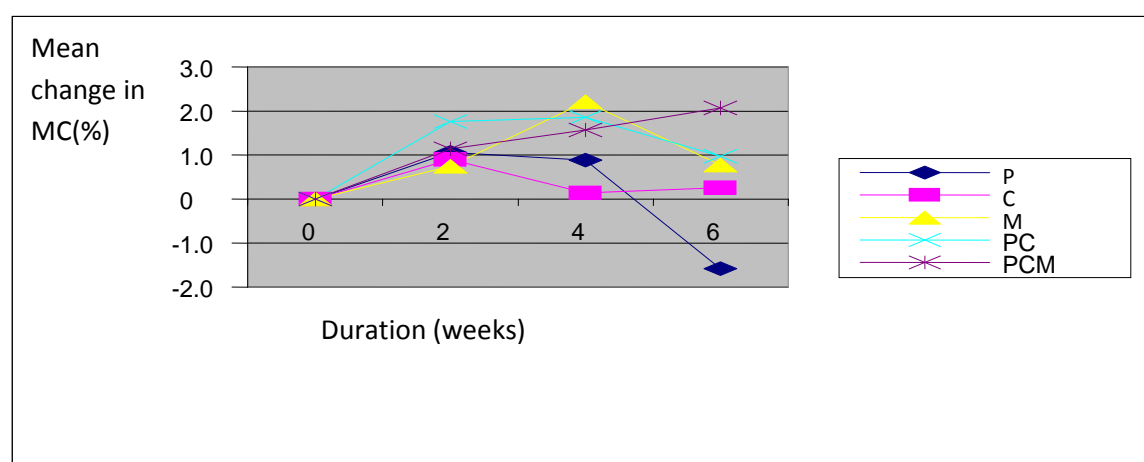


Figure 3. Figure 5.3 Effects of packaging materials on moisture content of finished furniture.

In the case of the plastic and cardboard packaging, the moisture contents of the different packaging materials were consistently decreasing after the two-week period as indicated in the figure 3, but the drop was minimal (0.2%) in week four, and subsequently dropped heavily by 1% in week six. This trend of change was due to the continual heat generated in the packs because of the finish applied on the parts, which are highly volatile.

The average weather conditions prevailed at the site of the experiment during the period under study.

Period	Two weeks	Four weeks	Six weeks
Av. Min.Temp. (°C)	22.6	22.9	23.3
Av. Max.Temp. (°C)	32.4	32.9	33.3
RH 0600 (%)	93	92	92
RH 1500 (%)	55	55	55

Source: Regional Meteorological Services - Kumasi

Discolouration of the surface finish of furniture parts.

A visual comparative analysis conducted with the photographs taken before and after packaging revealed that, there were no significant change in the colour with the samples packaged for the period of two weeks. However, 10% of the unfinished specimens packaged with plastic slightly darkened in colour from 14 to 12 on the colour chart. This could be attributed to the rise in MC (1.4%) of the furniture parts after packaging since moisture, dehydration and temperature has damaging effect on packaged furniture. The four-week duration also showed no difference in colour but in the case of the finished furniture parts, about three out of ten specimens were slightly faded from 14 to 16. This may also be due to the internal heat generated in the pack for two weeks as indicated in the work of Kollman and Côte, (1984).

Conclusion and Recommendations

This study on the effects of packaging materials on the moisture content (MC) and surface finish of packaged furniture was necessitated by the need to prevent the number of packaging problems associated with moisture changes that confront furniture manufacturers and exporters in Ghana. The study looked at the effect of five different packaging on the moisture content with time. The test was also concurrently undertaken on unfinished, semi-finished and finished furniture parts. It was found generally that cardboard packaging recorded the least change in MC throughout the test. However, plastic and metallic packaging recorded higher moisture contents in most of the test conducted.

In the case of the unfinished furniture, it was realized that cardboard material and the combination of plastic and cardboard material recorded the least and highest MC changes respectively for two weeks packaging. The four weeks packaging revealed the combination of plastic, cardboard and metallic material as the method with least MC changes while metallic packaging recorded the highest. However, metallic material recorded the lowest while plastic and cardboard packaging recorded the highest MC change.

Semi-finished furniture parts packaging also proved that, cardboard material recorded the lowest and highest moisture content respectively for the two weeks packaging. Metallic material and cardboard material recorded least and highest moisture content respectively for four weeks while cardboard material and metallic material recorded lowest and highest MC changes respectively in the sixth week.

The finished furniture parts' test further proved cardboard material's superiority as the packaging material with the lowest MC increase throughout the three time levels. That is, plastic material for two weeks, plastic plus cardboard material for four weeks and plastic plus cardboard and metallic for six weeks.

In the case of the effect of the packaging materials on the surface finish of the furniture parts, it was found generally that there was no clear-cut difference in the colours of the furniture parts before and after packaging. Some recorded slight differences but it was too slight that it could not be quantified.

It was noted that not every packaging situation should call for the same packaging material. The selection of a packaging material must be based on most likely events that are "normally" encountered. A packaging material to protect against every event would be extremely expensive if not practicable.

In view of the observations made during the study, the following recommendations are made.

- For better understanding of the test, adequate samples of different ecological zones must be tested to confirm the absorption rate of the wood with the five different packaging materials.

- Products to be packaged for six weeks are to be packaged in metallic container. However, for the problem of moisture ingress of the furniture parts due to high humidity on sea, they must be packaged with the plastic and cardboard and metallic combination as being done by some companies.
- Furniture parts to be packaged for less than six weeks must be packaged with cardboard but in the case of high humidity, the plastic plus cardboard and metallic can be used with an absorbent material enclosed to absorb any form of moisture likely to build-up on the surfaces to change the colour of the wood.
- Wood finishes add to the beauty and protect the product, but no finish is indestructible, therefore where plastics are to be employed on finished furniture, gaps should be created between the furniture surfaces and the plastic sheet since their ingredients can react to soften the finish to smudges and streaks when in contact with hard surfaces.

References

- Amoako D.K. (1993). Wood and wood products consumption by Kumasi based end use sectors. MSc. Thesis, KNUST, Kumasi, Ghana. 12-13pp
- Appiah, S.K. (1990). Timber Industry Development Division Annual Report, 1990
- Ashby, M.F, D.R.H. Jones, (1998), Engineering Materials. Volume 2, 2nd Ed, Guildford And King's Lynn, London, 212-213pp.
- Baidoe, J.F. (1987), The Export Development and the Ghana Timber Trade and Industry. TIDD, Takoradi, Ghana, 10pp.
- Bolton, W. (1988), Engineering Materials. Vol.3, Bodmin, London.
- Covell, P. (2002), Packaging, Microsoft Encarta Encyclopaedia, USA.
- FEIT, (2001), Furniture Packaging Optimization , Research Report, Hertfordshire, London, U. K. 16pp
- Gloag, J. (1969), A Short Dictionary Of Furniture, George Allen And Unwin Ltd London; 40 Museum Street, WC 1, Revised And Enlarged Edition, 345pp.
- ITTO, (2004), Enticing small operators out of the woodwork, Tropical Forest Update (14), (2), Yokohama, Japan. 9pp
- Kollmann, F.F.P., W.A. Côte, (1984), Principles of Wood Science and Technology, (1), New York, 528-529 pp.
- Kotler, P. (1984), Marketing Management, Eagle Wood Cliffs NJ Prentice Hall.
- Kellogg, R. M., R. W. Meyer, (1982), Structural Use Of Wood In Adverse Environment, Van No strand Reinhold Company Inc, New York, U.S.A, 170pp
- Metcalfe, H.C., J.E. Williams and J.F. Castka (1966), Modern Chemistry, Holt, Rinehart and Winston, Inc. USA, 295pp.
- Okai R, (2002), A study on the Milling and Strength Properties of Branchwood suggests that logging residues could be used to help meet the timber demands of the downstream processing sector: In ITTO Tropical Forest Update (12), (1)

- Page, J.M Jr, (1973), Economic Efficiency and Comparative Advantage in Ghana's Wooden Furniture Manufacturing Industries. A Report Prepared For The U.S Agency For International Development Mission In Ghana, 3pp.
- Prempeh, A. A. (1993), Construction In The Production And Marketing Of Knock-Down Furniture In Ghana, Msc. Thesis, KNUST, Kumasi, Ghana.
- Pröyry, J., (2003), World Paper Markets Up To 2015, (6), Vantaa Finland. 5pp.
- Ratnasingam, J. (1998). The South East Asian Furniture Industry Under Siege, Southern African Wood And Timber Times 24(1): 68-72pp
- Rietz, R. C. (1957), Importance Of Dry Lumber, U.S. Forest Products Laboratory Report No.1779, Madison, Wisconsin. U.S.A.
- Willinston, M. (1988), Lumber Manufacturing, Revised Ed, U.S.A. 434pp

MODELING PREDICTIVE FACTORS OF WORK-RELATED MUSCULOSKELETAL DISORDERS AND ASSOCIATED DISABILITY AMONG BANK WORKERS IN GHANA.

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Musculoskeletal Disorders (MSDs) are a major cause of occupational disability worldwide and impose a considerable burden on the individual, society and industry in terms of absenteeism and cost of treatment. The 12-month period-prevalence of self-reported MSDs was studied among three hundred and thirty bank workers in Kumasi. The cross-sectional survey used a previously validated self-administered questionnaire that included the Nordic musculoskeletal questionnaire (NMQ) and the 12-item general health questionnaire (GHQ12). Two multi factor-predictor logistic models fitted to the data showed that female sex; longer job duration and high GHQ12 score were significant predictors of MSDs while high GHQ12 score sedentary lifestyle and alcohol drinking were significant predictors of MSD-associated disability. Attitudinal change, treatment and interventional programmes may reduce the incidence of this common occupational injury.

Keywords: Musculoskeletal disorders; NORDIC musculoskeletal questionnaire; General health questionnaire; Predictors; Disability.

Introduction

Musculoskeletal disorders (MSDs) include a wide range of inflammatory and degenerative conditions affecting the muscles, tendons, ligaments, joints, peripheral nerves, and supporting blood vessels (Punnett and Wegman, 2004). Work related MSDs are defined as musculoskeletal disorders that result from a work related event (Salik and Ozcan, 2004).

MSDs represent a leading cause of occupational injury, pain, illness, disability, reduced productivity and work absenteeism (Buckle, 2005; Menzel et al., 2004; Maul et al., 2003), and are prevalent across a range of industries and jobs (Alrowayeh et al., 2010; Bio et al., 2007; Quansah 2005).

A recent study in Kuwait has shown that bank office workers represent a significant group of people who are affected by MSDs (Akrouf et al., 2010). A number of intrinsic and extrinsic factors are known to be risk factors (Devereux et al., 2002; Corona et al., 2005). The rapid development of information technology during the last decades has resulted in a number of people using computers in their workplace and at home. In the banking industry, workers are involved in long periods of static work, awkward posture and repetitive computational and clerical activities.

Several publications have linked computer usage to increase risk of musculoskeletal disorders (Klussmann et al., 2008; Janwantanakul et al., 2008; Woods, 2005; Korhonen et al., 2003; Cook et al., 2000). Musculoskeletal disorders have become the centre stage of occupational health research from all over the world, yet there is paucity of data on this important topic in Ghana. Therefore the aim of this study was to fill the knowledge gap by investigating the prevalence of MSDs among a cohort of bank workers and to identify potential risk factors.

Materials and Method

Conceptual and Mathematical Model of Logistic Regression

The usual goal of regression analysis is to describe the mean of a dependent variable Y as a function of a set of predictor variables. The logistic regression, however, deals with the case where the basic random variable Y of interest is a dichotomous variable taking the value 1 with probability π and the value 0 with probability $1 - \pi$. Such a random variable is called a point-binomial or Bernoulli variable, (Le, 2004; Slavin, 2011). It has the simple discrete probability distribution

$$\Pr(Y = y) = \pi^y (1 - \pi)^{1-y}, \quad y = 0, 1$$

Suppose that for the i th individual of a sample ($i = 1, 2, \dots, n$), Y_i is a Bernoulli variable with

$$\Pr(Y = y_i) = \pi_i^{y_i} (1 - \pi_i)^{1-y_i}, \quad y_i = 0, 1$$

The logistic regression analysis assumes that the relationship between π_i and the covariate value x_i of the same person is described by the logistic function

$$\pi_i = \frac{1}{1 + \exp[-(\beta_0 + \beta_1 x_i)]}, \quad i = 1, 2, \dots, n$$

The basic logistic function is given by

$$\pi_i = \frac{1}{1 + e^{-z}}$$

where, as in this simple regression model,

$$z_i = \beta_0 + \beta_1 x_i$$

or, in the multiple regression model of subsequent sections,

$$z_i = \beta_0 + \sum_{j=1}^k \beta_j x_{ij}$$

representing an index of combined risk factors. Under the simple logistic regression model, the likelihood function is given by

$$L = \prod_{i=1}^n \Pr(Y_i = y_i) = \prod_{i=1}^n \frac{[\exp(\beta_0 + \beta_1 x_i)]^{y_i}}{1 + \exp(\beta_0 + \beta_1 x_i)}, \quad y_i = 0, 1$$

from which we can obtain maximum likelihood estimates of the parameters β_0 and β_1 . As mentioned previously, the logistic model has been used both extensively and successfully to describe the probability of developing ($Y = 1$) some disease over a specified time period as a function of a risk factor X .

Regression analysis serves two major purposes (Le, 2004; Slavin, 2011): (1) control or intervention, and (2) prediction. In many studies, one important objective is measuring the strength of a statistical relationship between the binary dependent variable and each independent variable or covariate measured from patients; findings may lead to important decisions in patient management (or public health interventions in other examples). In epidemiological studies, such effects are usually measured by the relative risk or odds ratio; when the logistic model is used, the measure is the odds ratio. For the case of the logistic regression model, the logistic function for the probability π_i can also be expressed as a linear model in the log scale (of the odds):

$$\ln \frac{\pi_i}{1 - \pi_i} = \beta_0 + \beta_1 x_i$$

We first consider the case of a binary covariate with the conventional coding:

$$(X_i = \begin{cases} 0 & \text{if the worker is not exposed} \\ 1 & \text{if the worker is exposed} \end{cases})$$

Here, the term exposed may refer to a risk factor such as smoking, or a patient's characteristic such as race (white/nonwhite) or gender (male/female). It can be seen that from the log-linear form of the logistic regression model,

$$\begin{aligned} \ln(\text{odds}; \text{nonexposed}) &= \beta_0 \\ \ln(\text{odds}; \text{exposed}) &= \beta_0 + \beta_1 \end{aligned}$$

So that after exponentiating, the difference leads to

$$e^{\beta_1} = \frac{(\text{odds}; \text{exposed})}{(\text{odds}; \text{nonexposed})}$$

represents the odds ratio (OR) associated with the exposure, exposed versus nonexposed. In other words, the primary regression coefficient β_1 is the value of the odds ratio on the log scale.

Similarly, we have for a continuous covariate X and any value x of X ,

$$\ln(odds; X = x) = \beta_0 + \beta_1(x)$$

$$\ln(odds; X = x + 1) = \beta_0 + \beta_1(x + 1)$$

So that after exponentiating, the difference leads to

$$e^{\beta_1} = \frac{(odds; X = x + 1)}{(odds; X = 1)}$$

represents the odds ratio associated with a 1-unit increase in the value of $(X, X = x + 1)$ versus $X = x$.

Design of the Study

The cross-sectional study was carried out in forty randomly selected banks in Kumasi from December 2011 to January 2012. A three-part, self-administered questionnaire was distributed personally to employees of the selected banking institutions after seeking their consent and approval. Part one collected data on participants' personal information (age, sex, gender, marital status, smoking/alcohol history, work tenure, physical activity, and perceived job demand). Part two assessed occurrence of MSDs using the short version of the standardized Nordic Musculoskeletal Questionnaire (Kuorinka et al., 1987) in which participants were asked whether they have or have had troubles in the indicated areas during the preceding 12 months. Part three assessed psychological well-being using a modified Goldberg's (1978) 12-item general health questionnaire (GHQ12). Each GHQ12 question is scored on a three-point likert scale (0 to 3). In all, 400 questionnaires were distributed. The questionnaire had a good internal consistency (Cronbach's $\alpha = 0.81$).

Participants who had less than a year of work experience in the current job were excluded from the current study as well as those having, or having had any underlying disease or accidents affecting the musculoskeletal system. The data was analyzed using SPSS version 17. Statistical analyses were considered significant if $p \leq 0.05$.

Results

Participation was generally low (241/400 respondents, yielding a basic response rate of 60.3%) due to lack of time, as explained by the non participants. After excluding incomplete questionnaires and respondents who did not meet the eligibility criteria, the final response rate was 57.5%. Table 1 presents the demographic characteristics for the 230 bank worker in this study. The mean age of workers within this study was 30.6 years. Females and males accounted for 51.7% and 48.3 % of the population respectively. Approximately, two-fifth (37.0%) were currently married while majority (53.0%) were single. Alcohol consumption was reported by 19% and smoking by none. All workers attained above secondary education and the mean duration of job was 4.0 years. The mean GHQ12 score was 'normal' (10.7 ± 5.8) and only 0.9% were psychologically distressed (moderate to severe). Majority (66.1%) of them were physically inactive and sedentary.

Table 1. Demographic of characteristics of the Study Population (n=230)

Characteristic	N	%
Gender		
Male	111	48.3
Female	119	51.7
Marital status		
Single	145	63.0
Married	85	37.0
Education		
Post Secondary Institution	10	4.3
University	220	95.7

Alcohol drinker		
Yes	39	17.0
No	191	83.0
Smoker		
Yes	0	0.0
No	100	100.0
Physical activity		
Active	78	39.9
Sedentary	152	66.1
GHQ12 Scale		
Normal (0-12)	153	66.5
Mild distress (13-24)	75	32.6
Moderate to Severe distress (25-36)	2	0.9

	Mean	S.D
Age (years)	30.6	5.4
GHQ12 Score	10.7	5.8
Job tenure (years)	4.0	3.2

The 12-month-period prevalence of MSDs at any body site among the bank workers was 83.5%. Figure 1 shows that the prevalence rate was highest in the lower back (64.8%), followed by the upper back (61.7%), neck (47.4%) and shoulder (37.4%) but least in the knees (2.2%) and wrists (3.0%).

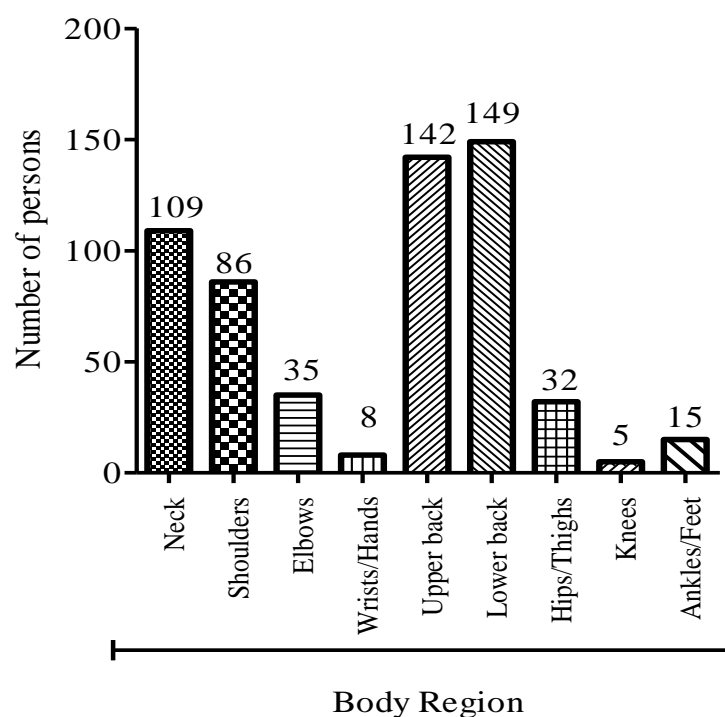


Figure 22 Prevalence of MSDs among the bank workers

A total of 15.7% had suffered disabling effects, with lower back pain (8.3%) and upper back pain (4.8%) as the main contributing factors. (Figure 2)

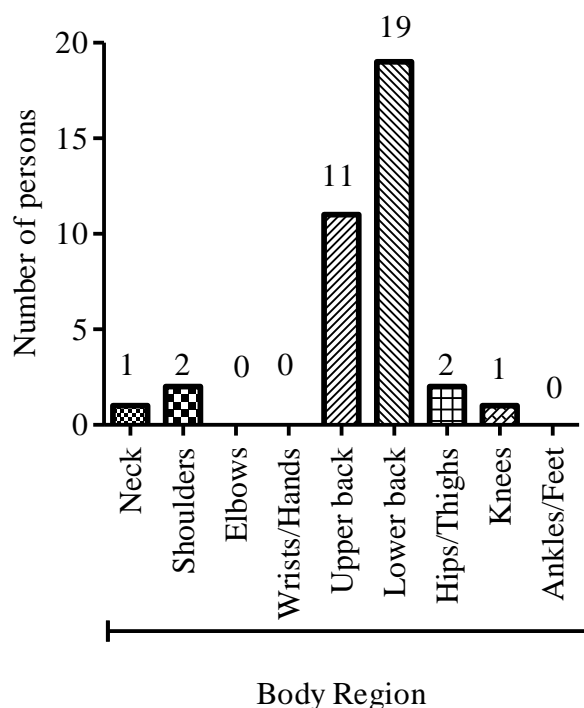


Figure 23 MSD-Associated Disability among the Bank Workers

Table 2 shows the logistic regression analysis of independent factors associated with MSDs and associated disability among bank workers. Factors that are significantly associated with MSDs were GHQ12 score, job tenure and gender while alcohol consumption, sedentary lifestyle and high GHQ12 score were positively associated with disabling MSDs.

Table 2 Univariate logistic predictors of musculoskeletal disorders (MSDs) and associated disability among the bank workers.

Predictor	MSDs		MSD-associated absenteeism	
	β	OR (95% CI)	β	OR (95% CI)
Gender	1.32	3.74*(1.67-8.40)	-0.35	0.71 (0.35-1.45)
Marital status	0.70	2.02 (0.98-4.18)	0.34	1.40 (0.65-3.02)
Alcohol drinking	0.88	2.42 (0.70-8.33)	-0.96	2.61*(1.16-5.89)
Education	0.81	2.25 (0.95-5.33)	-0.77	0.46(0.20-1.10)
Physical activity	-0.64	0.53(0.23-1.23)	1.94	6.93*(2.05-23.41)

	Yes	No		Yes	No	
	Mean (SD)	p value		Mean (SD)	p value	
Age (years)	30.4(5.5)	31.3(4.7)	0.346	30.2(3.8)	30.6(5.6)	0.641
Tenure of work (years)	4.5(3.3)	2.6(1.2)	0.004*	3.4(1.9)	4.1(3.3)	0.232
GHQ12 score	11.5(5.8)	7.1(4.1)	0.000*	12.6 (5.8)	10.5(5.7)	0.048*

*P<0.05. Means were compared using unpaired t test. Data was coded as follows: Gender (male-2,female-1), Marital status (single-1,married-2), Alcohol drinking (yes-1,no-2), Education(university-1, post-secondary institute-2), physical activity(sedentary-1, active-2). OR-Odds ratio

Factors were entered stepwise into a multiple logistic regression model to obtain multivariate predictors of MSDs. Significant results are shown in Table 3. MSDs were positively associated with work tenure, GHQ12 score and female gender while disability was positively related to GHQ12 score, alcohol drinking and sedentary lifestyle.

Table 3 Multiple logistic regression predictors of Musculoskeletal Disorders (MSD) and associated disability among the bank workers.

Predictors	MSDs		MSD-associated disability	
	β	OR (95% CI)	β	OR (95% CI)
Alcohol drinker	-	-	1.03	2.79 (1.17-6.23)
Sedentary lifestyle	-	-	1.90	6.68 (1.96-22.81)
GHQ 12	0.33	1.40 (1.22-1.60)	0.53	1.05 (1.00-1.12)
Female	2.25	9.44 (3.27-27.25)	-	-
Job tenure	0.78	2.18 (1.47-3.23)	-	-
Constant	-6.79	0.01	-4.01	0.02

OR-odds ratio

Discussion

People at work face a variety of hazards owing to several factors including adverse ergonomic conditions, physical and psychosocial factors. The rapid development of information technology during the last decades has resulted in a number of changes in the work-life of people (Eltayeb et al., 2007). Bank workers are engaged in long periods of awkward positions and repetitive computer activities. Computer use has been associated with musculoskeletal discomfort (Baker 2010). The present study assessed the prevalence of MSDs among a sample of bank workers. It was found that 83.5% of the workers suffered at least one episode of MSD during the past 12 months while 15.7% suffered disabling effects. Our finding of high prevalence of MSD in the population is consistent with similar studies conducted in Kuwait (Akrouf et al., 2010, Woods 2005). The common affected body parts were lower back (64.8%), upper back (61.7%) and neck (47.4%) while the less affected body parts were the knees (2.2%), wrists (3.0%) and ankle/foot (6.5%). However, these findings were inconsistent with the afore-mentioned studies. The difference in the ranking of symptoms may be attributed to personal, geographical or environmental differences that exist among different populations. The study also showed that females were more likely to suffer MSDs than men, confirming earlier studies that reported similar gender differences (Akrouf et al., 2010; Korhonen et al., 2003; Jensen et al., 2002). Gender differences could be attributed to differences in occupational exposure among men and women (Ekman et al., 2000) and sex differences in biological and anthropometric measurements (Jensen et al., 2002).

In this study, psychological distress was positively associated with MSDs. An association between musculoskeletal disorders and psychosocial factors has been previously suggested among bank office workers (Akrouf et al., 2010). We also showed that sedentary life and alcohol drinking were significant predictors of MSD-associated disability. Sedentary activity in leisure time was associated with higher prevalence rates of low back symptoms and sick leave due to low back symptoms (Hildebrandt et al., 2000)

Conclusion

In conclusion, this study has proposed two logistic models for predicting MSDs and MSD-associated disability. According to the first model, high GHQ12 score and long job tenure were positively related to MSDs. Given the same job tenure and GHQ12 score, females were more likely to suffer MSDs than males.

The second model showed that given the same GHQ12 score, a sedentary worker who drinks alcohol was more likely to suffer disability due to MSDs than the physically active worker who does not drink alcohol.

Attitudinal change, treatment and interventional programmes may reduce the incidence of this common occupational injury. Further research is required to investigate the inter-relationship between musculoskeletal disorders and risk factors such as physical load, psychosocial load and other factors.

References

- Akrouf, Q.A., Crawford, J.O., Al-Shatti, A.S. and Kamel, M.I. (2010) Musculoskeletal disorders among bank office workers in Kuwait. *East Mediterr Health J* 16(1), 94-100.
- Alrowayeh, H.N., Alshatti, T.A., Aljadi, S.H., Fares, M., Alshamire, M.M. and Alwazan, S.S. (2010) Prevalence, characteristics, and impacts of work-related musculoskeletal disorders: a survey among physical therapists in the State of Kuwait. *BMC Musculoskelet Disord* 11, 116.
- Baker, N.A. (2010) The Relationship between Computer-Related Discomfort and Everyday Activities. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* 54(9), 714-717.
- Bio, F., Sadhra, S., Jackson, C. and Burge, P. (2007) Low back pain in underground gold miners in Ghana. *Ghana Med J* 41(1), 21-25.
- Buckle, P. (2005) Ergonomics and musculoskeletal disorders: overview. *Occupational Medicine* 55(3), 164-167.
- Cook, C., Burgess-Limerick, R. and Chang, S. (2000) The prevalence of neck and upper extremity musculoskeletal symptoms in computer mouse users. *International Journal of Industrial Ergonomics* 26(3), 347-356.
- Corona, G., Amedei, F., Miselli, F., Padalino, M.P., Tibaldi, S. and Franco, G. (2005) [Association between relational and organizational factors and occurrence of musculoskeletal disease in health personnel]. *G Ital Med Lav Ergon* 27(2), 208-212.
- Devereux, J., Vlachonikolis, I. and Buckle, P. (2002) Epidemiological study to investigate potential interaction between physical and psychosocial factors at work that may increase the risk of symptoms of musculoskeletal disorder of the neck and upper limb. *Occupational and Environmental Medicine* 59(4), 269-277.
- Ekman, A., Andersson, A., Hagberg, M. and Hjelm, E.W. (2000) Gender differences in musculoskeletal health of computer and mouse users in the Swedish workforce. *Occup Med (Lond)* 50(8), 608-613.
- Eltayeb, S., Staal, J.B., Kennes, J., Lamberts, P. and de Bie, R. (2007) Prevalence of complaints of arm, neck and shoulder among computer office workers and psychometric evaluation of a risk factor questionnaire. *BMC Musculoskelet Disord* 8(1), 68.
- Hildebrandt, V.H., Bongers, P.M., Dul, J., van Dijk, F.J. and Kemper, H.C. (2000) The relationship between leisure time, physical activities and musculoskeletal symptoms and disability in worker populations. *Int Arch Occup Environ Health* 73(8), 507-518.
- Janwantanakul, P., Pensri, P., Jiamjarasrangsi, V. and Sinsongsook, T. (2008) Prevalence of self-reported musculoskeletal symptoms among office workers. *Occup Med (Lond)* 58(6), 436-438.
- Jensen, C., Finsen, L., Sjøgaard, K. and Christensen, H. (2002) Musculoskeletal symptoms and duration of computer and mouse use. *International Journal of Industrial Ergonomics* 30(4-5), 265-275.
- Klusmann, A., Gebhardt, H., Liebers, F. and Rieger, M. (2008) Musculoskeletal symptoms of the upper extremities and the neck: A cross-sectional study on prevalence and symptom-predicting factors at visual display terminal (VDT) workstations. *BMC Musculoskelet Disord* 9(1), 96.

- Korhonen, T., Ketola, R., Toivonen, R., Luukkonen, R., Hakkanen, M. and Viikari-Juntura, E. (2003) Work related and individual predictors for incident neck pain among office employees working with video display units. *Occup Environ Med* 60(7), 475-482.
- Kuorinka, I., Jonsson, B., Kilbom, A., Vinterberg, H., Biering-Sorensen, F., Andersson, G. and Jorgensen, K. (1987) Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Appl Ergon* 18(3), 233-237.
- Le, C.T.(2004): *Introductory Biostatistics*. John Wiley Publications
- Maul, I., Läubli, T., Klipstein, A. and Krueger, H. (2003) Course of low back pain among nurses: a longitudinal study across eight years. *Occupational and Environmental Medicine* 60(7), 497-503.
- Menzel, N.N., Brooks, S.M., Bernard, T.E. and Nelson, A. (2004) The physical workload of nursing personnel: association with musculoskeletal discomfort. *International journal of nursing studies* 41(8), 859-867.
- Punnett, L. and Wegman, D.H. (2004) Work-related musculoskeletal disorders: the epidemiologic evidence and the debate. *Journal of electromyography and kinesiology : official journal of the International Society of Electrophysiological Kinesiology* 14(1) 13-23.
- Quansah, R. (2005) Harmful Postures and Musculoskeletal Symptoms Among Sanitation Workers of a Fish Processing Factory in Ghana: A Preliminary Investigation. *International Journal of Occupational Safety and Ergonomics (JOSE)* 11(2), 171–180.
- Salik, Y. and Ozcan, A. (2004) Work-related musculoskeletal disorders : A survey of physical therapists in Izmir-Turkey. *BMC Musculoskelet Disord* 5(1), 27.
- Slavin, S.(2011): *Statistical Tools for Epideniologic Research*. Oxford University Press
- Woods, V. (2005) Musculoskeletal disorders and visual strain in intensive data processing workers. *Occupational Medicine* 55(2), 121-127.

MARKOV CHAIN MODELS OF THE INCIDENCE OF HIV/AIDS DATA IN UPPER EAST REGION

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The main aim of this paper was to use the Markov chain models to analyze the incidence of Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome (HIV/AIDS) data in the Upper East Region of Ghana. In order to preserve the chains' stationary distributions, care was taken in writing the chains' transition matrices based on their initial probability distributions and the assumptions made for the transition matrices. At the end of the simulations, the two-state gender groups and the three-state age groups reached steady states. The steady states distributions for the gender groups were regular and that of the age groups were non-regular. The non-regular sub-classifications meant that some groups were promiscuous while children were not transmitting HIV/AIDS virus. These justified the use of the Markov chain methods as suitable for analyzing the HIV/AIDS data in Ghana. This method should therefore, be adopted in research analyses in Ghana.

Key words: HIV/AIDS; Markov chains; Steady states; Regular; Non-regular.

Introduction

The purpose of this study is to explore the use of Markov chain models to analyze the dynamics of HIV/AIDS transmission using data from the Upper East Region of Ghana. Markov chain analysis combines an initial probability distribution, S_0 extracted from the actual HIV/AIDS data with a transition matrix P_{ij} of a random variable, X_n (i.e. gender and age) to produce the state distribution, S_{ij} . The continuous simulation of the product $S_0 P_{ij}^n$ derives the stationary probability distribution, S (Roberts and Rosenthal, 2004; Mira and Sargent, 2006; Smith, 2007).

The Problem

The most popular methods for reporting the HIV/AIDS pandemic in Ghana have been caseloads and prevalence rates. It is difficult for one to predict or forecast the behaviour of the disease. Markov chain simulation could be a better method for such data. Mathematically, the algorithms involve Markov chains $\{X_n\}$ having a stationary distribution S , for which it is important to understand as precisely as possible the nature and convergence of $\{X_n\}$ to the stationary distribution, S as the number of years, n increases (Roberts and Rosenthal, 2004; Walsh, 2004; Mira and Sargent, 2006; Smith, 2007). The convergence of $\{X_n\}$ to S could be regular or non regular. In either case, the ultimate aim is to forecast the nature of the convergence, and how to deal with the disease thereafter. If it is regular, then all groups (i.e. gender and age) contribute to its future existence. But if is not regular, then some groups may contribute to its future occurrence.

Review of Markov Chains

In the Markov models, the initial distributions were represented as $S_0 = [X_{11} \dots X_{1n}]$, the state distributions as $S_{ij} = S_0 P_{ij}$, and the steady or stationary state distributions, as S ; where P_{ij} is the transition matrix. The Markov chain methods define, for the i^{th} row and j^{th} column of the transition matrix the P_{ij} as;

In order words, $X_0, X_1, X_2, \dots, X_n$ representing a discrete random sequence with the Markov property (memoryless) is called a Markov chain. Having the Markov property means that, given

$$P_{ij} = \Pr(X_{n+1} = j \mid X_0 = i_0, X_1 = i_1, X_2 = i_2, \dots, X_n = i_n) = P(X_{n+1} = j \mid X_n = i_n).$$

the present state (X_n), future states (X_{n+1}) are independent of the past states (X_{n-1}). Thus, a Markov chain is a sequence of consecutive trials such that;

$$P_{ij} = \Pr(X_{n+1} = j \mid X_0 = i_0, X_1 = i_1, X_2 = i_2, \dots, X_n = i_n) = P(X_{n+1} = j \mid X_n = i_n) \quad (1)$$

In summary, a sequence of discrete random variables $X_0, X_1, X_2, \dots, X_n$ forms a Markov Chain if:

1. at any discrete time n , the future state (X_{n+1}) only depends on the present state (X_n) and not the past state (X_{n-1}).
2. P_{ij} is the n -step transition probability and it is time invariant (Lawler, 1995; Lawson, 1996; Tan, 1997; Barnett, et al., 2000; Chen, 2003; Mathews and Fink, 2004; Weisstein, 2005; Nie and Ren, 2006; Law, 2008).

State Distribution Theorems

A state matrix represents the conditional probability of a system moving from one state to another in a given finite time, n . Equation (1) defines P_{ij} as $i \rightarrow j$; which represents present state, i moving to a future state, j in a definite time, n . In the Markov chain analyses, the product of S_0 and P_{ij} an initial first-state distribution, S_1 is then used as a new initial state to calculate the second-state distribution, S_2 and up to the steady state, S . Each stage of the product produces a state distribution matrix.

Stationary State Distribution Theorems

There are two main computations for the Markov chain models to reach a stationary state distribution, S and must satisfy two conditions—existence of the limit, S and independence of time, n .

Theorem 1: Let $P = [P_{ij}]$ be the transition matrix and S_0 being the initial distribution. Then the probability that the chain is in state S_i after n steps is the i^{th} entry in the vector $S_{(n)} = S_0 P_{ij}^n$ as in (1). At this stationary state,

$$S_{(n)} = S_{(n+1)} = S_{(n+2)} = \dots = S \quad (2)$$

$$\text{where } S P_{ij}^{(n)} = S \quad (3)$$

This stationary vector S is reached regardless of the initial state, S_0 of the system.

Theorem 2: Let $P = [P_{ij}]$ represents the transition matrix of a Markov chain. Then the $i - j^{th}$ entry, $[P_{ij}^n]$ of the matrix P_{ij}^n gives the probability that the Markov chain, starting in state s_i will be in state s_j after n steps. The

$$\begin{array}{ccccccc} \text{stationary} & & \text{state} & & \text{is} & & \text{reached} & & \text{when} \\ P_{ij}^{(n)} = P_{ij}^{(n+1)} = P_{ij}^{(n+2)} = \dots = \bar{P} & & & & & & & & \end{array} \quad (4),$$

Here, the rows are identical and the same as the stationary-state vector, S in (4), (Barnett, et al., 2000; Cao, 2003; Law, 2008; Nauroze, 2009).

Fundamental Theorem

Theorem 3: Let P_{ij} be a Markov Chain with states $S_0, S_1, S_2, \dots, S_n$. The Fundamental Theorem tells us that after a sufficiently large number of steps, the probability of being in the future state, S_{n+1} is the same as being in the present state, S_n as in equations (3) to (4). This probability distribution is known as an equilibrium, steady-state, invariant or stationary distribution (Barnett, et al., 2000; Cao, 2003; Law, 2008; Nauroze, 2009).

Uniqueness Theorem

Theorem 4: If the discrete-time Markov chain X_n is stationary, with transition matrix $P = P_{ij}$, then there is exactly one probability vector, S , which satisfies equation (4), $SP_{ij}^{(n)} = S$ and $s_1 + s_2 + \dots + s_n = 1$. We say that, S is unique. This is always the same on all steps/states (*unique*) (Barnett, et al., 2000; Cao, 2003; Law, 2008; Lam, 2009; Nauroze, 2009).

Regular

A Markov chain model is regular if the following conditions are satisfied:

- There are no zero elements in the transition matrix $P = [P_{ij}]$ (*i.e.* $P_{ij} > 0$).
- some powers of P_{ij} are positive (*i.e.* $P_{ij}^n > 0$).
- as $n \rightarrow \infty$, the powers of P_{ij} approach a limiting matrix, \bar{P} with identical rows and $\bar{P} > 0$.
- $S = SP$ (*i.e.* S is unique).

Theorem 6: Let P_{ij} be the transition matrix and \bar{P} be an arbitrarily probability vector. Then, every regular Markov chain must satisfy equation (5), of $P_{ij}^{(n)} = P_{ij}^{(n+1)} = P_{ij}^{(n+2)} = \dots = \bar{P}$, where \bar{P} is the stationary distribution of $P_{ij}^{(n)}$ having identical rows. Every transition matrix that behaves as theorem (6) is regular (Barnett, et al., 2000; Cao, 2003; Carter Jr., 2008; Law, 2008; Nauroze, 2009).

Non-Regular

A transition matrix is not regular if it contains some zero entriess in P_{ij} *i. e.* $[P_{ij} \geq 0]$. Two main conditions then exist at stationary state(s).

Absorbing: A Markov chain is *absorbing* if it has at least one absorbing state, and if from every state it is possible to go to an absorbing state (not necessarily in one step) but cannot leave that absorbing state (*i.e.* $P_{ii} = 1$).

Transience: In an absorbing Markov chain, a state which is not absorbing is called *transient*. A state is transient, if given that we start in state i , there is a non-zero probability that we will never return to i .

Theorem 7: In an absorbing Markov chain, the canonical transition matrix $P_{ij} = \begin{bmatrix} I & 0 \\ R & Q \end{bmatrix}$, represents the probability that the process will be absorbed is 1 (*i.e.* $Q^{(n)} \rightarrow 0$, as $n \rightarrow \infty$). The limiting matrix, \bar{P} of the non-absorbing Markov chain is then;

$$\bar{P} = \begin{bmatrix} AB & TR \\ AB & I & 0 \\ TR & FR & 0 \end{bmatrix}$$

AB represents absorbing states and TR represents transient states. Let $B = [b_{ij}]$ be the probability that an absorbing chain will be absorbed in the absorbing state s_j if it starts in the transient state s_i . Then $B = FR$, is a *txr* matrix, where $F = (I - Q)^{-1}$ is the fundamental matrix, being the number of transitions before reaching the absorbing states and R is in the canonical form (Barnett, et al., 2000; Cao, 2003; Law, 2008; Nauroze, 2009).

Methodology

There are two models used with the HIV/AIDS data. These are the two-state gender based dynamics and three-state age based dynamics. In the Markov chain models, strong assumptions based, on the data were used to derive the

transition matrix, $P = [P_{ij}]$. The initial distribution vector S_0 was the proportion of people infected with the HIV/AIDS in any group. This was calculated based on the available data obtained from the HIV/AIDS sentinel sites of the region. In the gender groups, 42% and 58% of males and females respectively, were their proportions in the HIV/AIDS data. In the age groups, 2% were children from 0 to 14 years, 81% were youth aged 15 to 49 years and 17% were adults from 50 years and above.

The researchers further represented the analyses by transition diagrams (see Figures 1 and 3 in Appendix), and extracted from these to form the transition matrices for the two-state gender groups as $P_{ij} = \begin{bmatrix} 0.4 & 0.6 \\ 0.7 & 0.3 \end{bmatrix}$ and three-

state age groups as $P_{ij} = \begin{bmatrix} 1 & 0 & 0 \\ 0.2 & 0.8 & 0 \\ 0.1 & 0.4 & 0.5 \end{bmatrix}$ being the initial distributions of HIV/AIDS in the gender and age

groups. The transition trees combined both the initial distributions and transition matrices (see figures 2 and 4 in appendix) to form mutually exclusive and repeated occurrence of the HIV/AIDS pandemic in the region. Computations or simulations of the initial distributions and the transition matrices, using equations (2) and (5) obtained the stationary state distributions and their classifications.

Results

Results on Gender Based Model

We discuss here the assumptions, the transition matrices, the stationary state distributions and their classifications.

Assumptions

- Males (M) and females (F) interact only heterosexually and not homomosexually.
- If a male is the source of spread, then within a given time step he infects another male through a female or he infects only a female directly
- If a female is the source of spread, then within a given time step she infects another female through a male or she infects only a male directly

Transition Matrix

The transition matrix for the gender based model is computed as

Here the assumptions used are as indicated in 3.1.1. above. Thus, the probability that males will only directly infect females in the given time step is 0.6 and that females will only directly infect males is 0.7.

Stationary States Distributions

Let S_0 represent the initial state distribution vector, and P_{ij} represent the transition matrix elements and let S represent the stationary state distribution for the gender based model. Then the following results are obtained:

$$(a). \quad S = S_0 [P_{ij}^{(\infty)}] = [0.42 \quad 0.58] \begin{bmatrix} 0.4 & 0.6 \\ 0.7 & 0.3 \end{bmatrix} \begin{bmatrix} 0.4 & 0.6 \\ 0.7 & 0.3 \end{bmatrix} \dots = [0.5385 \quad 0.4615] \quad (7)$$

$$(b). \quad [P_{ij}^{(\infty)}] = \bar{P} = \begin{bmatrix} 0.5385 & 0.4615 \\ 0.5385 & 0.4615 \end{bmatrix} \quad (8)$$

$$(c). \quad S[P_{ij}^{(\infty)}] = S = [0.5385 \quad 0.4615] \quad (9)$$

$$(d). \quad S \text{ is a row of } [P_{ij}^{(\infty)}] = \bar{P} \quad (10)$$

Equations (7) and (8) are the stationary distributions, and (9) and (10) support the theory that S is unique. Therefore, the stationary state distribution S has been reached.

Results on Age based Model

Assumptions

- There exist only heterosexual relationships within age groups and also between age groups. Again infections to the same genders are indirect only.
- Children do not transmit HIV/AIDS to the younger adult and older adult age groups (They are assumed to be not promiscuous) but the younger and older adult groups are assumed to be promiscuous and transmit to other age groups.

Transition Matrix

The transition matrix becomes $P_{ij} =$

$$\begin{matrix} & \begin{matrix} \text{State } C_h & Y_o & A_d \end{matrix} \\ \begin{matrix} C_h \\ Y_o \\ A_d \end{matrix} & \begin{bmatrix} 1 & 0 & 0 \\ 0.2 & 0.8 & 0 \\ 0.1 & 0.4 & 0.5 \end{bmatrix} \end{matrix} \quad \text{for the three age groups.}$$

We can notice that there exists a 1 in the matrix at P_{11} of C_h . Thus, this is an absorbing Markov chain. We can

regroup it in canonical form as $P_{ij} =$

$$\begin{matrix} & \begin{matrix} \text{State } C_h & Y_o & A_d \end{matrix} \\ \begin{matrix} C_h \\ Y_o \\ A_d \end{matrix} & \begin{bmatrix} 1 & : & 0 & 0 \\ \dots & : & \dots & \dots \\ 0.2 & : & 0.8 & 0 \\ 0.1 & : & 0.4 & 0.5 \end{bmatrix} \end{matrix}, \text{ and compute its stationary vector or matrix.}$$

Stationary States Distributions

Let $[P_{ij}]$ be the transition matrix and \bar{P} represents the limiting matrix of $[P_{ij}]$. We partition $[P_{ij}]$ so that the non-absorbing states precede the absorbing states. We then calculate the fundamental matrix, F to be able to estimate the stationary distribution, S as follows:

$$[P_{ij}] = \begin{matrix} & \begin{matrix} C_h & Y_o & A_d \end{matrix} \\ \begin{matrix} C_h \\ Y_o \\ A_d \end{matrix} & \begin{bmatrix} 1 & : & 0 & 0 \\ \dots & : & \dots & \dots \\ 0.2 & : & 0.8 & 0 \\ 0.1 & : & 0.4 & 0.5 \end{bmatrix} \end{matrix} = \begin{bmatrix} I & 0 \\ R & Q \end{bmatrix} \quad (11)$$

$$F = (I - Q)^{-1} = \begin{bmatrix} 5 & 0.4 \\ 4 & 2 \end{bmatrix} \quad (12)$$

$$S = \begin{bmatrix} I & 0 \\ FR & 0 \end{bmatrix} = \begin{matrix} C_h & Y_o & A_d \\ \begin{bmatrix} 1 & 0 & 0 \\ 1 & 0 & 0 \\ 1 & 0 & 0 \end{bmatrix} \end{matrix}, Q \rightarrow 0, n \rightarrow \infty \quad (13)$$

Here, both S and \bar{P} have identical rows as in equations (13) and (14), and but each row of \bar{P}

$$\bar{P} = \begin{matrix} C_h & Y_o & A_d \\ \begin{bmatrix} 1 & 0 & 0 \\ 1 & 0 & 0 \\ 1 & 0 & 0 \end{bmatrix} \end{matrix}, Q^{(n)} \rightarrow 0, n \rightarrow \infty \quad (14)$$

does not necessarily represent the stationary distribution, S since $[P_{ij}]$ contain some zeros (i.e. irregular).

Classification at Stationary-State Distribution

The transition matrix, $P_{ij}^n \geq 0, i, j \geq 0$ and $\bar{P}_{ii} = 0; i, j = 0$, and so non-regular. The Markov chain has the following properties:

- Transient: Young and adult groups are transience because, once they are infected, they can easily transfer the disease to any age group (children).
- Absorbing: The children are absorbing because once they infected, they cannot transfer the disease to any age group (young ones and adults).

Discussions

The initial state distribution of gender based model was $S_0 = [0.42 \ 0.58]$ as the initial proportions of males (M) and females (F) infected with HIV/AIDS in the study area respectively. The

transition probability matrix became $[P_{ij}] = \begin{matrix} M & F \\ \begin{bmatrix} 0.4 & 0.6 \\ 0.7 & 0.3 \end{bmatrix} \end{matrix}$, as computed from our assumptions. The transition

probability matrix was regular since the stable state S was $S = [0.5385 \ 0.4615]$, and was a row of the limiting

matrix, $\bar{P} = \begin{bmatrix} 0.5385 & 0.4615 \\ 0.5385 & 0.4615 \end{bmatrix}$.

Therefore, we concluded that initially, 42% of males and 58% of females had been infected with the HIV/AIDS virus. After one year, the percentage of males had increased to 57% while females had dropped to 43%. If this trend continues, then eventually about 54% of males while 46% of females would be infected in future. In other words, males may tend to have higher prevalence rate of HIV/AIDS prevalence than females in the long run, if its current rates of infections (i.e. the transition matrix, P_{ij}) remains the same. This would definitely reverse the trend of the spread of HIV/AIDS between males and females in the future.

Here too, the steady state was reached regardless of the initial state of the disease among the males and females. The limiting matrix $\lim_{n \rightarrow \infty} P_{ij}^{(n)} \rightarrow \bar{P}$ approached the steady state vector, S in which the rows of the limiting matrix were all identical, and nonzero. Thus, we have satisfied both the uniqueness and fundamental theorems, at regular stationary states (i.e. irreducible and aperiodic).

Also, the age based model had groups divided into children, C_h (0-14 years old), the younger adults, Y_o (15-49 years old) and older adults, A_d (50 years and above). The initial state distribution, $S_o = [0.02 \quad 0.81 \quad 0.17]$ were the proportions of C_h , A_d and Y_o respectively as obtained in the HIV/AIDS data, and the initial transition probability matrix was

$$[P_{ij}] = \begin{matrix} & \begin{matrix} C_h & Y_o & A_d \end{matrix} \\ \begin{matrix} C_h \\ Y_o \\ A_d \end{matrix} & \begin{bmatrix} 1 & 0 & 0 \\ 0.2 & 0.8 & 0 \\ 0.1 & 0.4 & 0.5 \end{bmatrix} \end{matrix}.$$

Here, the existence of 1 in the first row and column, which is the principal diagonal of the matrix, showed that this transition matrix was *not* regular (i.e. absorbing states at C_h , and non-absorbing or transient states at Y_o and A_d). This means that children could not infect any other age group with HIV/AIDS, but the younger adults and older adults could transfer the disease to these children.

Thus, in the long run, we regularized the initial transition matrix, P_{ij} by canonical method to obtain the limiting matrix of \bar{P} . The fundamental matrix F indicated that, if we start from the youth, it will take the youth 5 years to reach children. If we start from the adults, it will take the adults 6 years to transfer the disease to children. In other words, young persons will take an average of 5 (5+0) years in the youth and adult age groups before spreading HIV/AIDS to children. Adults will equally spend an average of 6 (4+2) years within the youth and adults before reaching children. Both of these numbers of transitions are relatively short and depicted how volatile the pandemic could be spreading within the age groups. However, the youth would take relatively shorter periods to reach children than the adults would do in future. In other words, sexual interdependence between the young and children is quite higher than that of the adults and children.

Initially, the youth have a probability of 0.2 of transferring to children, 0.8 of transferring to youth and no chance of transferring to adults. Adults have probability of 0.1 of transferring to children, 0.3 of going to young people, and 0.5 chance of remaining in adults. At the end, however, if the transmissions start with either the youth or the adults, the probability is 1 that they would transfer the disease to children, and none to either the youth or the adults. Children would therefore, would have to stay with the HIV virus and suffer the consequences. This is a worrying analogy, since the country's posterity lies on our health-looking and reproductive children today. Hence, social intervention programmes must be geared towards these children to arrest the situation. Rigorous education prevention strategies must be implemented and sustained.

Conclusions and Recommendations

The Markov chain models produced stationary distributions of HIV/AIDS data in Upper East Region in both gender and age groups. These stationary distributions were either regular or non-regular. At steady states too, the transition matrices of both gender and age groups, whether regular or not, satisfied the fundamental and uniqueness theorems

that $\sum_{i=1}^n S_0 P_{ij}^n = S, i, j \geq 0$ and $SP_{ij} = S$ respectively. The regular means that such chains possess the properties of irreducibility and aperiodicity, and non-regular means that the chains had transient and absorbing states. In either case, we concluded that there was the likelihood that HIV/AIDS infections will not change or change much in the future in the gender and age groups (i.e. reached stationary states). Therefore, Markov chain models could be used to analyze such data.

Markov chain's theory can also be integrated in the study of applied mathematics and statistics. Topics in matrix algebra, linear algebra, probability models and difference equations can integrate Markov chains for study in our tertiary institutions of Ghana. This may diversify the applications of research tools of data analyses in Ghana.

Research Limitations

The major limitation was the inability to access a detailed, complete and comprehensive HIV/AIDS data from all the districts of Upper East Region. It was not easy to gather a complete data from all the sentinel sites in the region. So, much of the data was collected from the regional coordinator of HIV/AIDS, instead of the individual district focal persons. Therefore, the analysis may not represent the true picture of all the districts in the region.

Direction for Further Research

- The research needs to be replicated in the other regions of Ghana to ascertain its wider use and acceptability of the Markov chain methods.
- The researchers used discrete data to explore the Markov chain theory. We believe that better results could be obtained if one uses a continuous data.
- Secondary data was used for the whole analysis. The researchers recommend that a medical expert undertakes this type of research to assess its real scientific base.

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References

- Barnett, R.A. Ziegler, M.R. and Byleen, K.E. (2000). *Applied Mathematics for Business, Economics, Life Sciences and Social Sciences (7ed)*. New Jersey: Prentice-Hall, pp. 463-509.
- Carter Jr, E.F. (2008). Random Walks, Markov Chains and the Monte Carlo Method. [<http://www.taygeta.com/rwalks/rwalks.html>, accessed May 27, 2009].
- Cao, X.R. (2007). *Stochastic Learning and Optimization, A Sensitive-Based Approach*. New York: Springer[<http://www.ust.hk/~eecao>, accessed 2008, October 24].
- Chen, J. (2003). *Applied Probability Theory (Lecture Notes)*. Fall: Waterloo University.[<http://www.stat.ubc.ca/~jhchen/stat461/ttitle.pdf>].
- Lam, P. (2009). *Convergence Diagnosis*. [<http://www.people.fas.harvard.edu/convergence/convergence-print.pdf>, accessed 9th July, 2009].
- Lawler, F.G. (1995). *Introduction to Stochastic Processes*. Florida: Chapman and Hall/CRC, pp. 1-17.

- Law, J. (2008). *Discrete-Time Markov Chains*. course.ie.cuhk.edu.hk/~ieg4140/tutorial%20notes/tutorial%201.ppt, accessed September 4, 2009).
- Lawson, T. (1996). *Linear Algebra*. New York: John Wiley and Sons, Inc., pp. 233-293
- Mathews, J.H. and Fink, K.D. (2004). *Numerical Methods Using Matlab (4th ed)*. New Jersey, pp. 609.
- Mira, A. and Sargent, D.J. (2006). *A new strategy for speeding Markov chain Monte Carlo algorithms* [http://www.springerlink.com/content/812605777731h323 accessed March 30, 2009].
- Nauroze, S.A. (2009). *Queuing Theory and Telegraphic Systems*. http://web.uettaxila.edu.pk/CMS/coeQTTSbsSp09/notes%5CLecture%202.pdf, accessed September 4, 2009).
- Nie, J.Y. and Ren, F. (2006). *Random Walks Markov Chains* [http://www.taygeta.com/rwalks/node7.html, accessed 2008, October 23].
- Roberts, G.O. and Rosenthal, J.S. (2004). *General State Space Markov Chains and MCMC Algorithms*. [www.emis.de/journals/ps/images/getdoc510c.pdfid=35, access May 30, 2009].
- Ross, M.S. (2000). *Introduction to Probability Models, (7th ed)*. San Diego: Academic Press, pp. 137-142.
- Smith, B.J. (2007). *BOA: An R Package for MCMC Output Convergence Assessment and Posterior Difference*. [http://www.jstatsoft.org/v21/i11/paper, access May 30, 2009].
- Tan, S.T. (1997). *Applied Finite Mathematics (5th ed)*. New York: Brooks/Cole, pp. 518-577.
- Walsh, B. (2004). *Markov Chain Monte Carlo and Gibbs Sampling*. [http://www.maths.surrey.ac.uk/personal/st/S.Brooks/mcmc/.pdf, accessed May 19, 2009].
- Weisstein, E. W. (2005). *Markov Chains* [://mathworld.wolfram.com/MarkovChain.html, accessed 2008, September 27].

TENDERIZATION OF BAMBARA BEANS USING PAPAIN

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The study was undertaken to investigate the effect of papain on the proximate and mineral composition of Bambara beans (*Vigna subterranea*). Processing methods namely raw, soaking, pressure cooking, and the use of fresh and dried pawpaw peels (papain) were employed. The cooking time of bambara beans cooked with pressure cooker was lower (50 minutes) compared to that of both fresh and dried pawpaw peels (papain) which had 3h: 8min and 3h: 13minutes respectively. However that of raw cooked bambara beans attained the highest cooking time of 3h: 35minutes. There was substantial recovery of crude protein after processing from 19.90 ± 0.27 to 24.81 ± 0.20 (g/100g dry weight). Result of the moisture content ranged from 9.55 ± 0.32 to 10.42 ± 0.23 (g/100g dry weight), ether extract 11.97 ± 0.20 to 13.89 ± 0.36 (g/100g dry weight), carbohydrate 45.62 ± 0.23 to 51.39 ± 0.34 (g/100g dry weight), ash content 1.55 ± 0.22 to 3.37 ± 0.20 (g/100g dry weight), and crude fibre 2.30 ± 0.51 to 3.75 ± 0.35 (g/100g dry weight). Minerals such as calcium, iron and phosphorous were not significantly affected by the various cooking methods employed. Sensory evaluation showed that sample B (pressure cooked bambara beans) was the most preferred by untrained panelist. The results show that the processing improved the nutritional value of the bean which could serve as important component of food.

Key words: Bambara Beans; Processing; Proximate composition; Mineral content.

Introduction

The high cost and reduced supply of animal protein, the economics of meat productions, and the recognition that meat consumption is often accompanied by an increased intake of saturated fat and cholesterol have possibly brought about an increased emphasis on the use of plants as a source of protein recently (Brough and Azam-Ali, 1992). The major source of plant proteins are legumes, nuts and cereal grains. Bambara beans are a typical example of a legume and can be consumed in different forms either in the immature green state or matured form. During maturity, the seeds become very hard and therefore require boiling before any specific preparation can be carried out. Various mature dry legumes contain about 20 – 40% proteins. Bambara beans is one of the best sources of plants protein, especially for vegetarians and it is a cheaper source of protein than meat. It is also a rich source of complex carbohydrate and contains low level of fats. It has no cholesterol and is a good source of fiber; furthermore, it is a source of plentiful supply of thiamine (Vitamin B) and some minerals (Brough and Azam-Ali, 1992). Seeds of Bambara beans are not sold on world markets but play an important part in the diet of people in several West African countries where they are the third most important commodity after cowpea and groundnut in the national production and consumption statistics (Baudoin and Mergaei, 2001). Bambara beans is the only legume whose seeds are referred to and used as complete food because they contain protein, carbohydrate and fat in sufficient proportions to provide a nutritious food (Goli, 1995). The seed are consumed either immature or in matured states, but dry seeds are hard and difficult to cook and may be ground before use (Tweneboah, 2000).

Brough and Azam-Ali (1992), also reported that Bambara beans seed makes a balance food as it contains carbohydrate (63%), protein (16.25%), and fats 96.35% with relatively high proportions of lysine and methionine as percentage of the protein (6.6 and 1.3%) respectively. The ripe seeds contain on average 10% water, 15-20% protein, 4-9% fat, 50-65% carbohydrate and 3-5% fiber (Boudion and Mergaei, 2001). The gross energy value of Bambara groundnut seed is greater than that of other common pulses such as cowpea, lentil and pigeon pea (FAO, 2001). Purseglove (1992) also reported that the ripe seeds contain: protein 16-21%; fat 4.5-6.5%; carbohydrate 50-60%; thus providing a completely balanced food. Brink *et al* (2006) mentioned that dried leaves for fodder contain crude protein 15.9%, crude fiber 31.7%, ash 7.5% and fat 1.8%.

The protein in Bambara beans is incomplete because it lacks the essential amino acids methionine and tryptophan. The grains example, wheat, and rice have adequate levels of these limiting amino acids, methionine and tryptophan. As a result when beans and the grains are blended together, the quality of protein in the grain is complemented by the amino acid in the beans.

Cooking is an important way of processing beans. Legumes contain certain anti-nutritional and toxic factors that must be inactivated before their full value is realized. For example, raw soybeans contain an anti-trypsin factor or trypsin inhibitor and other legumes contain hem agglutinins. These factors interfere with normal growth of animals and humans; fortunately they can be inactivated by cooking or by controlled heating during processing (King *et al.*, 1985). Milner (2000) reported that proteins in legumes coagulate during cooking, and become more available.

In Ghana, the beans used to be canned in gravy at GIHOC Cannery in Nsawam. The product was thus available throughout the year and over 40,000 cans of various sizes were produced annually (Doku and Karikari, 1971). Currently, to reduce processing time the methods used include;

- Soaking of the beans in cold water overnight
- Addition of potassium nitrate (saltpeter) or baking soda to bambara beans during cooking.

Soaking makes the Bambara beans a bit tender before cooking and reduces cooking time. The results obtained by Gates (1987) when a pressure cooker operating at 15pounds pressure was used to one cup of soaked soybean, indicated a 57.1% reduction in cooking time as against the one without soaking. Soaking in water also reduces the flatulence factor. However, it leads to nutrient losses, especially minerals and water-soluble vitamins. The use of regular saucepan requires several hours of cooking which may lead to greater nutrient losses, increased fuel consumption with its concomitant increased cost of production, affecting cost at which it is sold.

The use of saltpeter and baking soda also reduces processing time but may cause stomach upset. Papain belongs to a family of related proteins with a wide variety of activities, including endopeptidases, amino peptidases, dipeptidyl peptidases and enzymes with both exo- and endo-peptidase activity (Rawlings and Barrett, 1994).

Members of the papain family are widespread, found in baculovirus, eubacteria, yeast, and practically all protozoa, plants and mammals (Rawling and Berrett, 1994). The proteins are typically lysosomal and proteolytic cleavage of the propeptide is required for enzyme activation. Its utility is in breaking down tough meat fibers and has been utilized for thousands of years in its native South America. It is sold as a component in powdered meat tenderizer available in most supermarkets.

Research has shown that papain attacks the protein in meats and breaks it down to make it tender. It is also believed that the enzyme (papain) in the peels of pawpaw could similarly attack the proteins in bambara beans to make it tender. If a best processing method is ascertained it could be use as a cooking method which will be accepted by consumers and also help reduce the time for cooking bambara beans, reduce fuel consumption and also reduce nutrient losses.

Objectives

To determine the cooking time for Bambara beans with papain from the pawpaw peel and those without papain (raw, soaking and pressure cooked bambara beans).

- To assess the nutritional composition of the cooked Bambara beans and
- To evaluate the consumer acceptability of the cooked Bambara beans.

Method of Cooking Bambara beans

Beans and dried legumes require soaking in room temperature water, a step that rehydrates them even before cooking. Table 1 shows the pressure cooking time for beans, legume and lentils.

Table 1: Pressure Cooking Timetable for Dried Beans, Legume and Lentils

Dried Beans & Legume	Dry, Cooking Time (in Minutes)	Soaked, Cooking Time (in Minutes)
Adzuki	20 – 25	10 – 15
Bambara beans (<i>Vigna subterranea</i>)	20 – 45	20 – 40
Black beans	20 – 25	10 – 15
Black-eyed peas	20 – 25	10 – 15
Chickpeas (chick peas, garbanzo bean or kabuli)	35 – 40	20 – 25
Cannellini beans	35 – 40	20 – 25
Gandules (pigeon peas)	20 – 25	15 – 20
soya beans	25 – 30	20 – 25

SOURCE : (Ko lar *et al.*, 1983)

Bambara Beans

Bambara beans (*Vigna subterranea* L. Verdc) is a novel legume of African origin grown mainly by subsistence female farmers intercropped with major commodities such as maize, millet, sorghum, cassava, yam, peanut and cowpea. Sellscope (1962) stated that Bambara groundnut is the third most important legume after groundnut (*Arachis hypogea*) and cowpea (*Vigna unguiculata*) in Africa.

Bambara beans is a pulse with subterranean fruit-set and is cultivated by smallholders over much of semi-arid Africa (Azam-Ali, 1992). The crop is a legume species of African origin Bender (1992), and is widespread south of the Sahara (Ocran *et al.*, 1998). Food legumes have a major role to play in the fight against malnutrition. It is therefore necessary that their levels of consumption, which are already too low in a number of developing countries, should be increased (Bender, 1965).

Uses of Bambara Beans

Bambara bean is eaten in various ways, depending on the region. They can also be processed into flavour for use in soups, purees and flat cakes. The canning of Bambara seeds in sauce has been reported in Ghana (Baudoin and Mergaei, 2001). The crop is grown mainly for its edible protein and not as an oil crop. When dried, the seeds are very hard and can only be eaten when ground into flour. Unripe seeds can be eaten fresh but seeds have to be soaked and boiled before eating (Gibbon and Pain, 1985). Doku and Karikari (1971), reported that in Ghana, the nuts are boiled with pepper and salt in the preparation of ‘Aboboi’ which, when served with ‘gari’ (grated and roasted cassava) or ‘tatare’ (mashed fried ripe plantain), makes a very delicious meal.

In many West African countries, the fresh pods are boiled with salt and pepper, and eaten as a snack. In Cote d’Ivoire, the seed is used to make flour, which makes it more digestible. In East Africa, the beans are roasted, then pulverized, and used to make a soup with or without condiments. Bread made from Bambara beans flour has been

reported in Zambia. In Senegal leaf preparations are applied to abscesses and infected wounds, leaf sap is applied to the eyes to treat epilepsy, and the roots are sometimes taken as an aphrodisiac. Pounded seeds mixed with water are administered to treat cataracts. The leaves which are rich in protein and phosphorus are used as fodder for livestock.

- It is made into a relish mixed with onions, tomatoes and oil.
- The seeds are milled into flour and used to make small flat cakes or biscuits.
- The flour is mixed with cereals and used to make porridge.
- It is mixed with maize to make a very filling porridge.
- It is boiled and eaten together with plantains.
- Fresh seeds are roasted and eaten as a snack.

Materials and Methods

Source of Materials

The pawpaw was obtained from the Ministry of Food and Agriculture (MOFA) in Kwabeng in the Eastern region. Bambara beans were purchased at the Makola market, Accra. Various processing methods were employed to prepare the bambara beans and these include cooking of Bambara beans using the soaking method, cooking of Bambara beans using papain (dried pawpaw peels), cooking of Bambara beans using papain (Fresh pawpaw peels), cooking of Bambara beans with a pressure cooker, cooking of raw Bambara beans.

Nutritional Analysis of Samples

Nutritional composition of the raw, soak, pressure cook and papain cook bambara beans were carried out using Official methods of analysis, (AOAC, 1980).

These were all done in duplicates.

Statistical Analysis

Statistically Analysis were carried out using Complete Randomized Design (CRD) with SPSS VERSION 10, and determinations were done in duplicates. A p-value of less than 0.05 was considered statistically significant.

Sensory Evaluation using Untrained Panelist

Sensory evaluation of the various processing methods employed in cooking bambara beans were done using untrained panelists. The panelists were to assign score to their preference for the various attributes using a seven (7) point hedonic scale with 1 being like extremely and 7 dislike extremely. The attributes that were looked out for were appearance, flavour, taste, mouth feel, after taste, colour and overall acceptability.

A= bambara beans cooked with papain from dry papaw leaves

B= bambara beans cooked with pressure cooker

C= bambara beans soak in water overnight before cooking

D= bambara beans cooked with papain from fresh papaw leaves

E= bambara beans cooked without adding anything

RESULTS

Composition of processed Bambara Beans

The proximate and mineral compositions of processed Bambara beans are shown in Table 2.

Table 2: Proximate and mineral compositions of processed Bambara Beans

Components	Contents of Samples				
	Raw Bambara Beans	Pressure Cooked	Soaked Bambara	Fresh Pawpaw peel (papain)	Dried Pawpaw peel (papain)
Moisture	9.55±0.32	9.85±0.33	10.42±0.23	9.70±0.33	9.90±0.20
g/100g dry weight					
Crude protein	19.97±0.27	24.81±0.20	23.40±0.26	21.70±0.25	21.60±0.30
g/100g dry weight					
Crude Fat	11.97±0.28	13.89±0.36	12.97±0.37	12.50±0.30	12.45±0.31
g/100g dry weight					
Ash	3.37±0.20	2.27±0.25	1.55±0.22	2.49±0.21	2.65±0.24
g/100g dry weight					
Crude fiber	3.75±0.35	3.56±0.10	2.30±0.51	3.02±0.41	3.20±0.11
g/100g dry weight					
Carbohydrate	51.39±0.34	45.62±0.32	49.36±0.25	50.59±0.21	50.20±0.21
g/100g dry weight					
Iron	1.92±0.00	2.96±0.00	2.61±0.00	2.30±0.21	2.12±0.10
(mg)/100g					
Calcium	0.20±0.11	0.36±0.00	0.23±0.10	0.22±0.00	0.21±0.01
(mg)/100g					
Phosphorus	0.23±0.10	0.28±0.00	0.26±0.21	0.25±0.16	0.24±0.30
(mg)/100g					

Food processing may result in loss of nutrients or exposure of other nutrients which were hitherto unavailable in the raw food. Milner (2000) reported that processing of foods can influence the availability of nutrients either

positively or negatively. Consumption of processed Bambara groundnut makes the available nutrients more digestible, absorbable and available for growth and development. Bambara beans is the only legume whose seeds is referred to and used as complete food because they contain protein, carbohydrate and fat in sufficient proportions to provide a nutritious food (Goli, 1995), however, cooking time depends on the type of beans. It was observed that the pressure cooker took 50 minutes to cook the beans due to inbuilt pressure in the cooker; this was in contrast with (Kolar *et al.*, 1983), who reported that bambara beans should take between 20-45 minutes to cook. It was followed by the soak beans which took 2h: 34min for the fact that the beans absorbed more water during soaking which made the beans turgid. Papain from fresh and dried pawpaw peels had 3h: 8min and 3h: 13min respectively due to the release of enzymes to break down the peptide bond in the beans as reported by (Lopes *et al.*, 2007). However, the raw Bambara beans attained the highest cooking time of 3h: 35min for the fact that it was not given any treatment. Table 2 shows the results of proximate and mineral composition of the processed bambara beans, crude protein value of 19.97 ± 0.27 , 21.60 ± 0.20 , 21.70 ± 0.26 , 23.40 ± 0.25 , 24.81 ± 0.30 (g/100g dry weight), were observed for raw, dried pawpaw peels (papain), fresh pawpaw peel, soaked and pressure cooked respectively. The observed increased may be due to destruction of certain anti nutritional factors resulting in the release of nutrient. Ether extract significantly increased with the pressure cooked bambara beans with value of 13.89 ± 0.36 (g/100g dry weight) compared to the raw with a value of 11.97 ± 0.28 (g/100g dry weight). The ash content greatly reduced from 3.37 ± 0.20 (g/100g dry weight) in the raw to 1.55 ± 0.22 (g/100g dry weight) in the soaked. Crude fibre values range from 3.75 ± 0.35 (g/100g dry weight) to 2.30 ± 0.51 (g/100g dry weight) in the raw and soaked respectively, while values of 9.55 ± 0.32 to 10.42 ± 0.23 (g/100g dry weight) and 51.39 ± 0.34 to 45.62 ± 0.32 (g/100g dry weight) were recorded for moisture and carbohydrate respectively.

The mineral composition of the raw and processed bambara beans, as shown in Table 2, revealed that all the minerals investigated are present in appreciable levels. Processing caused a reduction in the amount of some minerals as observed in calcium (0.36 ± 0.00 to 0.20 ± 0.02) (mg/100g) ash, iron (2.96 ± 0.00 to 1.92 ± 0.10) (mg/100g) ash, and phosphorous (0.28 ± 0.00 to 0.23 ± 0.30) (mg/100g) ash, calcium, iron and phosphorous contents were not significantly affected by processing. This is in contrast to the observation by Osho *et al.* (1995) that processing techniques such as soaking etc contribute significantly to minerals and vitamin losses.

Sensory Evaluation by Untrained Panelist

Sample A was bambara beans cooked with papain from dry papaw leaves, sample B was cooked using a pressure cooker, sample C was bambara beans soak in water overnight before cooking, sample D was bambara beans cooked with papain from fresh papaw leaves and sample E was bambara beans cooked without adding anything. The attributes that were looked out for were appearance, flavor, taste, mouth feel, after taste, colour and over all acceptability. Cooked samples A-E were presented for sensory evaluation by thirty untrained panelists. The results of this study are presented in Table 3.

SAMPLES	A	B	C	D	E
ATTRIBUTES					
Appearance	2.45	1.93	2.32	2.57	2.33
Flavour	2.40	2.22	2.30	2.42	2.24
Taste	2.60	2.20	2.36	2.80	2.48
Mouth feel	2.70	2.11	2.52	2.71	2.60
After taste	2.40	2.05	2.10	2.47	2.20
Colour	2.25	1.91	2.09	2.32	2.13

Overall acceptability	2.52	2.10	2.30	2.80	2.41
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Appearance, flavor and taste of cooked samples ranged from 1.93 to 2.57, 2.22 to 2.42 and 2.20 to 2.8 for sample A and E respectively, sample B was the most preferred and D the least preferred. Sample B was ascribed because it was prepared using the pressure cooker which gave it good organoleptic properties such as appearance, flavor etc and these are easily perceived by the senses compared to sample D which was bambara beans treated with fresh pawpaw peels (papain).

After taste and mouth feel of cooked samples ranged from 2.05 to 2.47 and 2.11 to 2.71 for samples B and D respectively. Colour and over all acceptability of cooked samples had values ranging from 1.91 to 2.32 and 2.10 to 2.80 for samples B and D respectively. Sample B was the most preferred and D was least preferred. Significant difference ($P < 0.05$) was observed between both the samples and the respondents. This could be assigned to the fact that sample D was prepared from fresh pawpaw peels compared to sample B which is cooked using the pressure cooker which has good organoleptic properties which were easily perceived by the senses.

Conclusion and Recommendation

This study has shown that the various methods of cooking such as soaking, pressure cooking, and the addition of papain etc affected the cooking time and nutritive value of Bambara beans with some losses of nutrients. The cooking time of bambara beans cooked with pressure cooker was low compared to that of both papain from fresh and dried pawpaw peels with that of raw cooked bambara beans attaining the highest cooking time. There was substantial recovery of crude protein after processing, with a substantial increase in moisture, crude fibre, fat and carbohydrate content. Minerals such as calcium, iron and phosphorous were not significantly affected by the various cooking methods employed. Sensory evaluation showed that sample B (pressure cooked bambara beans) was the most preferred by untrained panelist. It is therefore recommended that pressure cooking of legumes for that matter bambara beans is the best processing method to be adopted to achieve maximum dietary needs.

References

- **AOAC (1980).** Official methods of analysis. 13 ed. Washington, DC: Association Official Analytical Chemists.
- **Azam-Ali, S. N (1992).** Evaluating the potential of Bambara groundnut beans and soybean intake. *Am J Clin Nutr (suppl)*; 70:464S–74S. pp. 89
- **Baudoin, J.P. and Mergeai, G (2001)** Grain Legumes in Crop production in Tropical be antiestrogenic in male mice. *J Nutr* ;125:437–45.
- **Bender, A.K. (1965).** Dictionary of nutrition and food technology. 2nd ed. London: and Co Ltd. Pp 12-118.
- **Brough S.H and Azam-Ali S.N (1992).** The effect of soil moisture on the proximate composition of soybean. *Am J Clin Nutr (suppl)*; 1431S–10S. Vol. 14. pp 15-25
- **Doku EV. and Karikari, S.K. (1971).** The role of ants in pollination and pod: 1st ed. Macmillan Education Limited. pp 147-149, 224-228, 246-247
- **FAO (2001).** Agricultural and Horticultural Seeds. FAO Agricultural Studies No. 55.

- **Fetuga, B.L., Babatunde, G. and Oyenuga, V. A. (1973).** Protein quality of some Nigerian foodstuffs. 1. Chemical assay of nutrients and amino acid composition. *J Sci Food Agric*; 24: 1505-14.
- **Gate, J.C. (1987).** Basic foods. 3rd ed. Library of Congress Cataloging –in- Publication data. Harcourt Brace Javanovich College Publishers. U.S.A. Pp. 31
- **Gibbon, D. And pain A. (1985).** Crops of the Drier Regions of the Tropics, Longman. U.S.A P 66
- **Goli A.E. (1995).** Potential of African indigenous fermented foods. In: Prague L, ed. Development of indigenous fermented foods and food technology in Africa. Proceedings of the IFS/UNU Workshop held in Duala, Cameroon, October 1985. Provisional Report No. 20. Stockholm: International Foundation for Science: pp 35-71.
- **King J, Nnanyelugo DO, Ene-Obong HN, Ngoddy PO.** Household consumption profile of cowpea (*Vigna unguiculata*) among low income families of Nigeria. *Ecol Food Nutr* 1985: 16: 209- 21.
- **Kolar, C. W., S. H. Richert, C. D. Decker, F. H. Steinke, and R. J. Vander Zanden. (1983).** Isolated Soy Protein Orlando Academy Press.
- **Lopes MC, Mascarini RC, da Silva BM, Flório FM, Basting RT (2007).** "Effect of a papain-based gel for chemomechanical caries removal on dentin shear bond strength". *J Dent Child (Chic)* 74 (2): 93–7. PMID 18477426.
- **Milner, J. A (2000):** Functional foods: the US perspective. *The American Journal of Clinical Nutrition* 71 (6): 1658 – 1662.
- **Ocran V. K. Delimini, L. L. Asuboah, R. A and Asiedu, E. A (1998).** Seed oestrogens in Japanese men. *Lancet* 1993;342:1209–10.
- **Osho, S.M, Ogundipe, H.O and Dashiell, K. (1995):** Soyabeans processing and utilization in Nigeria. In: Tropical post Harvest. Osagie, A.U. (ed) Post Harvest Research Unit, University of Benin. P. 109 – 115
- **Purseglove J. W (1992).** Tropical crops (Dicotyledons). Longman House Burnt Mill quality of proteins containing antinutritional factors and of poorly digestible p.115-160
- **Rawlings ND, Barrett AJ (1994).** "Families of cysteine peptidases". *Meth. Enzymol.* **244**: 461–486. PMID 7845226.
- **Sellscope, J.P.F., 1962.** Cowpea (*Vigna unguiculata*L.Walp). *Field Crop Abstract*, 15: 259-266.
- **Tweneboah, C. K (2000).** Modern Agriculture in the tropics food crops. Co-wood University of California (Division of Agricultural Science)

SURVEY OF COMMERCIAL VEHICLE TIRES USED IN GHANA; A CASE STUDY OF FOUR CITIES

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The use of second-hand tires in Ghana is on the increase. The study conducted was to access the type of vehicle tires used on most of our commercial vehicles in Ghana, whether they are new or used types, the life span of such vehicle tires and the rationale behind the use of such tires on commercial vehicles in Ghana. Commercial vehicle drivers' knowledge on the information's written on the tires used on their vehicles were accessed. Structured interviews were conducted with some commercial drivers in some selected major lorry parks in Ghana – Tema, Accra, Kumasi and Koforidua. SPSS software was used to analyse the gathered data. Nine hundred commercial vehicles (900) were accessed, making up of three thousand and six hundred (3600) vehicle tires were studied to check on the combinations under the vehicle, expiring dates and the overall nature of the tires under the vehicles.

Keywords: Second-hand tires; Vehicle; Lorry Parks; Expired tires; SPSS software.

Introduction

The importation of used vehicle tires into Ghana is on the increase; however, there are no checks on the state of such tires as they find their way onto the Ghanaian markets. Many vehicle users rely on these tires for replacement on their vehicles. This research is to ascertain the state of tires used on commercial vehicles which seems to carry not more than five passengers for taxi cab, between twelve and fifteen passengers for mini vans and above fifteen passengers for large buses. Tires, like any other rubber product, have a limited service life, regardless of tread depth and use. Automobile tires are among the most critical components of the motor vehicles, requiring proper maintenance to minimize the risks of accidents associated with failure. Tire failures at high speeds in vehicles such as Sport Utility Vehicles (SUVs) have resulted in vehicle rollovers, serious injuries and occupant death. Tire degradation, as a result of age related factors, can be contributor to tire failure for which many people may have little awareness. Tire aging, or more technically, thermo-oxidative aging, refers to the reduction in or loss of a tire's material properties, which leads to a reduction in the tire's performance. Aging is affected by heat generation and the chemical degradation of the rubber components from oxidation.

Although it is well known that many people are killed in vehicular crashes, it is less well known that a substantial number of crashes (an estimated 6000 in the U.S. annually) are caused by improper vehicle maintenance and defective tires (National Highway Traffic Safety Administration, NHTSA, 2001). The pervasive role of improper maintenance and defective tires in crashes was brought sharply into focus following the discovery of a large number of Ford Explorers with Firestone tires that were involved in rollover accidents around the world.

According to one source (Kane, 2003), old tires – more than five to six years old become increasingly susceptible to separation or blow-out because tire components dry with age and can separate, causing the tire material to disintegrate. Tires are even more susceptible to failure when they are driven at high speeds or in hot and dry weather even if they have plenty of tread (Kane, 2003). In a 1997 report from Mercedes Benz Research and Technology Division, it says 'Tires undergo an ageing process even when they are not in use. The rubber parts become less elastic, the steel webbing inside the tyre corrodes and the rubber mixture of which the tread is formed hardens (Safety Research & Strategies, Inc., 2005).' Thus, spare tires, tires in storage or on a shelf prior to use, or tires that are infrequently used on trailer or recreational vehicles, run the risk of premature aging and may be unsafe even though they may have sufficient amounts of tread or appear 'new.'

Background on Passenger Tires

This section deals with the introduction and overview of basic terminology and trends pertaining to passenger tires and their uses, background on the development and the structure of tires, and tire regulations and standards.

Pneumatic, or air-filled, tires are used on vehicles as diverse in form and function as airplanes, bicycles, tractors, and race cars. Accordingly, they encompass a wide range of sizes, designs, materials, and construction types. Nevertheless, structural elements that are common to all of these tires are the casing, bead, and tread band. The casing often called the carcass is the structural frame of the tire. It usually consists of directionally oriented cords banded together by rubber into layers, called plies, which give the tire strength and stiffness while retaining flexibility. The number of plies is determined by tire type, size, inflation pressure, and intended application. Plies oriented mainly from side to side are "radial," while plies oriented diagonally are "bias." In the area where the tread is applied, the plies in the radial casing are usually covered by a relatively stiff steel belt or a steel belt covered by a circumferential nylon cap ply. The steel belt is made by using fine wire twisted into cables as cords. For the inflated tire to be retained on the wheel rim, the plies are anchored around circumferential hoops made of multiple strands of fine, high-tensile wire located at the inner edges of the two sidewalls where they mate with the rim. These two hoops, called beads, are pressed against the rim flange by inflation pressure, thereby seating and sealing the tire on the rim. Encircling the tire is the tread. This is a thick band of rubber that forms the tire surface, from its crown (its largest radius) to its shoulders (the areas in which the tread transitions to the sidewalls). The tread is the only part of the tire that comes in contact with the road surface during normal driving. The tread band consists of a grooved section on top of a base. The tread's design, including its grooved pattern, helps in the removal of road surface water and other contaminants from under the tire while maintaining an adequate level of frictional adhesion between the tire and road to generate torque, cornering, and braking forces under a wide range of operating conditions.

Figure 1, below displays the information molded in the passenger tire sidewall, including the size designation that usually follows the tire's name.

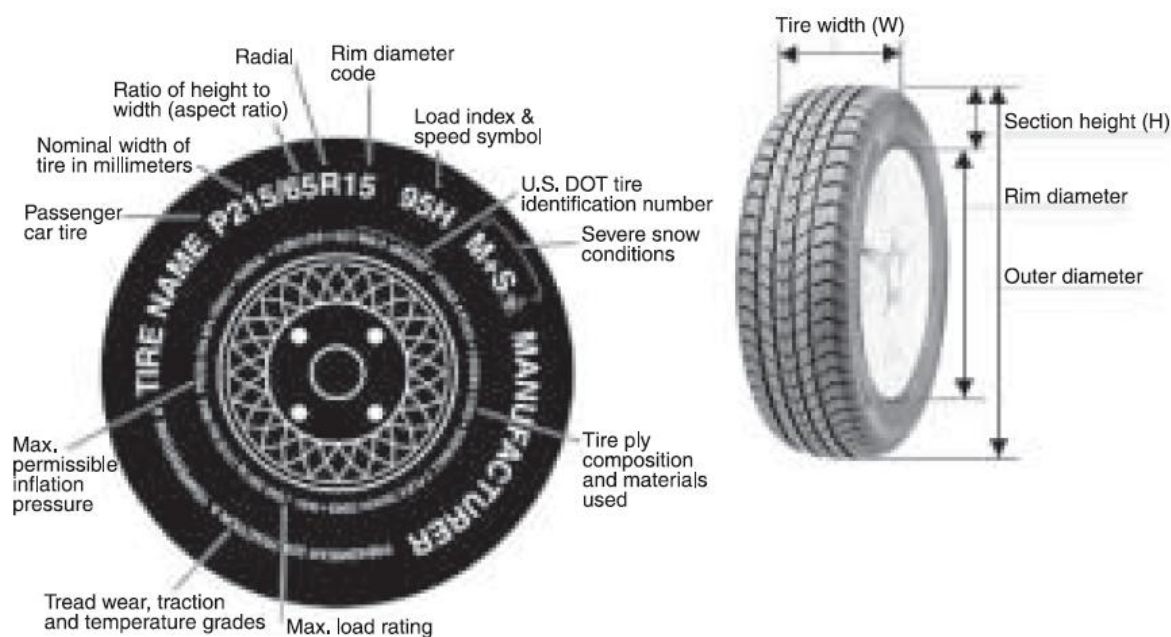


Figure 1: Passenger tire sidewall information and major dimension.

(SOURCE: www.tireguides.com)

The tire's section width (in millimeters) is the first number in the size designation, followed by its aspect ratio, which is calculated by dividing the tire's section height by its section width and multiplying by 100. Rim diameter (in inches) is the last number in the series, after "R" for radial. Hence a passenger tire with size designation P215/65/R15 has a section width of 215 millimeters, an aspect ratio (or profile series) of 65, and an inner circumference to fit a rim 15 inches in diameter.

Dangers with Old Tires

It is recorded that from 1994 to 2004, the NHTSA reported that about 400 fatalities occurred in the United States due to tire failure (source: National Highway Traffic Safety Administration). Tire's longevity is affected by factors like oxidation, over-and under-inflation, overloading a vehicle beyond an acceptable weight, improper maintenance, structural defects and improper installation of the tire.

Aged tires are more prone to failure even they appear to be new (as in the case of original spare tires). When oxidation of a tire occurs, the breakdown of material properties in that tire can lead to tread separation. Figure 2.below indicates tire tread separation which did contributed in the rollover of the vehicle.



Figure 2. Tire treads Separation.

(SOURCE: Leslie, M. and Theodore, J. 2010)

Tread separation is when the tread section of a tire peels off from the rest of the tire during use. Oxidation causes the steel belts in the tire to lose their adhesion to the rest of the components. The combination of these factors can then cause the entire tread to separate from the tire, potentially causing driver to lose at least some control over the vehicle. Research findings suggest that tires age faster in regions with higher ambient temperatures, and that low tire pressure was not the only failure mechanism at work. The U.S., NHTSA performed a field study, where the agency determined that this thermo-oxidative degradation is accelerated with higher temperatures and is a contributing factor for tire failures, such as tread separations. Figure 3: an overage tire, which was manufactured in the 44th week of the year 2004, this indicates that the tire is almost eight years since it was manufactured to date (the year 2011).



Figure 3: An over-aged tire
(Source: Field study).

Research Methodology

Inspection done on vehicles tires can be mandatory or voluntary. The inter- inspection interval of a mandatory scheme can vary according to the age of the vehicle. In Ghana periodic vehicle tires inspections are almost non-existent. Due to the lack of accurate and detailed accidents statistics on failures of vehicle tires in accidents, data were collected from,

- Commercial vehicles stations (at Accra, Kumasi, Tema, and Koforidua) concerning the general conditions of their tires.
- Commercial drivers on their knowledge on vehicle tire- aging and how to identify the expiration of their tires.

It is known that,thereare only four small areas of the tire tread that makeestablished contact between the vehicle and the road.This allows the power developed by the engine to starta vehicle in motion and keep it in motion. The tire tread contact areaallows the steering system of a vehicle's direction to be controlled and also, enables the braking system to bring thevehicle to a stop. It is apparent that avehicle's tires are probably of the most importantcomponents as far as safety is concerned. In addition,tire inflation pressure, thread condition, the state of the tire and expiring age of the tires play amajor role in determining second hand tire characteristics. Although tire manufacturers stipulate the tire pressures for variousvehicles, there is a tendency to ignore the importanceof this factor to vehicle safety. Therefore, thissurvey sampledcommercial vehicles in some selected regional capitals in Ghana and concentrated on tire wear, state of the tire, expiring condition of the tires andinflation pressure. These properties were noted while the vehicles were parked during the day attheir stations. The data were obtainedwhile the vehicles were stationary.

The data obtained were compiled using SPSS software as well as the analysis of the data obtained.

Results

This is a representation of the data collected from the field of study which includes:

- types of vehicles
- classes of tires used
- drivers awareness on expired tires and the consequences
- expired tires used on vehicles
- condition of the tires used.

The samples of the vehicles collected from four major lorry parks in Ghana from three regional capitals and one metropolis on the capital city are shown in table 3.1. The mini buses sampled in these parks were 420 making up about 47% of the total vehicles since they were the preferred mode of transportation in these areas. However, the buses were for long distance journeys which makes up only about 22 % and the taxis for short distances make up about 31 %.

Table 1: Types of vehicles involved in the study.

Type of vehicle	Frequency	Percentage
Taxis	281	31.2
Mini Bus	420	46.7
Bus	199	22.1
Total	900	100.0

(Source: These are results of the project survey).

About 20 % of the vehicles sampled use new tyres as shown in table 3.2. However, 60 % of the vehicles, making up the majority use second hand while close to 10 % use both new and old tyres. Adequate information on the status of the tyres for 92 vehicles could not be obtained because the drivers were not available to provide them.

Table 2: Class of vehicle tires being used by the drivers.

Class of tires being used	Frequency (vehicles)	Percentage
New	181	20.1
Second hand	541	60.1
Mixed(New & Second-hand)	86	9.6
Missing(Drivers not available)	92	10.2
Total	900	100.0

(Source: These are results of the project survey).

Significantly, over 90 % of the vehicle drivers are not aware that vehicle tyres expire and will require replacement after six years of manufacture, as shown in table 3.3. Whereas 155 vehicles knew of tyre expiration, 89 of drivers were not available for the response.

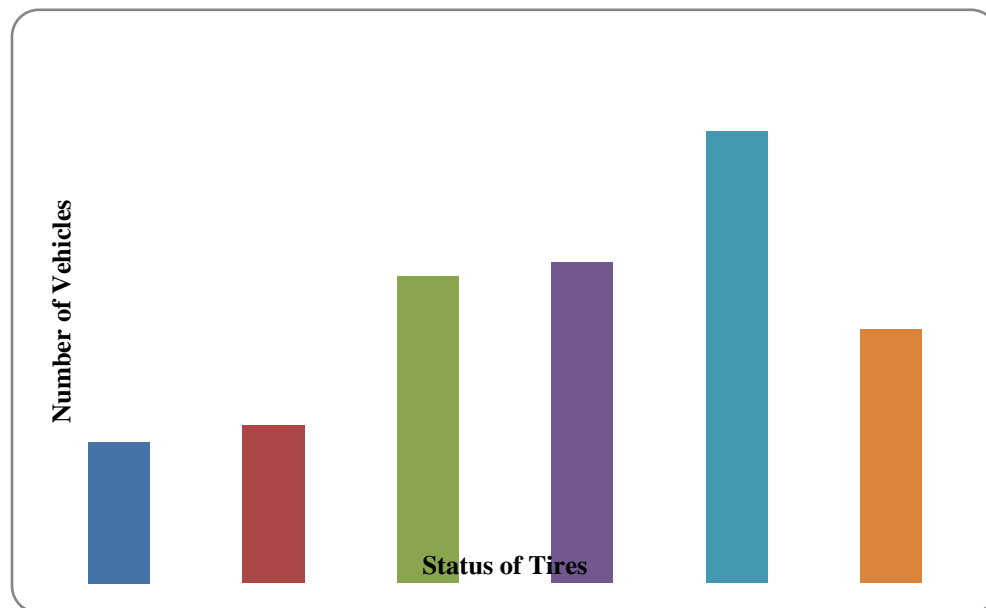
Table 3: Awareness of drivers on expired tires

	Frequency(Drivers)	Percentage
Yes	155	17.2
No	656	72.9
Missing(Drivers not available)	89	9.9
Total	900	100.0

(Source: These are results of the project survey.)

It was observed that 249 (27.7 %) of the vehicles examined were using new tires and 8.7 % were using tires that were expired as shown in Figure 4.

Figure 4: The state of tires employed on commercial vehicles- taxis and mini buses



(Source: These are results of the project survey.)

4.0 Discussions

Types of vehicle

In all a total number of nine hundred commercial vehicles were involved in the research study, 31.2 % - taxis, 46.7% - mini buses and 22.1% - Buses. With these numbers of vehicles, eight hundred and eleven drivers were available to us for their view on second hand tires as well as their knowledge on the expired or aged tires. The remaining drivers (89) were not around their vehicles as the data were recorded, even though their vehicles were accessed.

Classes of Vehicle Tires used against Types of Vehicles

Table 4 gives a cross tabulation of type of vehicles and class of tires used on them. It will be realized that, about five hundred and forty-one (541) vehicles comprising of the types had second-hand tires on their vehicles, only one hundred and eighty-one(181) vehicles used new tires and eighty –six (86) vehicles had a mixed of new and second tires on their vehicles. The remaining eighty-two (82) vehicles were not classified because the respective drivers were not available at the station when the data was being collected, even though the tires on the vehicles were accessed.

Figure 5: cross tabulation of type of vehicles used and the class of tires used.

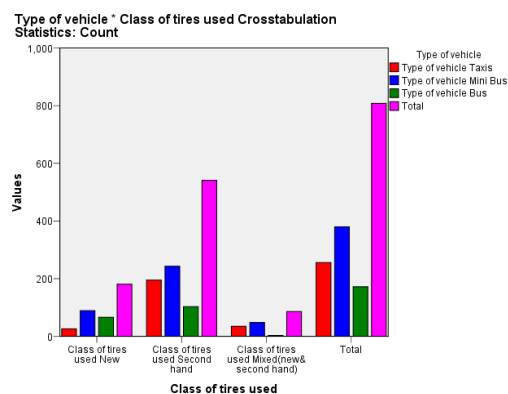


Table 4: The state of tires and the type of vehicles/classification of vehicle using them.

		The state of vehicle tires being used					Total
		All four tires expired	Three tires expired	Two tires expired	One tire expired	None expired	
The type of vehicle	Taxis	28	28	61	54	57	228
	Mini Bus	45	40	65	96	120	366
	Bus	5	19	43	27	72	166
	Total	78	87	169	177	249	760

(Source: SPSS analysis - cross tabulation of state of tires and class of vehicle).

From,table 4, it could be realized that, only two hundred and forty-nine (249) vehicles had none of their tires expired, indicating that five hundred and eleven(511) vehicles had at least one tire expired with details in table 4.3 as shown above. Now the tendency of these five and eleven vehicles experiencing tire failure in the course of driving is high. There might be vehicle tread separating, tire blown out, cracks and other forms of failure can result in road accidents on our roads in Ghana. The remaining one hundred and forty(140) vehicles had their tires wrongly fitted on the rims, with that the details written on the tires will be turned inside, making it impossible to have the detailed information on the tire.

Drivers Awareness of Expired Tires

From the study, it was realized that, one hundred and fifty-five drivers who participated in the study were aware that vehicle tires expired but they were unable to tell how that code could be read on the tire. Six hundred and fifty-six (656) drivers were not aware that vehicle tires expire. Eighty nine drivers (89) were not available for their views to be captured.If majority of commercial vehicles drivers patronized second-hand tires are not aware of tire aging and their consequences as they are being used, then one could tell what can happen on our roads in Ghana. Precious human lives are being lost, injured and some remain incapacitated forever, because of these importations of aging vehicle tires into Ghana. Also, some might buy new tires alright, but ignorance of aged tires would also end up in vehicle tire failures in the cause ofdriving, which wouldresult in accidentson our roads.

Conclusion

In conclusion, this research reveals that many commercial drivers buy these second hand tires without knowing that they have expired and can be very dangerous on our roads, even though, these tires may have enough tread on them. Also, there must be massive education to all vehicles users and owners on the safety of vehicles tires and why one should buy newer tires which arenot over aged. The Ghana Standard Board (GSB) must ensure that, brand new tires that are being sold in Ghana are not inferior, since it was one the reasons why drivers prefer buying second hand tires to newer ones. Accident statistics, complied by Motor traffic and transport unit (M.T.T.U) of the Ghana Police service should ensurethat, data complied on the state of vehicle tires used any time they visit an accident scene and take records. Lastly, the Driver and vehicle Licensing Authority (D.V.L.A), should ensure that before issuing any road worthy Certificate to a vehicle, the tires of the vehicle should not go beyond six years from the week of manufactured.

Acknowledgement

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References

- Ford Motors Company. Tire Safety. Retrieved 15th February, 2010. From: <http://www.ford.com/en/innovation/safety/resources/tireSafety.htm>.

- Kana, S.E (2003).Tire age present serious hazards(Strategic Safety comments to NHTSA tire ruling dockets). Strategic Safety. Retrieved on 3rd March,2011, from:
• <http://www.strategicsafety.com/library/si008.pdf>.
- NHTSA (2001). Many U.S Passenger Vehicles are driven on under-inflated Tires. NHTSA
• 46-01. Washington D.C., U.S.A. Retrieved on the 3rd March, 2010.From:
• <http://www.nhtsa.dot.gov/people/ncsa>.
- Safety Research & strategies, Inc. (2005). ‘Aged’ Tire case Number Grow: Spares and used
• Tires top the list. Strategic Safety.Retrieved on 11th February, 2011. From:
• <http://www.safetyresearch.net/library/SRS039.pdf>.
- Starch, R. (1999). Tire Safety Survey. Retrieved on 29th February,2011.From:
• <http://www.safetyresearch.org/pdf/tss.pdf>.
- Tire aging.’ Why should you care? Retrieved on 20th March, 2012.From:
• <http://www.cdn.trustedpartner.com/docs/library/leopoldkuvin2011/.../LKTireAging.pdf>.

DESIGN OF ELECTROMAGNETIC SLEEP INDUCER FOR PATIENT SUFFERING FROM INSOMNIA.

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Sleeping difficulty known as insomnia is characterized by a chronic inability to fall asleep and stay asleep. Insomnia tends to increase with age and affects about 40 percent of women and 30 percent men. It is often the major disabling symptom of an underlying medical disorder. Many people experience sleeping well in natural surroundings due to their unconscious ability to perceive the natural magnetic field known as Geo-magnetic field. (This project is aimed at generating Geo-magnetic stimulation to modulate the electromagnetic potential rhythm of the cerebral cortex of the brain to induce sleep.) The electro-magnetic sleep inducer uses the effect of resonance in an electromagnetic field to control the potential rhythm of the cerebral cortex of the brain. These neurons being controlled by the body clock known as circadian rhythm signals when to fall asleep, perceived by the natural earth's magnetic field. In designing the device, a plastic box was used to enclose the circuit since metal cases severely limit electromagnetic radiation. After conducting tests on ten different people the result showed that, in comparison with melatonin stimulants and other sleep-aided devices, magnetic stimulation can influence and modulate the activities of brain potentials and consequently promote the efficiency of sleep process.

Keywords: Geo-magnetic; Electro-magnetic; Cerebral; Cortex; Modulate

Introduction

Sleep is a natural recurring state characterized by reduced or absent consciousness relatively suspended sensory activity, and inactivity of nearly all voluntary muscles. It is also a heightened anabolic state, accentuating the growth and rejuvenation of the immune system, nervous, skeletal and muscular systems. Sleep may be defined as a physiological process which performs restorative functions for the brain and the body. It is necessary in order to maintain a healthy status for most living organisms. The myriad metabolic dysfunctions that are symptoms of deficiency of sleep are a witness to this important fact. Sleep is a vital ingredient needed for the body and mind to function efficiently. Most of the human life is spent in slumber, re-charging the mind and the body for the day ahead. The brain which functions as the 'battery' of the body, needs adequate sleep to be able to perform its many functions correctly. This includes the handling of emotions to regulating physical necessities such as body temperature, heartbeat and breathing. When quality of sleep is compromised and inadequate, the body cannot perform at its best, and many of the body's systems are negatively affected. (Andrew, et al Neuropsychology. Psychology press. 2001).

When a person first enters into sleep, his brain waves decelerate from beta (12 to 18 cycles/second) to alpha (8 to 12 cycles/second) and then to theta (4 to 8 cycles/second) (Jessica R. et al Electromagnetic field. 2011). At this point, stage one begins. This stage lasts for only a few minutes of light sleep. He experiences a lowering of body temperature and blood pressure, relaxation of his muscles, and a slowing of his breathing and heart rate. Brain waves are slow and low-voltage. The first "stage one" of the sleep period is called "descending stage one. At" Stage two, he is now in a deeper sleep, and more difficult to awaken. The muscles relax. Stage two is recognizable by its predominance of theta waves and the appearance of "sleep spindles" (momentary occurrences of high-voltage brain waves at 12 to 14 cycles per second) which occur only during this stage. During stage three, he becomes more relaxed, and experiences a decrease in heart rate, body temperature, blood pressure, and respiratory rate. His brain waves are increasingly within the delta range (1 to 3 cycles per second). The stage four takes about 20 minutes and is characterized by profound muscle relaxation, difficulty in awakening, and a majority of the brain waves are within delta. When he leaves stage four, he ascends through stage three and two and one. As the cycle continues throughout the sleep-period, stage four becomes shorter -- and by the end of the night, he is alternating only between stage two and stage one. Stage four is experienced only two or three times during the sleep period. Ascending stage

one (also called "emergent stage one.") One returns to stage one approximately 90 minutes after entering sleep. Unlike the first stage one, this is a period of rapid eye movements and Rem (rapid eye movement) dreaming. (Non-REM dreams can occur at any time during sleep.) The first time one enters "emergent stage one," the period continues for only about five to ten minutes before he descend again to stage two and so on; by the end of the night, stage one might continue for as long as one hour -- for a total of approximately 90 minutes of REM throughout the sleep-period

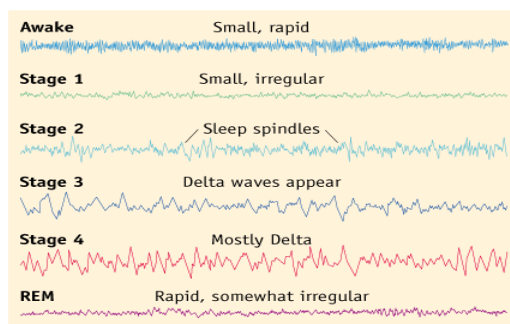


Fig 1 Brainwaves during wakefulness and sleep.

Melatonin also known chemically as N-acetyl-5-methoxytryptamine is a naturally occurring compound found in animals, plants, and microbes. In humans, circulating levels of the hormone melatonin vary in a daily cycle, thereby allowing the entrainment of the circadian rhythm of several biological functions. Many biological effects of melatonin are produced through activation of melatonin receptors while others are due to its role as a pervasive and powerful antioxidant with a particular role in the protection of nuclear and mitochondrial DNA. (Preissl, H et al encephalography Academic press. 2005).

Insomnia

Insomnia is a sleep disorder that is characterized by difficulty falling and staying asleep. Insomnia, the common problem of not being able to fall asleep, is a symptom - not an illness and may be linked to a variety of disorders and conditions such as depression, anxiety or even hypoglycaemia. Insomnia is also a common side effect linked to the use of certain prescription drugs such as antidepressants and stimulants (. Kenneth R,et al Earth's magnetic dipole image. 2003)

Causes of Insomnia

Causes of acute insomnia

- Significant life stress (job loss, death of a loved one, divorce)
- Illness
- Emotional or physical discomfort
- Environmental factors like noise, light or extreme temperatures (hot or cold) that may interfere with sleep.
- Some medications (for e.g. those used to treat colds, allergies, depression, high pressure, asthma). (Houston.et al Electricity in Every-day life. . 1905)

Causes of Chronic Insomnia

- Depression
- Chronic stress
- Pain or discomfort at night

Insomnia may cause:

- Dark circles under the eyes
- Disorientation
- Fatigue
- Irritability
- Posture changes

Electro Accupuncture Sleeping Device

This is a drug free answer for insomnia, stress, worry, jetlag and a host of factors can contribute to the misery of insomnia. This is also called sleep partner, a simple bracelet strap that stimulates the accupuncture points of the wrists traditionally associated with sleep. To reduce or increase the pressure, you simply rotate the movable dial. It is advised that you strap on 30minutes before bedtime and keep it on throughout the night. The sleep partner/electroaccupuncture sleeping device is simple and easy to use, comfortable, light weight, portable, easy to wear, looks great etc. (Farrago et al, An introduction to linear network analysis, pg. 18-21, 1961).Sleep partner is simply strapped onto the wrist over the correct acupuncture points, tightened and worn like a wrist watch band.Minutes electrical impulses are released along the correct acupuncture meridian, and acts as a sleep aid. (No needles are used as in traditional acupuncture, simply an electrical contact).It's worn for 30minutes prior to sleeping time and removed in the morning after sleep. After some trials have been conducted on people, it was discovered that this device is 70% effective for insomnia. But it is not a therapeutic device, is slow and cannot work for all kinds of insomnia since not all the patients during the trial could fall asleep, only 70% of them did. (Kenneth R,et al Earth's magnetic dipole image. 20030)

Aim

This project is aimed at generating Geo-magnetic stimulation to modulate the electromagnetic potential rhythm of the cerebralcortex of the brain to induce sleep.

Objective:

The technique of transcutaneous magnetic stimulation has been established and is relatively advanced in comparison with electrical stimulation techniques. This project sought to use the principle of geomagnetism focused on neurological system using pulsed magnetic field. To achieve the aim of the study, the equipment (electromagnetic sleep inducer) was designed such that; it could generate a natural electromagnetic field, makes easier to fall asleep, induces a prolonged and sound sleep without the use of drugs, with no side effect

Problem Statement

Sleeping disorders are problem that face most people and there are a lot of therapeutic devices and drugs to help correct these disorders. Most of these devices are not therapeutic and tend to be invasive and causes chemical reaction as well as causes the reoccurrence of these disorders. This project device is designed in such a way that to cure these sleeping disorders and prevent any reoccurrence.

Materials and Methodology

ELECTONIC RESISTORS

R1, R5.....1K 1/4W

R2.....10K 1/4W

R3, R6.....10M 1/4W

R4, R7.....2m2 1/4W

R8, R9.....4K7 1/4W

CAPACITORS

C1, C7.....47 μ F 25V ELECTROLYTIC CAPACITORS

C2.....100nf 65V POLYSTER CAPACITOR

C3, C4.....330nF 63V POLYSTER CAPACITORS

C5, C6.....15nF 63V POLYSTER CAPACITORS

DIODES

D1, D3, D4, D5.....IN4148 75V 150mA

D2.....LED (any type)

INTEGRATED CIRCUITS

IC1.....4060 14 STAGE RIPPLE COUNTER AND OSCILLATOR IC

IC2.....4093 QUAD 2 INPUT SCHMITT NAND GATE IC

TRANSISTOR

Q1.....BC327 45V 800mA PNP

SWITCHES

SW1....2 POLES 4WAYS ROTARY SWITCH

SW2....SPST SLIDER SWITCH

OTHERS

L1.....RADIATOR COIL

P1.....SPST PUSH BUTTON

B1.....V PP3 BATTERY

CLIP FOR PP3 BATTERY

3.2 BLOCK DIAGRAM

The voltage across the capacitor rises to predetermined value under the charge of the high voltage circuit. The high voltage and large current switch was controlled by the timing circuit which was opened and closed at a determined

frequency to make the charges stored in energy storage condenser discharge to the coil. As such, a pulsed field was formed. (John H, et al, The Electronics club 2011)

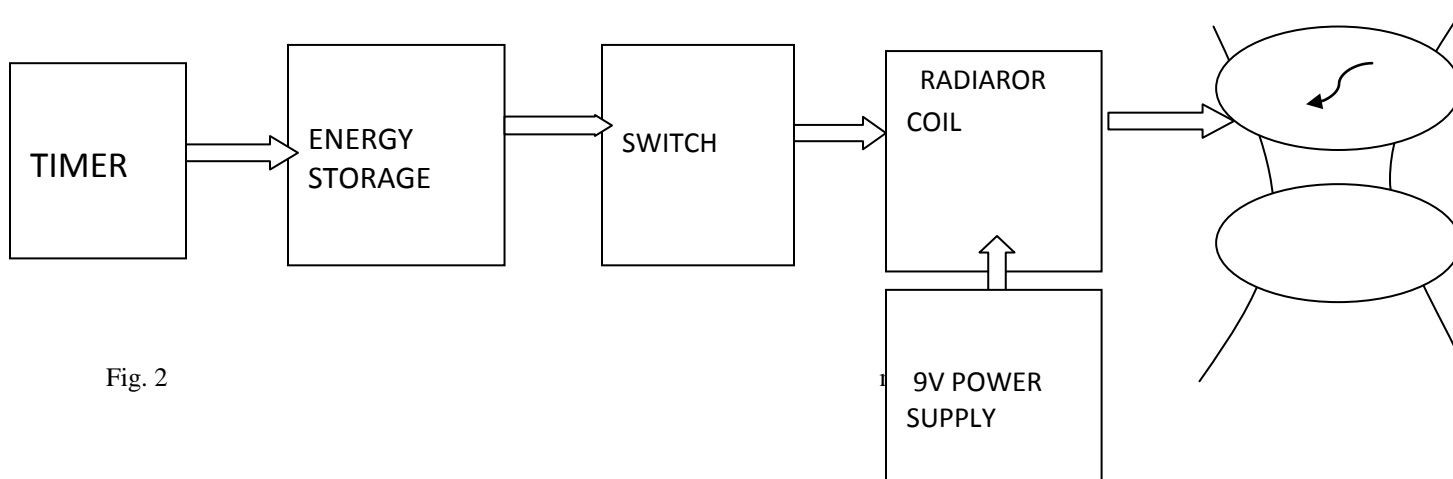


Fig. 2

Circuit Diagram

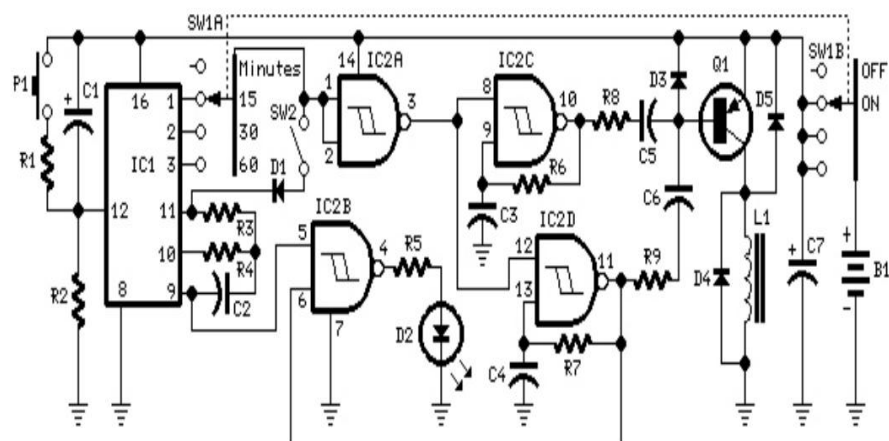


Fig 3

Methodology

Selecting a timing option by means of the rotary switch SW1. Choosing 15, 30 or 60 minutes operation. Selecting “STOP” or “ALTERNATE” mode operation by means of SW2. With SW2 closed (stop mode operation), the electromagnetic radiation stops after the pre-set time is elapsed. With SW2 opened (alternate mode operation), the device operates for a pre-set time, then pauses for the same amount of time. This cycle repeats indefinitely. When SW2 is closed, the first time output pin1 of IC1 goes high; the internal oscillator of the IC1 is disabled by means of the Diode D1. The circuit remains off until a reset pulse is applied to pin 12 by means of the push button P1 or when the device is restarted again. When SW2 is left open, after 15 minutes pin1 of IC1 goes low, pin 3 of IC2A goes high and oscillators are enabled again. The timing can be increased to 30 or 60 and same thing occurs obviously changing time length. IC1, IC2A and IC2B form the timer section. C1 and R2 provide auto-reset of IC1 at switch ON. The internal oscillator of IC1 drives the 14 stage ripple counter and after about 15 minutes, output pin 1 goes high, pin 3 of IC2A goes low and stops IC2C and IC2D oscillation. IC2C and IC2D generate two square waves at 1.2 and 5Hz respectively. These waveforms are converted into 60 microseconds pulses at the same frequency by means of C5 and

C6 and mixed at Q1 Based. The transistor Q1 drives the radiator coil with a scalar series of pulses of 60microseconds length and 9V amplitudes. IC2B drive pilot LED (D2) which operates in 3 different modes.

- Flashes quickly almost randomly when the radiator coil is driven.
- Flashes somewhat slowly and regularly when the radiator coil is pausing during the alternate mode operation.
- Is off when the circuit auto-stops (stop mode operation).

The L1(radiator coil) is obtained by winding randomly 600turns of 0.2mm enamelled wire on a 6mm diameter and 40mm long steel bolt. The winding is secured with insulating tape. The mean current drawn is about 7mA, decreasing to less than 4mA during pauses when in Alternate mode operation. Plastic box is used to enclose the circuit to increase electromagnetic radiation flow unlike the metallic casing which limits electromagnetic radiation. If the LED2 and its associate resistor R5 are omitted, it will increase the life span of the battery

Results and Calculation

Results

Ten persons suffering from acute and chronic insomnia were exposed to different kinds of stimulation such as 1.2 and 5HZ respectively. Both were able to fall asleep at specific periods of time.

4.2 CALCULATIONS

$$F = \frac{1}{2\pi\sqrt{RC}} \quad F = \frac{1}{2\pi\sqrt{1667 \times 100^{-9}}}$$

$$F = \frac{1}{2\sqrt{0.0129}}$$

$$F = 12\text{H} \quad T = \frac{1}{12}$$

$$T = 0.08\text{s.}$$

Auto-reset at IC1;

$$F = \frac{1}{2\pi\sqrt{0.685}}$$

$$F = 0.23\text{Hz}$$

$$T = \frac{1}{F}$$

$$T = 1/0.23$$

$$T = 4\text{s}$$

Where; F= frequency (HZ)

T= period of pulses(s).

From the calculations, the frequency generated by the internal oscillator of IC1 by R3, R4, and C2 causes brain entrainment to induce sleep which is 12 Hz at 0.08s pulse. IC2C and IC2D generate low frequencies of 1.2 and 5Hz and are applied to the persons at 60ms

Discussion

The results showed that there is some correlation between the applications of a low frequency pulsed magnetic field and the length of time to the first appearance of slow wave sleep pattern in the persons. As such, low frequency magnetic stimulation is seen to couple to the brain and affect the EEG activity of the acute person in 30minutes and that of the chronic person in 45minutes. Further, magnetic stimulation was shown to be a reasonably effective method for inducing sleep, and the effectiveness is dependent on the frequency of the applied stimulation. The result provides a potentially new therapeutic approach for clinical treatment of insomnia.

Conclusion

After conduct of tests on ten different people, the result showed that, in comparison with melatonin stimulants and other sleep aided devices magnetic stimulation can influence and modulate the activities of brain potentials and consequently promote the efficiency of sleep process.

Limitations

One of the significant limitations of this project is that it can't reduce pain in a patient and as well as treat sleep apnea which is a disorder characterized of interrupted breathing during sleep. It usually occurs in association with fat build-up or loss of muscle tone with aging. The potential implications of using external magnetic stimulation to modulate the pattern of EEG activity in the cerebral cortex may also go along way beyond inducing sleep

Recommendation

We recommend that further studies be made on whether activities such as thoughts, memory and pain can be influenced by external stimulation. This may be of great benefit.

References

- Andrew K, et al (2011) Dreamate sleep inducer.
- Andrew, et al (2001) Neuropsychology. Psychology Press.
- Farrago et al, An introduction to linear network analysis, pg. 18-21, 1961.
- Houston.et al (1905) Electricity in Every-day life. .
- Jessica R.et al (2011) Electromagnetic field.
- John H, et al, (2011) The Electronics club.
- Kenneth R, et al (2003) Earth's magnetic dipole image.,
- Preissl, H et al (2005) encephalography Academic press.

EVALUATION OF TURNKEY PROJECTS IN URBAN WATER DELIVERY IN GHANA

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Abstract

Turnkey project is a development project in which the contractor assumes all risks until the structure is ready for use. Due to the essential role the Ghana Water Company Limited (GWCL) plays in urban water delivery, construction projects are undertaken by the institution. It is necessary for a research to be conducted into the various forms of contracts awarded and the consequences resulting. The research aimed at investigating the implementation and management of turnkey projects by GWCL. The research further analysed turnkey projects and its cycle, the criteria for evaluating turnkey delivery, success factors, risks management and dispute resolution strategies. Through interviews, questionnaires and literature review the study revealed that, turnkey contracts may be awarded under emergency situations and based on complexity of project. The study further revealed that the criteria for evaluating turnkey contracts include the financial position and experience of the contractor, technology involved etc. Prompt handing over of site, provision of relevant information, paying for completed works etc. helps contractors to comply with specifications and general award of contracts. The research concluded that turnkey project delivery is a contract delivery method in which the contractor bears a lot of risks. The choice of a contractor for a turnkey project depends on the financial position, experience, time, quality and cost involved in the project. Efficient and fair procurement practices, provision of adequate project information help in the success of the project. The study recommended that post contract evaluation and training of operatives and support staff should be undertaken.

Keywords: Turnkey, Water, Contract, Delivery, Project, Management

Introduction

Contracting is a highly regulated activity and once a contract is awarded, there are rules governing the ethics of interactions between the parties to the contract. Despite these constraints, contract managers must develop and put in place organizational strategies that reach into the behaviour pattern of parties to the contract.

There are some basic types of contract used in the construction industry. These include:

1. Lump sum
2. Measurement
3. Reimbursement

The construction industry has been searching for the most effective project delivery systems to maximize project performance over the past decades. Some forms of project delivery systems are:

- a) Design, Bid and Build (D B B).
- b) Design and Build (D B).
- c) Design, Build, Operate and Transfer (DBOT)
- d) Build, Operate and Transfer (B O T).

Currently, no single project delivery system is most appropriate for any kind of project. Instead, combinations of different strategies are used for different circumstances (Gordon 1994). Design/build is the oldest approach that is regarded as a new and alternative delivery method. During ancient times in Mesopotamia and Egypt, the master builder was responsible for the design and construction of the entire project.

This continued to be the most commonly used project delivery method until the late 19th century, when advances in science and technology allowed the fields of architecture and engineering to become two different professions (Songer and Molenaar 1996). The contractor usually has the task of assembling a group of designers and constructors to perform the job for this type of delivery method.

Design, Build and Turnkey

Design, Build Project

The Design/Build concept of project delivery has become one of the most widely favoured in the engineering construction industry. Though the method is not appropriate for all projects, when the right projects are selected, the design-build may offer significant benefits for both parties to the agreement.

The Design-Build method is a method of project delivery in which a client executes a single contract with one entity (the Design-Builder) for design and construction services to provide a finished product. It is the duty of the client to describe output rather than on the process of obtaining the defined outcome.

It is very important for the client in a design-build contract to define the basic objectives of the project in the early stages of the project. This includes physical components, operational requirements, performance expectations and public service. It is necessary to describe the project in such a way that the Design-Builder has enough information to deliver the intended project.

Turnkey Projects

Turnkey project is the American version of Design and Build or commonly called *Packaged Deal*. It is usually described as a development project in which the contractor assumes all risk until a certain point has been reached, usually at completion of the project or where the structure is ready for use. Permanent financing by a take-out lender can be arranged at that point, provided certain conditions are met.

Turnkey project is also a development in which a developer completes the entire project on behalf of a buyer; the developer turns over the keys to the buyer at completion. Many government-owned public housing projects are turnkey projects. A private developer undertakes all activities necessary to producing the project, including land purchases, permits, plans, and construction, and sells the project to the housing authority. (Business Glossary 2006) The turnkey contract usually involves the entire process of design, specifications, construction, commissioning and operation of facilities. For some instances, the contract includes the maintenance of facilities by the contractor for a period extending beyond the retention period (Greenwood, 1988).

Evaluation and Control of Contracts

The project manager has a role of evaluating and controlling the activities of a contract. These activities are essential in keeping the project on track. Depending on the size of the project, control and evaluation would be simple or complex. Project controls help in preventing disputes and conflicts (Passenheim, 2009).

The aim of this study is to evaluate turnkey contracts awarded by the Ghana Water Company Limited. This study is intended to help investigate the implementation and management of turnkey projects. Evaluation and control of projects and contracts are part of the project manager's core functions and it helps the project to be on track and also aids the client to achieve its set targets.

To achieve the aim of the study, the following activities were carried out:

4. Analysed turnkey projects
5. Identified the criteria for evaluating turnkey contract delivery.
6. Identified success factors for turnkey contracts in the construction industry.
7. Identified risk management and dispute resolution measures during project implementation.
8. Recommendation of factors for turnkey contract or project evaluation.

Methodology

The research is based mainly on the project management activities undertaken by the Ghana Water Company Limited (GWCL).

Project Management Structure of Ghana Water Company Limited

The Project Management Structure of GWCL is shown by the organogram in figure 1 below:



Figure 24: Project Management Structure of GWCL

The GWCL has a chief manager who is in charge of project planning and development. He oversees the operations of the contract manager, investment manager, the project quantity surveyors and other support staff. It is the duty of the Project Team to oversee all projects being undertaken by the GWCL.

Ghana Water Company Limited Operations

In 1995, a stakeholder meeting was held to consider options for Private Sector Participation (PSP) in the water sector. The meeting opted for management contract arrangements which were endorsed by the government. The management contract was implemented within the framework of the urban water project. The World Bank has since then provided a grant of US\$103 million to supplement US\$5 million from the Nordic Development Fund and US\$12 million from the Republic of Ghana to support the Urban Water Project. In addition the Royal Kingdom of the Netherlands has provided US\$13million in support of the project bringing the total amount of financing to US\$133 million.

Objectives of the Urban Water Project

The objectives of the Urban Water Project are:

- To expand the reliable supply of safe water in the urban areas.
- To ensure that low income consumers have access to potable water at affordable price.
- To ensure sustainability of the sector through cost recovery.
- To ensure steady flow of investment fund, with emphasis on low cost and concession financing.
- To support the introduction of the private sector into management and operation of the water supply systems.

Components of the Urban Water Project

The Urban Water Project comprises four components:

System Expansion and Rehabilitation

This component is to support:

- Increasing the amount of treated water for sale,
- Extending service to low income areas,
- Rehabilitating existing network to reduce non-revenue water.
- Dam safety upgrades, procurement and installation of meters, and provision of engineering services, vehicles and equipment for Grantor's regional and district offices.

Public-Private Partnership Development

This component supports the payment to the operator under the Management Contract as well as payment to Technical and Financial Auditors to measure the Operator's performance.

Capacity Building and Project Management

This component mainly includes training of seconded staff and technical assistance. Also included under this component are allocations for training at GWCL's headquarters, vehicles, office equipment, support for the Project Management Unit and the PURC as well as provision for environmental safeguards.

Severance Programme

This component was designed to finance the severance programme undertaken by Ghana Water Company Limited.

Services undertaken by GWCL may be categorised as follows:

- Rehabilitation of existing water supply schemes to bring them up to their designed capacities;
- Provision of operational support equipment;
- Limited extensions and improvements to existing systems;
- Construction of new water schemes

To be able to provide answers for the research questions posed above and achieve the set objectives of the research, the following research methodologies were employed:

Literature and research works done by other scholars relating to the topic were reviewed. This gave information on the research and the methods employed by these scholars. Also, the findings and challenges of these researchers were assessed and incorporated into the final analysis. The literature review was a good source of secondary data that proved to be very essential in achieving the objectives of the research.

Interviews were conducted with contractors and consultants who work on projects for GWCL and the project team of GWCL using a structured questionnaire as a guide. These provided the required information from the interview sessions and also go into specific areas.

A structured questionnaire was distributed to stakeholders who were not reached for the interview sessions.

Both primary data from field and secondary data from literature were analysed and salient conclusions and recommendations provided.

Results and Discussion

To be able to achieve the objectives of this research, seventy (70) questionnaires were sent out to stakeholders. The stakeholders were top level management in the water industry, consultants and other professionals involved in contracts and project delivery. Sixty-two (62) of the respondents returned their questionnaires and fifty-five (55) were used for analysis.

The respondents had ages ranging from twenty (20) years and above. Table 1 below shows the age distribution of respondents. It can be deduced from table 1 that about seventy-five percent (75%) of the respondent have ages of forty and above.

Table5: Age of Respondents

Age	Number of Respondents	Percentage (%)
20 – 29	4	7.3
30 – 39	8	14.5
40 – 49	25	45.5
50 and Above	18	32.7
Total	55	100

About eighty-five (85%) of the respondents have at least five years of experience in their field of work, especially on issues relating to contract delivery in the construction industry.

Results from the field data indicate that about 64% of the respondents have used turnkey contracts in their operations. Table 2 shows the respondents that have used turnkey contracts.

Table6: Respondents that have used turnkey

Response	Number of Respondents	Percentage (%)
Yes	35	63.6
No	20	36.4
Total	55	100

This therefore shows that slightly above a third of the respondents have come across turnkey products in their operations for this while.

Analysis of Turnkey Projects

The project management team of the GWCL indicated that they prefer turnkey mode of contract delivery when there is an emergency situation for the award of a contract and at a reasonable price. Also, the project team of the GWCL pointed out that, turnkey contract delivery helps to prevent multiple entities on a single project. According to the consultants, the start and completion of the project as well as the technical requirements makes it expedient to use the turnkey.

Criteria for Evaluating Turnkey Contract Delivery

The criteria for the evaluation of turnkey contract delivery by the GWCL project team and consultants are based on the financial position and capabilities of the bidder, experience in similar projects, the ability of the bidder to undertake feasibility study, design and preparation of appropriate specification.

Success Factors in Turnkey Contract Delivery

The success of turnkey contracts are depends on a number of factors. The respondents – GWCL project team, Consultants and some contractors indicated that, prompt handing over of sites to the contractor, swift payment of completed works and claims by the contractor and provision of relevant information related to the project process is very necessary.

Coordination with other stakeholders such as government agencies, safety of site, tax exemptions and visa for expatriate contractors and consultants and the conduct of fair procurement practices contribute to procurement success.

Project Delivery and Risk Management

All the respondents indicated that they have encountered various forms of risks in the discharge of their duties. About seventy-eight percent (78%) of the respondents said that the contracts they have worked on provided avenues for managing risks arising from the project delivery process. About twenty-two percent (22%) of the respondents said that there were no risk management avenues.

Some of the risks that were encountered by the respondents are

- Financial management related
- Expensive maintenance risk for unnecessary oversized project
- Unforeseen activity beyond scope of project
- Executing projects that do not have budgets
- Engagement of non-competent team to deliver
- Non – monitoring of project implementation
- Not rationally and objectively evaluating a delivery system
- Not understanding the prerequisites for the successful use of a given delivery system

Project Delivery and Dispute Resolution Measures

From the study, about 70% of the respondents indicated that they have encountered some forms of disputes and conflict while about 30% have not had any form of disputes or conflicts in their operations. The disputes and conflicts arise as a result of the following factors:

- Client's unwillingness to bear the costs of the delays and alterations
- Problems with land acquisition and compensation
- Delays in release of funds and payment certificates
- Weather variations
- New technologies that were not incorporated in the initial contract
- Difficulty evaluating bids
- Lack of control by employer on quality
- Unfair procurement practices

In resolving the conflicts and disputes, the following are some of the conflict resolution methods employed by the respondents:

Table 7: Methods for Dispute Resolution

Dispute resolution method	Number of Respondents	Percentage (%)
Diplomacy	24	28.6
Advocacy	10	11.9
Negotiation	34	40.5
Counselling	5	6.0
Prayers	9	10.7
Others	2	2.4
Total	55	100

Experiences of the GWCL

The use of turnkey contract in the GWCL has led to improvements in the infrastructural base of the company.

Out of ten (10) turnkey contracts awarded over a period of eight years (2004 – 2011), the following are some of the experiences from the GWCL contained in tender documents:

1. About 10 - 15% of the total project price goes into Costs Associated with Financing. The cost associated with project financing is very high considering the Ghanaian economy. The said amount could have been channelled into other sectors of the Ghanaian economy if the Ghana government had funded the project from its own resources.
2. The Engineering costs associated with the projects accounted for 7 - 10% of the total project price. This could have been reduced considerably if Ghanaian Engineers are well trained and involved in the entire project life cycle to enhance their learning and adequate preparation for future projects.

3. Some of the designs that are submitted by expatriate consultants and engineers, who are party to the turnkey contract, are unable to make provisions for changing environmental condition e.g. water pollutions. Example, during the operation of the facilities at the Sekyere-Hemang Water treatment plant in the Central Region of Ghana, the Water Quality Assurance Department reported some major challenges. Illegal gold mining activities is on the increase upstream. The major tributaries of River Pra – River Offin and River Birim have become the major hub of illegal gold miners. The plant should therefore be fitted to treat heavy metals i.e. mercury and cyanide used in the gold business.
4. In the implementation of the ten projects under consideration, there was provision for the training of operatives and technical personnel. According to the personnel that went through the training, the depth and period for training was not adequate and personnel were not resourced enough to undertake design, management and maintenance of future projects.

Conclusion and Recommendations

From the study above, the following are the conclusions drawn

- The turnkey contract involves the entire process of design, specifications, construction, commissioning, operation of facilities and sometimes maintenance for a period of time.
- The choice of a contractor for a turnkey project is dependent on the following factors:
 - ✓ The financial position and experience of the contractor
 - ✓ The technology involved in the project delivery
 - ✓ Time, quality and cost involved in the project
 - ✓ The complexity and technicalities required for project delivery.
- The success factors of a turnkey projects are:
 - ✓ Efficient and fair procurement practices
 - ✓ Provision of relevant information
 - ✓ Developing of projects to its implementation stage
 - ✓ Coordination of the stakeholders involved in the project
 - ✓ Paying for completed works, that is the prompt payment of claims
 - ✓ Conformance to specifications and expectations
- Risks involved in project delivery are
 - ✓ Unforeseen activity beyond the scope of work
 - ✓ Engagement of incompetent project team
 - ✓ Non-monitoring and evaluation of projects
 - ✓ Risk of cost exceeding the price lying entirely with the contractor
 - ✓ Changes in government during the contract period
 - ✓ Changes in foreign exchange
- Disputes in project delivery arise as a result of the following conditions
 - ✓ Client's unwillingness to bear the costs of the delays and alterations
 - ✓ Problems with land acquisition and compensation
 - ✓ Delays in release of funds
 - ✓ Weather variations and technological changes
 - ✓ Difficulty evaluating bids based on same criteria
 - ✓ Lack of control by employer on quality

To be able to obtain maximum benefits from turnkey projects, the following recommendations may be noted:

- Post contract evaluation should be undertaken. Details to be assessed during the post contract evaluation process should be well documented in the contract documents.

- Training of operatives and support staff should be adequate enough to help them handle the operation and maintenance of the facility concerned.
- Local engineers and technical personnel should be well-involved in the project delivery process – from inception to commissioning.
- Proper communication lines between all stakeholders involved in the project under consideration.
- Educational institutions should be used in organizing training of the staff. This makes it easier to organizer refresher courses for the personnel when the need arises.

References

- Gordon, C. M. (1994). *Choosing appropriate construction contracting method*. J. Constr. Eng. Manage., 120(1), 196–210.
- Business Glossary (2006). Barron's Educational Series, Inc [online]. [referenced 12.03.2010]. Available in www-form: [URL:http://www.allbusiness.com/glossaries/turnkey-project/4942539-1.html](http://www.allbusiness.com/glossaries/turnkey-project/4942539-1.html)
- Songer, A. D., and Molenaar, K. R. (1996). *Selective design-build: Public and private sector owner's attitudes*. J. Manage. Eng., 12(6), 47– 53.
- Greenwood, D., (1988). Building Technology and Management, *Journal of the Building Technology*, Vol. 14, 1987/88, p.24.
- Passenheim, O. (2009). *Project Management*. Ventus Publishing APS.

QUALITY OF SERVICE IN THE HOSPITALITY INDUSTRY IN GHANA: A STUDY OF SELECTED SMALL HOTELS IN HO TOWNSHIP

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The service industry occupies an important position in the economy of Ghana due to the numerous tourist attractions and tourist's activities in the country. Service quality is a measure of how well the level of service delivered matches customer expectations. Hospitality sector is a major service oriented sector in the economy of Ghana. The present paper sought to examine how selected small hotels in Ho the capital of Volta Region are meeting customer expectations on specific dimensions of service quality. The method for analysis was descriptive. Under the descriptive statistics the mean rating assigned to each factor of variable was presented and analysed using SPSS software version 18. The study revealed high gaps between customers' expectations and satisfaction level for facilities provided: comfort, food quality, brand image and advertisement. This implies that customer's expectation do not match what is perceived as service quality in the selected hotels. Based on the results revealed, of the gap analysis the conclusion drawn was food quality, waiting time for food and beverage service and other facilities customers were not satisfied with in all the five hotels.

Keywords: Service Quality; Gap; Tourists; Brand image; Customer; Hospitality

Introduction

In a service-dominated post-industrial economy in which work become a "game between persons" – between bureaucrat and client, between hotel clerk and guest – interpersonal skills must complement technical skills if the game is to be played well Bell,(2005). Providing hospitality to strangers has been a social and religious practice in the long history of human-kind Jones (1997). The advent of rapid industrialization necessitated movement of persons for business and commercial needs from one country to the other. Movement is also growing for sightseeing and excursion purposes Malhotra et al.(2005). Consequently, over the time, demand for lodging and boarding has increased exponentially Lewis & Booms (1983). This has resulted in the establishment of separate institutions called "hotels." Gunderson et al.(1996). In the past, the hotel industry has been one of individual ownership, because of the average hotel size, an individual businessman is able to finance a hotel-keeping operation and keep the ownership and management united, that is the owner takes care of all managerial activities by himself Groonooos (1987). Over the years, skyrocketing costs have resulted in the formation of hotel groups/chains Spinelli et al. (2000). Furthermore, The control of management has been transferred from owner to the professionally qualified managers Keaveney& Susan (1995). In addition, a maze of complex scientific, financial and operating systems were introduced for efficient running of a hotels (Raymond & Choi ,2001). Type of services provided by typical modern hotels can be broadly classified as primary, secondary and ancillary services Lewis (1987). The primary purpose of a hotel is to provide the customer with lodging and boarding. Secondary services include services which enhances the quality of primary service as entertainment services, swimming pool, dance room, gymnasium, games and sports facilities, television, internet and food and beverage services, teleconferencing and other business related services Mahadevappa (2004). Certain ancillary services called value added services are services to the basic hospitality services which include Conference room facilities, transportation service, business centre and mail-handling facilities, telephone service in the room, health related service, money changing facility, shopping complex, exhibition rooms and sightseeing service etc. In today's era of globalization, every industry faces competition. Hotel industry is no exception Baldachino (2000). For any hotel, a reasonable utilization of its room capacity is essential to earn a reasonable rate of return. Hence, retaining regular customers and attracting new customers are the priorities for the management. Any hotel which wants to retain the customers in the long run will have to constantly do better than the competitors when it comes to customer satisfaction. Many researchers studied the hotel industry in particular regarding the quality of service provided by these organizations. Research shows that, face-to-face interactions, developing customer trust through long-term strategy, understanding customer habits to consume, rendering quality service ,pre-testing new procedures, teaching consumers regarding use of service innovation

would help in closing the standard gap between customer expectation and perception Parasuraman et al.(1988). According to (Parasuraman) five distinct gaps on the service provider's side can impede delivery of service that consumer perceives to be high quality. The present research focuses on four of the gaps as follows:

Gap 1: Not knowing what customers expect

Gap 2: Not selecting the right service design and standards

Gap 3: Not delivering to service standards

Gap 4: Not matching performance to promises

Moreover, Parasuraman et al. argued that, numerous models exist that measure service quality, including the well known SERVQUAL instrument based on the assumption that perceived service quality derives from the consumer's comparison of expected services and actual service performance and SERVQUAL measures five dimensions thus: tangible elements (appearance of equipment, physical facilities and personnel), reliability (ability to perform the promised service accurately and dependably), responsiveness (willingness to help customers and provide prompt service), assurance (courteous and knowledgeable employees who can inspire confidence and trust), empathy (personalized attention and care), and functional quality is a more important dimension of perceived service than technical quality Gronross (1987). Furthermore, Graham (1987) stated that, customer judgment, customer panels and outcome plus delivery are important for better service quality and improvement of service quality – managerial vision, innovation, setting of standard and performance measuring Denton (1990). However, (McCaina et al.,2005) stated that, in the quest for improved quality, hospitality industry managers often face two major obstacles that is they do not know what aspects the customers consider to be important when evaluating the hotel experience and do not have reliable and valid instruments for measuring quality perceptions. Akbaba (2005) argued that, the role of quality service in the success of hotel businesses cannot be denied, it is vital for hotel managers to have a good understanding on what exactly the customers want, in each specific segment of hotel industry. Meanwhile, Agbola and Dehlor (2011) during their research identified that, hoteliers in Volta Region are unable to meet the expectations of their customers. Since the hotels continues to attract tourists it is necessary to examine how small hotels in Ho township were meeting customer expectations on specific dimensions of service quality since Ho is dominated with small hotels.

The specific objectives are as follows –

To assess the service quality perceptions of hotel service providers in small hotels.

To assess the expectations of customers with respect to quality of service in small hotels

To provide some policy implications for small hotels in the Volta Region of Ghana.

Methodology

The research design was descriptive. By this study the reasons for service quality gap between customer expectation and hotel service providers' perception in various small hotels in Ho Township were determined. Sample size included 20 customers from each of the small hotels, 5 units' heads and 5 managers were selected randomly for the study. In total 110 respondents were surveyed from the five hotels. Interviews were conducted by the use of structured questions to gather information from the unit heads and managers. Questionnaires were administered to the customers. Questions were both open and close ended in nature. Statistical techniques of t-test (paired t-test and t-test for independent variables) were used to analyze the data. T-test (5%) was used to test the significance of difference in mean scores of different variables for which gaps existed. Independent t-test and ANOVA (confidence interval 95%) were used to compare the parameters within the service quality gaps. SPSS version 18 statistical package was used for all analyses. Secondary data was collected from journals, internet, books etc

Results

Factors considered for selecting a hotel

In considering the basis for selecting the hotels we focused on friendliness, hotel image, security, prices, food quality, facilities and comfort which are presented in the table below:

Table 1

Item in the questionnaire	Degree of Importance	Degree of satisfaction	Gap	t-value
Friendliness	5.1	4.15	0.05	-635
Hotel Image	3.65	3.99	0.34	-4.675*
Security	0.35	3.25	0.22	-3.489*
Prices	3.73	4.04	0.34	-1.115
Food Quality	4.66	3.09	-0.95	-11.115*
Facilities	4.37	3.95	-0.45	-6.310*
Comfort	4.59	4.0	-0.65	-12.488*

The t- values presented in table 1 have associated p- values and the significant t- values have asterisk beside the figures in the table. Hotel image, food quality, security, facilities and comfort are statistically significant at 5% level of significance. Friendliness, prevailing price on the other hand were not statistically significant.

High gaps exist for food quality (gap = -0.95), comfort (gap = -0.65), facilities provided (-0.45). These unearth customers' perception with respect to quality of service. Low gaps are present for friendliness, security and price charged for the services provided by the hotel staff. The high gap shows that the customers were not satisfied with these factors, but they consider them very important. The low gap implies that customers were somehow satisfied with the services rendered by hotels in this regard.

Gap for Method use to Know Customer Expectation

On the issue of the methods used to know customers expectation the following method were taken into consideration: market research, seminars, face to face interaction and written feedback.

Table 2

Customer expectation	Perception	Expectation	Gap	t-value
market research	4.55	3.57	-1.45	1.479*
Seminars	2.87	2.58	-0.17	1.291*
Face to face	2.87	2.78	-0.19	1.294*
Feedback	6.22	3.81	- 2.35	1.554*

The t- values presented in the table 2 have associated p- values and the significant t- values have asterisk beside the figures in the table 2 above. All methods considered market research, seminars, face to face and written feedback were statistically significant. Low gaps existed for face to face interaction and seminars. Since the significant level is 5% the result is considered statistically significant.

Table 3: Gaps for Interaction Between Top Management and Customers

Mode of communication	Perception	Expectation	Gap	t-value
Meeting face to face	5.67	5.01	-0.66	-0.701*
Written communication	5.61	4.10	-1.51	1.149*
Through telephone	5.93	3.47	-2.46	1.515*
Management interaction/complain	5.85	3.71	-2.14	-0.974*

Table 3 shows that high gap exists for interactions of the customers with management and through telephone which is clearly testified by t-value in asterisk. Low gap exists for face-to-face interaction and written communication. The significant t- values have asterisk beside the figures.

Gaps for Efforts made to Maintain Relations

High gap exists for efforts made to maintain relations with the customers, which surely reject the assertion the hotel staff for maintaining relations with their customers to increase the retention rate through various means like informing them of new policies, providing gifts and providing service according to customers' expectations. The various methods used for imparting knowledge/education to the customers regarding the services existing in their respective organizations indicate that gaps are significant. Customers were not satisfied with the complaint handling system, room services, food quality, communication, and attribute of some of the waiting staff in some of the hotels. There exists huge gap in these areas.

Gap 2: Not selecting the right service quality design and standard

Service quality design is fully standardized for all the recognized hotels per rules and regulations by Ghana Tourist Board. There is a mismatch between customer perceived standard of service quality design compare to what employees and managers perceive as service quality design and standard. So high gap is present in level of standardization of hotel services and customer defined standards.

Gap 3: Not delivering to service standard

All the hotels have considered the communication skills to be most important for the selection of the employees. Factors like educational qualification and concern for customers have also been considered important. But the customers reject the claim made by hotel managers as is clear from very high gap existing on the issue of complaints.

Gap 4: Not matching performance to promises

Over promising has never been done as claimed by hotel staff, but the customers are not completely satisfied with some of the services being provided. Some of the hotels used all the methods such as face-to-face interaction, written communication, and comment from customers in their service environment to high extent.

Discussion

One hundred and ten respondents were (110) were selected for the study in all five hotels. The results revealed that, the t- values have associated p- values and hotels image, food quality, security, other facilities are statistically significant.

High gaps exist for food quality (gap = -0.95), comfort (gap = -0.65), facilities provided (-0.45). Low gaps also exist for friendliness, security and price charged for the services provided by the hotel staff. Moreover, on the issue of the methods used to know customer expectation, high gap exists in written feedback and market research. Low gaps exist for face to face interaction and seminars. In addition, on the issue of interaction of customers with top management high gap exists for interactions of the customers with management and through telephone which is clearly testified by t-value in asterisk. Low gap exists for meeting face-to-face and written communication. High gap exists for efforts made to maintain relations with the customers and standardization of hotel services and customer defined standards. Customers are not completely satisfied with some of the services being provided. This finding corroborate with the study of (McCaina et al.,2005) who stated that, in the quest for improved quality, hospitality industry managers often face two major obstacles that is they do not know what aspects the customers consider to be important when evaluating the hotel experience and do not have reliable and valid instruments for measuring quality perceptions. The results also revealed that, some of the customers neither confirmed their satisfaction nor dissatisfaction. There is a gap between customer's perceived service and what is delivered by service providers in the selected small hotels.

Conclusion

The present research examines quality of services in the tourism industry with the focus on selected small hotels in Ho township of Ghana. The research does not endeavour neither to test existing theory nor develop new research instruments. The study only present findings on quality perceptions of hotel service providers and expectations of customers with respect to quality of service in small hotels. However, high gap a exists between what is expected by the customer and what is perceived by the hotels as service quality. Quality service design is fully standardized for all the recognized hotels per rules and regulations by Ghana Tourist Board but there is a mismatch between customer perceived standard of service quality design compare to what managers perceive as service quality design and standard. The research described here could be used as a starting point for policy formulation on service quality for the tourism industry in Ghana.

References

- Akbaba, A 2005, Measuring service quality in the hotel industry: A study in a business hotel in Turkey" , *International Journal of Hospitality Management*.
- Armstrong, R, Connimok FM, Go Allan C 1997, The importance of cross-cultural expectations in the measurement of service quality perceptions in the hotel industry" , *International Journal of Hospitality Management*, vol. 16, no. 2, pp. 181-190.
- Bell, 2005, *The coming of Post Industrial Society: A venture in social forecasting*, New York: Basic Books.
- Baldacchino, G 2005, „Total quality management in a luxury hotel: A critique of practice" , *International Journal of Hospitality Management*, vol. 14, no.1, pp. 67-78.
- Bowen, J. 2006, „Development of a Taxonomy of Services to Gain Strategic Marketing Insights" , *Journal of the Academy of Marketing Science*, vol. 18, no. 1, pp. 43-49
- Denton, K.D. 1990, "The service imperative", *Personnel Journal*, March, pp. 66-74.
- Dehlor, S., & Agbola, E.T., 2011, Service Quality in Volta Region Hotels-Perspective from Tourists and Service Providers, *World Review of Business Research*, November, pp. 65-67.
- Ekinci, Y. and Riley M. 1998, „A critique of the issues and theoretical assumptions in service quality measurement in the lodging industry: Time to move the goal-posts?" , *International Journal of Hospitality Management*, vol. 17, no. 4, pp. 349-362.
- Gundersen, Marit G, Heide, M. and Olsson H. U. 1996, „Hotel guest satisfaction among business travelers: What are the important factors?" , *The Cornell Hotel and Restaurant Administration Quarterly*, vol. 37, no. 2, pp. 72-81.
- Gronross, C. 1987, „A service quality model and its marketing implementations" , *European Journal of Marketing*, vol. 18, no. 4, pp. 36-44.
- Jones, N 1997, „A study of service quality in small hotels and guesthouses" , *Progress in Tourism and hospitality research*, vol. 3, no. 4, pp. 351-363.
- Keaveney, Susan M 1995, „Customer switching behaviour in service industries and exploratory study", *Journal of Marketing*, vol. 59, pp. 71-82.
- Lewis, RC 1987, „The measurement of gaps in the quality of hotel services" , *International Journal of Hospitality Management*, vol. 6, no. 2, pp. 83-88.
- Lun, S and Allan, Y 2004, „Customer satisfaction measurement practice in Taiwan hotels" , *International Journal of Hospitality Management*, vol. 23, no. 4, pp. 397-408.
- Mahadevappa, B 2004, „Service quality in Indian Banks" , *Productivity*, vol. 45, no. 2, pp 259-266.
- McCaina, C and Shiang-Lih C. 2005, „Service quality gap analysis toward customer loyalty: practical guidelines for casino hotels" , *International Journal of Hospitality Management*, vol. 24, no. 3, pp. 465-472.

- Parasuraman, A., Zeithaml V, and Berry, L 1985, „A conceptual Model of Service Quality and its implications for Future Research” , *Journal of Marketing*, pp. 41-50.
- Raymond, C. and Choi TY 2001,“ Determinants of hotel guests” satisfaction and repeat patronage in the Hong Kong hotel industry” , *International Journal of Hospitality Management*, vol.20, no. 3, pp. 277-297.
- Shanker, D 1990, „Control combinations of marketing: Conceptual framework and empirical evidence” , *Journal of Marketing*, vol. 57, pp. 57-69.
- Spinelli and Canavos 2000, „Investigating the relationship between employee satisfaction and guest satisfaction”, *The Cornell Hotel and Restaurant Administration Quarterly*,. Vo.41, pp 29-33.

DC MOTOR CONTROL USING ELECTROMYOGRAPHY SIGNAL

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The skeletal muscle tissue is attached to the bone and its contraction is responsible for supporting and moving the skeleton. The contraction of skeletal muscle is initiated by impulses in the neurons to the muscle and is usually under voluntary control. A DC Motor –control is based on an electromyography (EMG) signal. It is focused on sensing an electromyography (EMG) signal from the muscles when contracted to control the DC motor. The EMG signal is obtained from the muscles using surface electrodes which are amplified by instrumentation amplifier, filtered by using a high pass filter sent through a comparator then to a driver circuit that makes the relay control the DC motor. The motor rotates in the clockwise direction during contraction of the muscles and LEDs connected to the device glows. This project serves as a resource for a man-machine interface and it was tested on different individuals and the same action potential were sensed using the electrodes and the motor rotated in the clockwise direction.

Keywords: Motor; Surface electrodes; Muscles; Contractions; Instrumentation Amplifier

Introduction

A muscle is composed of bundles of specialized cells capable of contraction and relaxation. The primary function of these specialized cells is to generate forces, movements and the ability to communicate such as speech or writing or other modes of expression. Muscle tissue has extensibility and elasticity. It has the ability to receive and respond to stimuli and can be shortened or contracted. Muscle tissue has four key functions: producing motion, moving substance within the body, providing stabilization, and generating heat. Three types of muscle tissue can be identified on the basis of structure, contractile properties, and control mechanisms: (i) skeletal muscle, (ii) smooth muscle, and (iii) cardiac muscle. The EMG is applied to the study of skeletal muscle. The skeletal muscle tissue is attached to the bone and its contraction is responsible for supporting and moving the skeleton. The contraction of skeletal muscle is initiated by impulses in the neurons to the muscle and is usually under voluntary control. Skeletal muscle fibers are well-supplied with neurons for its contraction. This particular type of neuron is called a “motor neuron” and it approaches close to muscle tissue, but is not actually connected to it. One motor neuron usually supplies stimulation to many muscle fibers. The human body as a whole is electrically neutral; it has the same number of positive and negative charges. But in the resting state, the nerve cell membrane is polarized due to differences in the concentrations and ionic composition across the plasma membrane. A potential difference exists between the intra-cellular and extracellular fluids of the cell. In response to a stimulus from the neuron, a muscle fiber depolarizes as the signal propagates along its surface and the fiber twitches. This depolarization, accompanied by a movement of ions, generates an electric field near each muscle fiber.

Each skeletal muscle is multinucleated, striated cell containing a large number of rod-like myofibrils that extend in parallel the entire length of the cell. Each myofibril is composed of still smaller units called myofilaments that contain the contractile proteins actin and myosin.

- Thin myofilaments are about 6nm in diameter and are composed primarily of actin, tropomyosin, and troponin.
- Thick myofilaments are about 16nm in diameter and are primarily of myosin.

Electromyography Signal

An EMG signal is the train of Motor Unit Action Potential (MUAP) showing the muscle response to neural stimulation.

The amplitude range of EMG signal is 0-10 mV (+5 to -5) prior to amplification.

When an alpha motor neuron cell is activated (induced by the central nervous system or as a result of a reflex action), the conduction of this excitation travels along the motor nerve’s axon and neurotransmitters are released at

the motor endplates. An endplate potential is formed at the muscle fibres and innervates the motor unit (the smallest functional unit where neural control over muscular contraction occurs). Muscle fibres are composed of muscle cells that are in constant ionic equilibrium and also ionic flux. The semi-permeable membrane of each muscle cell forms a physical barrier between intracellular (typically negatively charged compared to external surface) and extracellular fluids, over which an ionic equilibrium is maintained. These ionic equilibria form a resting potential at the muscle fibre membrane (sarcolemma), typically -80 to -90mV (when not contracted). This potential difference is maintained by physiological processes found within the cell membrane and are called ion pumps. Ion pumps passively and actively regulate the flow of ions within the cell membrane. When muscle fibres become innervated, the diffusion characteristics on the muscle fibre membrane are briefly modified, and Na^+ flows into muscle cell membranes resulting in depolarization. Active ion pumps in the muscle cells immediately restore the ionic equilibrium through the repolarization process which lasts typically 2-3ms. When a certain threshold level is exceeded by the influx of Na^+ resulting in a depolarization of the cellular membrane, an action potential is developed and is characterized by a quick change from -80mV to +30mV. This monopolar electrical burst is restored in the repolarization phase and is followed by a hyperpolarization period. Beginning from the motor end plates, the action potential spreads across the muscle fibres in both directions at a propagation speed of 2-6m/s. The action potential leads to a release of calcium ions in the intracellular fluid and produces a chemical response resulting in a shortening of the contractile elements of the muscle cells.

The depolarization-repolarization process described is a monopolar action potential that travels across the surface of the muscle fibre. Electrodes in contact with this wave front present a bipolar signal to the EMG differential. (Schaum's Human Anatomy and Physiology Pg. 123-127)

Amplifiers because the electrodes are measuring the difference between two points along the direction of propagation of the wave front. EMG signals provide us with a viewing window into the electrical signals presented by multiple muscle fibers and are in fact a superposition of multiple action potentials.

Methodology

Block Diagram

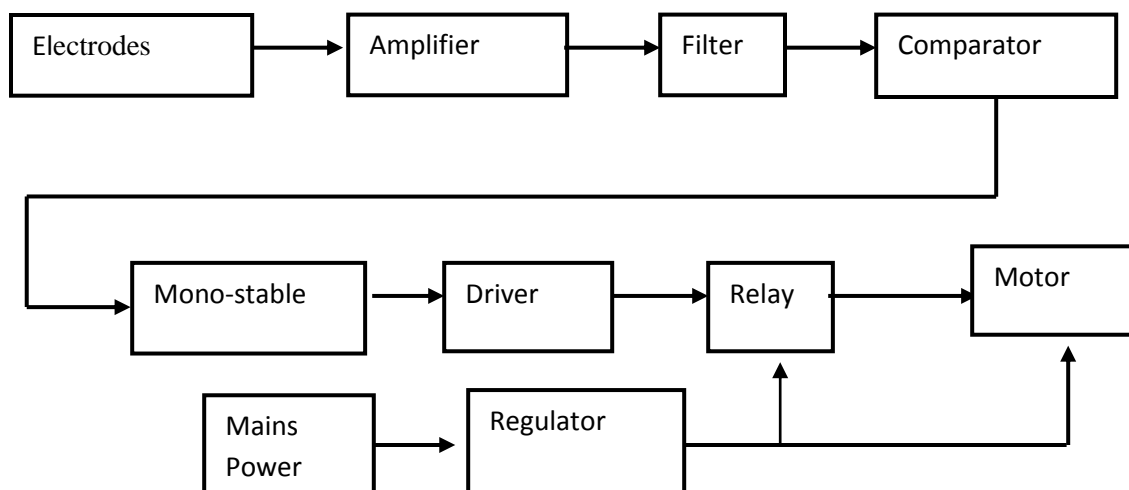


Figure 2.1 Block diagram of DC motor control using EMG

The electrode should be placed between two motor points, and along the longitudinal midline of the muscle. The reference electrode (at times called the ground electrode) is necessary for providing a common reference to the differential input of the preamplifier in the electrode.

The instrumentation amplifier used here is a type of differential amplifier that is outfitted with input buffers, which eliminate the need for input impedance matching suitable for use in measurement. It features are: High gain accuracy (1-10,000), High common mode rejection ratio (115dB at $G=1000$), High gain stability with low temperature coefficient (-40°C - 85°C), Low dc offset of 50mV and Low output impedance. (Carlson FD, et al, *Muscle Physiology*. Englewood Cliffs, NJ, Prentice-Hall, 1974.)

A HighPassFilter (HPF) is filter that passes high frequencies well but attenuates (i.e., reduces the amplitude of) frequencies lower than the filter's cutoff frequency. The actual amount of attenuation for each frequency is a design parameter of the filter. It is sometimes called a low-cut filter or bass-cut filter. HPF is used to remove drift and noise of EMG signals.

A comparator is a device which compares two voltages or currents and switches its output to indicate which is large. (Kleissen RFM, Buurke et al. *Electromyography in the biomechanical analysis of human movement and its clinical application*. *GaitPosture* 1998; 8(2):143-158.)

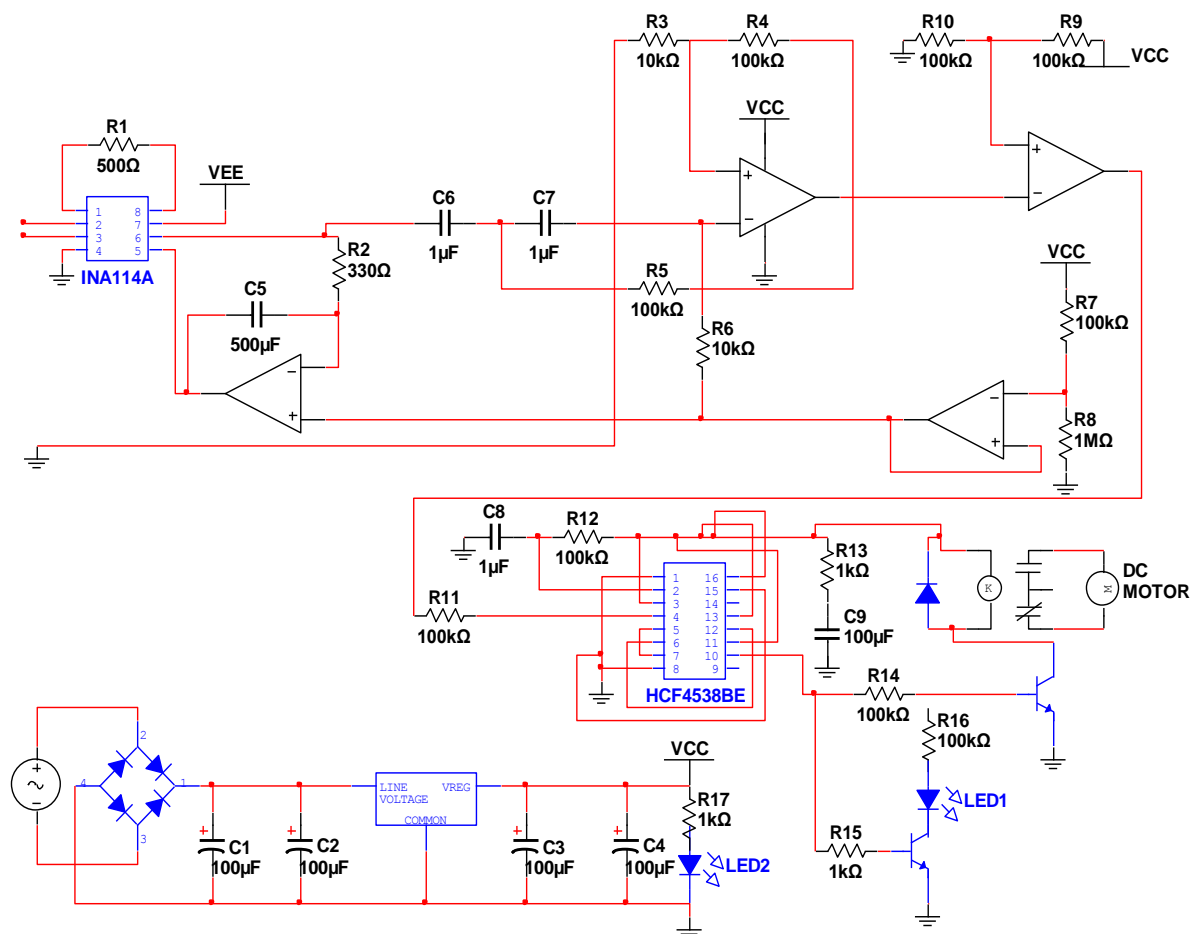
The mono-stable multivibrator has one stable state and one quasi state. It is used to generate single output pulse of adjustable time durations in response to the triggering input signal. An external resistor (R_x) and capacitor (C_x) control the timing and accuracy for the circuit.

The driver conveys the output of the mono-stable multivibrator to the relays. (Basmajian et al, *CJ. Muscles Alive The Functions Revealed by Electromyography*. 1985)

A relay is an electro mechanical device which is commonly used to connect two different circuits when the coil is energised, the centre core of the solenoid becomes magnetised and moves an arm closer to the coil contact connected to this arm and the contact touches another contact to complete a circuit. The contacts are labelled "common" for the moving contact, "normally open (NO)" and "normally closed (NC)".

The dc geared motor is suited to a wide range of applications requiring a combination of low speed operation and small unit size. The integral iron core DC motor provides smooth operation and a bidirectional variable speed capability while the gear head utilizes a multistage metal spur gear train rated for a working torque up to 0.2Nm.

Circuit Diagram



The circuit is made up of a power supply and it uses a full wave bridge rectifier, a 15-0-15 Transformer, Diodes ranging from D1 to D4 respectively, a voltage Regulator (7808 type) and bypass capacitors. During the positive half cycle, diodes D2 and D4 conduct in series while diodes D1 and D3 are in reverse bias and the current flows via the load. During negative half cycle, diodes D1 and D3 conduct in series, but diodes D2 and D4 switches off as they are in reverse bias. The full wave rectifier is designed to convert an AC sine wave to a full-wave pulsating DC signals with the aid of smoothing capacitors. The bypass capacitor converts the full-wave rippled output of the rectifier into a smooth DC output voltage as shown in the circuit diagram. In order to eliminate the potentially much greater noise signal from power line sources, a differential detecting configuration is employed. The signal is detected at two sites; electronics circuitry subtracts the two signals and then amplifies the difference. As a result, any signal that is "common" to both detection sites will be removed and signals that are different at the two sites will have a "differential" that will be amplified. Any signal that originates far away from the detection sites will appear as a common signal, whereas signals in the immediate vicinity of the detection surfaces will be different and consequently will be amplified. Thus, relatively distant power lines noise signals will be removed and relatively local EMG signals will be amplified.

This explanation requires the availability of a highly accurate "subtractor". The accuracy with which the differential amplifier can subtract the signals is measured by the Common Mode Rejection Ratio (CMRR) to suppress extraneous electrical noises. Notch filter to the instrumentation amplifier is mandatory to reject common-mode noise and differential dc voltage and offset error adjustment to null unwanted DC output signals, the output is then fed to the High pass filter. The [reactance](#) of a capacitor increases as the frequency of the signal through it decreases. Thus, in the circuit above, C6 and C7 tend to resist or block low-frequency signals, causing them to be attenuated at the output. On the other hand, the higher the frequencies of the input signal, the lower are the reactances of C6 and C7, and the closer the circuit resembles a [non-inverting amplifier](#). A comparator compares the input signal to a reference voltage and indicates which one is larger. A monostablemultivibrator triggers (extends the output pulse one period) on the application of each new trigger pulse. The external resistor and the capacitor control the timing and accuracy of the circuit. The driver conveys the output of the mono-stable multivibrator to the relays. The relays contacts are electrically conductive pieces of metal which touch together completing a circuit and allow the circuit current to flow and control the movement of the motor, just like a switch. Transistors are used to as switching elements to control the DC power to the load and the LED glows. The controlling current goes between emitter and the base.(Huxley AF et al ,Muscular contraction. **243**:1-43, 1974.)

Procedure of the Experiment

The procedure of the experiment is described as follow:

Step 1: The patient was made to sit in a chair and relax mood and explained the aim of the experiment to the patient so that he gets confident

Step2: The model was fixed according to the block diagram.

Step3: the electrodes were placed between two motor points, and along the longitudinal midline of the muscle. The longitudinal axis of the electrode (which passes through both detection surfaces) was aligned parallel to the length of the muscle fibers.

The reference electrode (called the ground electrode) is necessary for providing a common reference to the differential input of the preamplifier in the electrode.

Step4: The device was turned ON.

Step5: The patient was asked to contract the muscles.

Step6: The directional rotation of the dc motor was observed.

Results

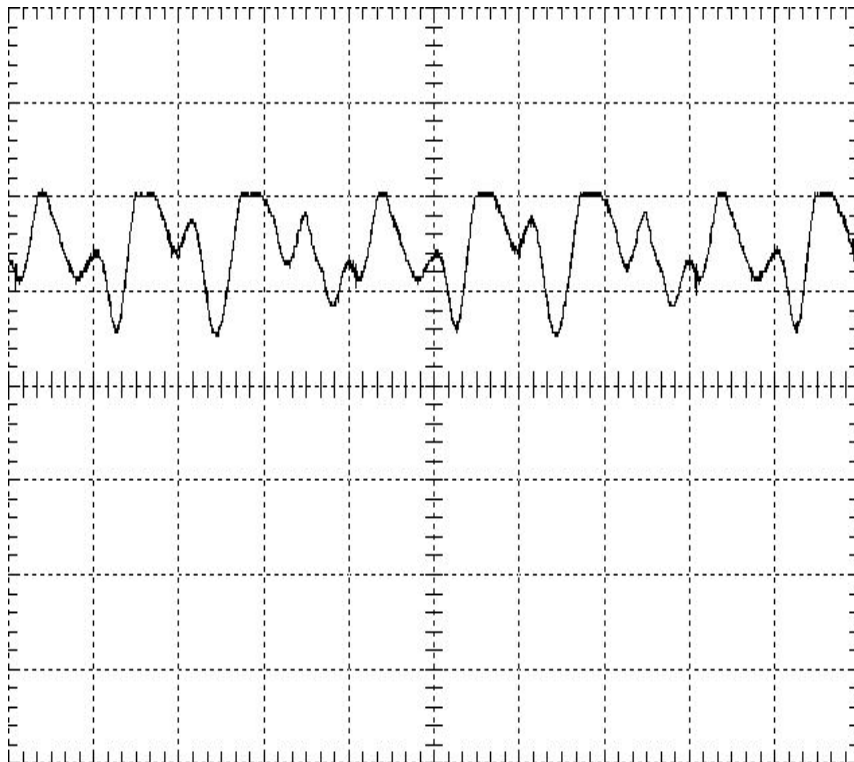
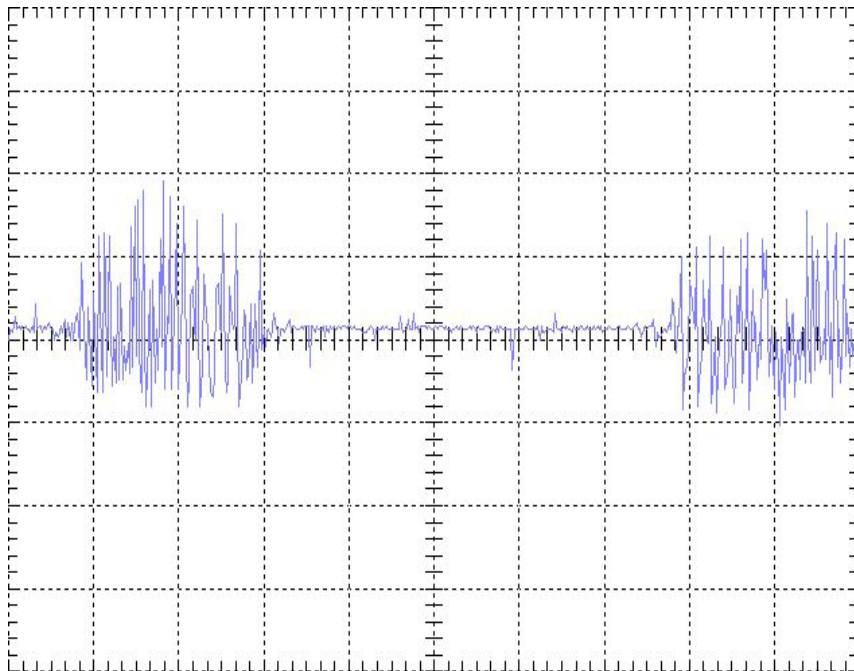
Motor Rotations

During the cause of experimental procedures, it was observed that the rotations per minute of the motor changed with the respect to the change in voltage applied. When the applied voltage increased, the rotations per minute also increased and when applied voltage decreased the rotations per minutes also decreases .Thus, the motor rotations per minute is directly proportional to the voltage applied (see table 1.).

Table 1 Relationship between voltage and motor rotation

Voltage (V)	Rotation (rpm)
8 V	40
5 V	20
2V	10
1V	5

3.2 ELECTROMYOGRAPHY WAVEFORM AT THE OUTPUT OF THE ELECTRODE AND AMPLIFIER



CALCULATIONS

GAIN OF AMPLIFIER

$$\text{GAIN} = 1 + \frac{50K\Omega}{R_g}$$

$$\text{GAIN} = 1 + \frac{50000\Omega}{500\Omega} = 101$$

Generally the gain is the ratio of the output voltage to the input voltage.

$$\text{GAIN} = \frac{\text{output voltage } ,V_{out}}{\text{input voltage } ,V_{in}}$$

Given that, IC gain = 101 and Input voltage = 50μV

$$101 = \frac{V_{out}}{50\mu V}$$

$$\text{Output voltage } (V_{out}) = 50\mu V \times 101$$

$$= (5 \times 10^{-6}) \times 101$$

$$= 5.05V$$

MONOSTABLE MULTI-VIBRATOR

Duration of output pulse = 0.693RC

$$R = 1K\Omega \quad C = 100\mu F$$

Duration of output pulse = 0.693 × 1000 × 0.0001

$$= 0.0693 \text{secs}$$

Discussion

Electromyography (EMG) activity originates from the depolarization and repolarization of the individual muscle cell membranes during muscle activity. Using surface electrodes it is possible to measure these potential differences on surrounding skin. (Kleissen RFM, Buurke et al. Electromyography in the biomechanical analysis of human movement and its clinical application. *GaitPosture* 1998; 8(2):143-158.)

Scope of Study

The knowledge obtained from the study of the biology, computer science, electrical engineering and robotics etc. have been employed for the development of many prosthetic devices to assist disable people in our society. Microprocessor based multifunction myoelectric control, Myoelectric devices based on EMG, and Targeted Muscle Reinnervation for Real-time Myoelectric Control of Multifunction Artificial Arms are typical examples of such devices.

Based on the literature review on design of biomedical devices to solve medical conditions, we realized that EMG signals can be measured more conveniently and safely than other neural signals. As a result of the non-invasive technique involved, i have decided to design a DC motor control using EMG signal which can constitute a major component required to fabricate an assistive device such as an artificial arm.

Applications

There are many applications for the use of EMG. EMG is used clinically for the diagnosis of neurological and neuromuscular problems. EMG is also used in many types of research laboratories, including those involved in grasp recognition, motor control, neuromuscular physiology, movement disorders, postural control, and physical therapy. A DC motor control using EMG signal can constitute a major component required to fabricate an assistive device such as an artificial arm

Conclusion

Muscle tissue at rest is normally electrically inactive. This project serves as a resource for a man-machine interface and it was tested on different individuals when the muscle is voluntarily contracted, action potentials begin to appear and can be used to drive the DC geared motor. Using the idea of this design, a control device for a rehabilitation device like hand prosthesis in the future could be done in order to make the life of people with a malfunctioning limb comfortable to a certain extent.

References

- Basmajian et al, C.J. Muscles Alive The Functions Revealed by Electromyography. 1985.
- Carlson FD, et al, *Muscle Physiology*. Englewood Cliffs, NJ, Prentice-Hall, 1974.
- Huxley AF et al, Muscular contraction. **243**:1-43, 1974.
- Kleissen RFM, Buurke et al. Electromyography in the biomechanical analysis of human.
- Schaum's et al, Human Anatomy and Physiology Pg. 123-127

EFFECTS OF REWARDS AND RECOGNITION ON STAFF RETENTION IN GHANAIAN POLYTECHNICS

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Within the polytechnics, enormous strides are being made with some of the polytechnics striving to introduce more market-driven programmes such as Bachelor of Technology (B. Tech). These emerging trends require that polytechnics position themselves in order to attract and retain staff. The use of human resource management techniques is thus critical. This prompted the need to investigate current rewards and recognition and their potential effects on employee retention at the polytechnic. The study employed descriptive cross-sectional survey approach to collect and analyse data. Both probability and non-probability sampling methods were used. Findings from the study suggest that staff were not generally satisfied with salaries and compensations available even though the salaries and compensations appeared the most favoured reward mechanism of staff. The study also established that staff members were not very impressed with the basis of determining their salaries. Equally, the research further observed that between the next one to ten years, the majority of the surveyed people had intentions of retiring or leaving the polytechnic, despite their average ages of less than 40 years. It is therefore recommended that polytechnics need to seriously address issues on rewards and recognition to improve staff retention.

Keywords: Reward, Recognition, Retention, Compensation

Background to the Study

Academic and non-academic staff members play an instrumental role in the development of tertiary institutions. There had been expansion of higher education in Ghana in the latter part of the 1990s (Ministry of Education 1993). There has also been instrumental role of research and innovation in the global knowledge-economy. As a result, demand and competition for highly qualified academics have intensified. Growth in global mobility and shifting demographic profiles, means recruiting and retaining talented and knowledgeable lecturers and researchers is an ever-increasing challenge (Metcalf, Rolfe, Stevens, & Weale, 2005). These have engendered a more strategic approach to human resource management in the higher education sector.

Reward and recognition management is a strategic tool, used by management to implement policies and strategies that are aimed at recognising and rewarding the members of the organisation in a way that is consistent with the organisational goals. Furthermore, it also encompasses rewarding people fairly in relation to their contribution and the value they add to the organisation.

All organisations have their reward systems. Executives and managers might often see rewards as being only monetary compensation, though it entails more than just pay (Huff, 2006). Without these rewards, employees would not join the organisation, be inclined to come to work, or perform in line with the mission or strategy of the organisation (Huff, 2006). A reward system is also a part of a larger human resource strategy, with the goal of strengthening employee loyalty, raising motivation and increasing job satisfaction (Tettey, 2006).

Rewards and recognition can be given to individuals based on their performance or to groups. It can also be linked to an organisation's pay and workforce strategy, workforce plan and over all human resource strategy to ensure that the organisation has the capability to deliver its overall corporate improvement plan (Armstrong & Stephens, 2005). In a wider context, this strategy enables change and progress through the development of new skills and behaviours which are needed to deliver organisational improvements and staff retention.

The purpose of a reward strategy is that it defines what the organisation wants to pay for. The strategy provides specific direction on how an organisation will develop and design pay, benefits and related programmes to ensure that it rewards the behaviours and contributions that support the achievement of its corporate objectives.

Martin (2003) however, found an inverse relationship between relative wages and retention. That is, organisations with relatively high pay had higher retention rate. The link between reward and recognition systems and retention or voluntary turnover appears to be inconclusive (Yorke & Longden, 2007).

Currently, polytechnics in Ghana have well documented conditions of service policy. Within the context of the policy, there are specific rewards and recognition systems within the policy. The policy specifies certain conditions which staff members are entitled to. Some of the specifics include retirement and pension benefits, accommodation, leave (study, sabbatical, casual and annual), health and medical, transportation, and death benefits. Even though these benefits may exist, staff may leave when they compare their qualifications with other colleagues at other establishments who earn higher recognition and rewards.

Justification of the Study

There are several reasons why this study was carried out. Studies on the extent to which reward influences organisations retention rates have been inconclusive (Milkovich & Newman, 1999; Martins, 2003). Furthermore, the research settings of these studies are different and make cross-cultural comparison difficult, as the economic and social fundamentals are different. A study on the effect of reward on retention in Ghana is missing and this study therefore fills the knowledge gap. In practice, the findings would assist Rectors and human resource practitioners in Ghanaian polytechnics to identify the best mix of human resource policies and practices that guarantees high level of employee retention. The study in addition aims at throwing more light on the issue of reward as a determinant of labour retention in an emerging economic environment such as Ghana.

Objectives of the study

The main objective of the study was to establish the degree to which reward and recognition practices of the polytechnics affect the retention of academic and non-academic staff. The specific objectives were to:

- Examine staff appraisal/assessment of rewards practices of polytechnics in Ghana;
- profile staffs' evaluation of current recognition traditions in polytechnics;
- examine how the recognition and rewards system affect actual and intended turnover at polytechnics; and
- recommend appropriate measures or actions that are likely to improve polytechnic staff retention in Ghana.

Contextual Information: Polytechnics Education in Ghana

Polytechnics are higher educational institutions responsible for training in scientific and technical subjects. Since 1992, when Government directed polytechnics in Ghana to run tertiary programmes, significant gains have been made in the output of the polytechnic graduate. The polytechnics provide the bulk of our people with technical education that is relevant, up-to-date in technology, and forward-looking in approach.

The polytechnics in Ghana were first established as technical institutes that offered craft courses.

In 1963, the technical institutes were re-designated as polytechnics to run non-tertiary programmes. The Tamale and Ho technical institutes were elevated to polytechnic status in

1984 and 1986 respectively. The Cape Coast Polytechnic which was planned as a polytechnic was opened in 1986. In 1987, the Government of Ghana constituted a University Rationalisation Committee (URC) to develop proposals for reforming the management, academic structure and funding of tertiary education in Ghana. (Ministry of Education, 1993) Following the submission of the URC's report, the government issued a White Paper in 1991 on the Reforms to the Tertiary Education System. The White Paper gave prominence to polytechnic education and in 1993, following the promulgation of the Polytechnic Law, 1992 (PNDCL 321), the Polytechnics were upgraded to tertiary status. In line with government's policy of making the polytechnics regionally based institutions, the Sunyani, Koforidua, Wa and Bolgatanga polytechnics were also established.

The White Paper specifically stated that the polytechnics have a distinct and important role to play in middle-level manpower development and that programs and courses were to be offered at the middle-level of technical training

leading to the award of higher national diplomas but not departing from syllabi dedicated to practical training. The provision of such programs will complete the cycle of technical education and provide a capacity for higher-level technician training and practical research (Ministry of Education, 1993).

Literature Review

There are empirical evidence on reward and recognition strategies and their impact on retention in organizations. Every employee needs to be compensated for work done. There are different recognition strategies which are used by human resource professionals.

Rewards Management

Compensation broadly refers to all the ways in which an organization may reward employees for the services that they render.

According to Syedain (1995), two schools of thought explain reward systems to employees. One way to do that is to say “thank you” in a formal way through a badge, certificate or a written note, whilst another way could be to give a concrete reward to create an impact. There are at least two factors that determine the attractiveness of a reward; one is how much of the reward is being offered and the second is how much the individual values the type of reward that is being offered. Lawler (2003) He argues that the more the individual values the type of reward and the more of it is offered, the greater the motivational potential. Rewards management simply means the process of developing and implementing strategies, policies and systems, which help an organisation to achieve its objectives by obtaining and keeping the people it needs, and by increasing their motivation and commitment (Beer et al., 1984). Effective reward management can help an organisation to achieve its business objectives by attracting and retaining competent people Deeprose (1994). Reward management strategy and policy is thus driven by corporate and human resource management strategies.

Elements of Rewards Programme

Armstrong and Stephens (2005) suggest four main areas that should be addressed in a reward management system. These are pay structures that combine the results of market surveys and job evaluation. Again, there are structures that define the levels of pay in the organisation. Another element is the description of employee benefits that satisfy the needs of employees for personal security and provide remuneration in forms other than pay, this is also known as financial reward. There is also flexible compensation, in this concept, employees select from the range of benefits that the employer is prepared to provide those that are relevant to the specific needs and requirement (Martocchio (1998) to Non-financial rewards satisfy employees’ needs for variety, challenge, responsibility, and influence in decision-making, recognition and career opportunities, and performance management.

Nelson (1995) argues that the value of informal rewards, which consists of spontaneous, non-monetary forms of recognition are increasing for two reasons. The first reason is that formal rewards such as compensation, benefits and promotions are less effective in motivating employees. Secondly, informal rewards are increasingly more effective and highly desired by today’s employees

Compensation denotes both the intrinsic and extrinsic rewards, which employees receive for performing their jobs. Martocchio (1998). Intrinsic compensation refers to the employee’s psychological mindsets that result from performing tasks. Extrinsic compensation includes both monetary and non-monetary rewards. Non-monetary reward includes the benefits that employees receive apart from pay. Barton (2002) argues that formal reward programmes represent financial rewards such as salary, fringe benefits, bonuses, promotions and share options, which play a significant role. In addition to this, people expect their organisation to offer good benefits, including access to medical aid and pension funds. Rewards system needs to have a positive impact on behaviour Wilson (1994) and should be meaningful and valuable to the individual, based on objective and attainable goals. In their drive to stay competitive, organisations increasingly reward and recognise employees as part of their total quality

programme. Such programmes provide a range of monetary and non-monetary rewards and are planned and implemented either in-house or using the help of consultants.

Performance-Based Rewards

Performance-based pay schemes improve the administration of schools Hoerr (1998).

As a safety precaution, Solomon and Podgursky (2001) advocate principals becoming recipients of school wide performance-based rewards, to ensure they remain objective in their evaluation.

Benefits of Rewards Programmes

Romano (2003), however, maintains that reward and recognition make people feel and look good and therefore are motivated to achieve more. Organisations therefore need to look beyond rewards alone as predictors of motivation. Rewards have to move in conjunction with recognition. Nevertheless, organisations usually consider cash as the first option when considering how to reward employees.

Informal recognition, according to Curran (2004), can lift employee motivation and improve overall organisational morale.

Strategies for Reducing Turnover

Lake (2000) suggests that differentiating avoidable and unavoidable turnover (from the organisation's point of view) can help organisations to understand voluntary turnover more fully. Avoidable reasons include employees leaving to find better pay or working conditions elsewhere, problems with management or leaving for better career opportunities. On the one hand, unavoidable reasons – which are beyond the organisation's control – include, for example, an employee having to move because of relocation by a spouse or leaving to fulfil family or caring responsibilities. If an organisation can identify that many of its voluntary turnovers are unavoidable, it could profit from initiatives that seek to manage turnover after the event rather than expend resources on implementing preventative measures. On the other hand, if the bulk of turnover is avoidable this offers the potential for targeted intervention.

Another step towards understanding turnover within an organisation is to determine whether retention difficulties are caused by internal or external factors.

Another strategy for reducing turnover is the application of crude wastage rate for measuring turnover. This is done by the number of leavers in a given period as a percentage of the average number of employees during the same period.

The Institute of Development Studies [IDS] (2004) explains that another way of measuring turnover is to base turnover rates on voluntary leavers or resignation rates only, thus excluding employees who have left for other reasons such as retirement, redundancy, dismissal or redeployment to another part of the organisation.

Some organisations employ exit interviews and surveys to obtain qualitative information on turnover. However, it is important to appreciate that the reasons people give for their resignations are frequently untrue or only partially true (CIPD, 2004). The use of exit interviews is widespread yet they can be unreliable, particularly when conducted by someone who may later be asked to write a reference for the departing employee.

Costing turnover is another strategy that employers use to measure extent of turnover on an organisation. The more complex approaches to costing turnover give a more accurate and higher estimate of the costs. Such approaches often take into account the costs associated with lost productivity (i.e. the productivity of a new employee during their first few weeks or months in the role and that of resignees during the notice period) and the effect on morale of the remaining workforce.

Methodology

The target population consisted of all teaching and non-teaching in polytechnics in Ghana with a sample size of five namely: Koforidua, Sunyani, Tamale, Kumasi and Bolgatanga. The study adopted the cross-sectional survey method. The study also relied on two main sources of data namely: primary and secondary data.

The primary data were collected through self-administered questionnaire. The secondary information is in the form of the polytechnics' human resource policies and procedures. Statistical Package for Social Science (SPSS) was used in processing and analysis of data.

Findings

Background characteristics

Across the five participating polytechnics, the data shows that there is 2,311 staff from 1998-2012. Table 1 shows the distribution of staff across the five polytechnics.

Table 1: Distribution of staff across the four polytechnics

Polytechnic	Number of staff	Percent
Sunyani	529	20.8
Koforidua	578	22.7
Kumasi	734	28.8
Tamale	470	18.5
Bolga	235	9.2
Total	2546	100.0

Table 1 shows that the distribution of staff strength across Sunyani, Koforidua and Tamale polytechnics is almost evenly distributed. However, Kumasi polytechnic had the highest (29%) staff strength, followed by Koforidua (22.7%), while Bolgatanga polytechnic recorded the polytechnic the least staff strength (9%). Further analysis of Table 1 shows that the staff strength of Kumasi polytechnic is about 19.6 percent higher than that of Bolga, while that of Koforidua is about 13.5 percent higher than that of Bolgatanga.

The variation in the staff strength across the polytechnics is highly attributed to the period for which they have been in existence and the number of programs being offered as well as the available facilities.

Results on staff resignation

Table 2 shows the total number of staff who resigned across the five polytechnics from 2007-2012

Table 2: Staff resignation across the four polytechnics (2007-2012)

	Sunyani		Kumasi		Tamale		Koforidua		Bolga		Total	
Resignation	f	%	f	%	f	%	f	%	f	%	f	%
Year	30	16.5	37	20.3	12	6.6	60	33.0	43	23.6	182	100.0

Source: Researcher construct

Table 2 shows that across the five polytechnics, 182 staff resigned from the period 2007-2012. Of this number, 33.0 percent were from Koforidua poly followed by Bolga poly. Tamale poly however had the least (6.6%) number of staff

who resigned for the period. That is to say that staff resignation is a common practice across the five polytechnics studied.

The primary data gathered from staff on their leaving intention across the five polytechnics showed that although majority (56%) of the respondents did not have the intention of leaving their institutions, should there be an alternative, they would resign. This gives the indication that staff have not been adequately rewarded and motivated, hence constantly looking for opportunities for another alternative jobs.

Major reasons gathered regarding respondents leaving intention include:

- Opportunities for advancement and further studies; and
- Inadequate financial reward schemes

The results in Table 2 gives the indication that, though the rate at which staff resign across the five polytechnics was not significantly high, staff were willing to resign should there be more alternative opportunities.

Figure 1 also gives the graphical distribution of staff resignation across the five polytechnics.

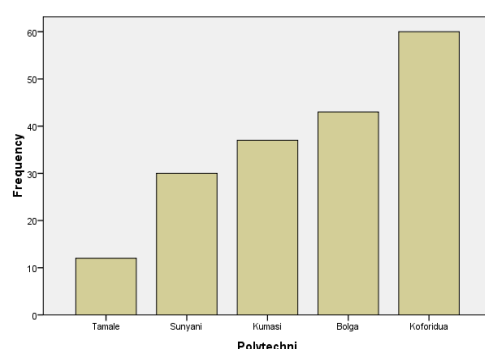


Figure 1: Staff resignation across the five polytechnics Source: Survey data

To adequately explore staff resignation and turnover rate, the study further performed analysis to assess the relationship between staff resignation across category (Academics and non-academics). This is to help examine which category of staff is most likely to resign. Table 3 also showed the category of staff who resigned across the four polytechnics.

Table 3: Distribution of staff across the five polytechnics

Polytechnic					
	Sunyani	Koforidua	Tamale	Bolga	Kumasi
Staff category					
Academics	15	19	1	23	12
Non-Academics	15	41	11	20	25
Total	30	60	12	43	37

Table 3 shows that in general, non-academic staff resigns more as compared to academic staff. For example, in Koforidua poly, of the 60 staff who resigned from the period 2007-2012, 41 were non-academic staff. That is more than 60 percent (68.3%) of the staff who resigned were non-academic staff. A similar trend is observed for both Tamale poly and Kumasi poly but with a very significant variation as compared to Koforidua. Of the 12 staff who resigned in Bolgatanga polytechnic, 91.6 percent were non-academic staff and in Kumasi poly 25 out of the 37 staff who resigned were non-academic staff representing 67.6 percent. Although the results depicted that non-academic staff are more likely to resign as compared to academic staff, the trend changed a little with regard to staff in Bolgatanga polytechnic. More than half (53.4%) of those who resigned in Bolgatanga polytechnic were academic staff. That is to say, even though the proportion of academic staff who resigned was higher than that of non-academic staff, the variation was marginal. Resignation across staff in Sunyani poly was evenly distributed. Figure 2 shows staff resignation across academic and non-academic staff.

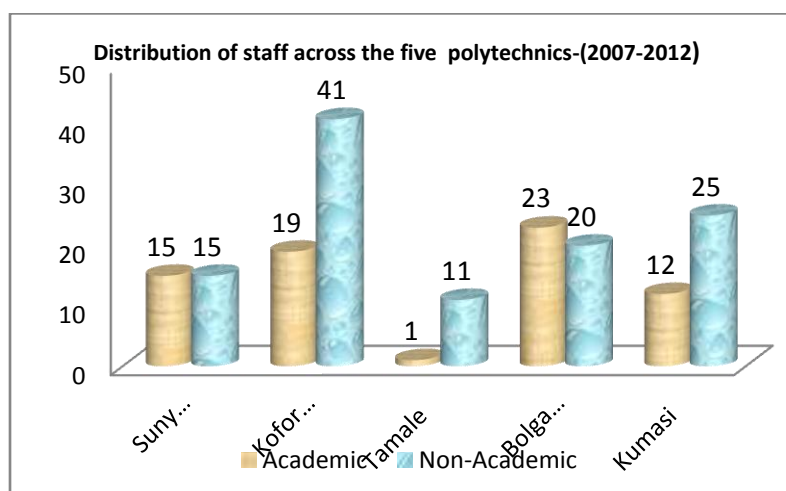


Figure 1: Staff Resignation across Academic and Non-Academic Staff

The results in Table 3 and Figure 2 implied that more attention is paid to academic staff's development and motivation as compared to non-academic staff.

Further analysis shows that among the non-academics, staff whose jobs require less educational qualification such as labourers, security guards, cleaners etc. are less likely to resign as compared to those whose jobs required higher academic qualifications such as accountants. This trend is attributed to the fact that staff with higher academic backgrounds were opened to more opportunities for securing alternative jobs. Hence if there are no effective motivational schemes in the polytechnic administration, the likelihood of more non-academic staff resigning will be higher than academic staff.

Conclusions

Tertiary educational institutions depend on their employees' skills, knowledge, and abilities for efficient and effective delivery of services in order to stay abreast with new changes and to achieve the vision of the institution. Therefore, attracting and retaining skilled employees have become an important aspect for institutions. Where there are no clear retention strategies to retain employees the ultimate goals of the institution might not be achieved.

Policies adopted by tertiary educational institutions play a key role in determining the future of an institution. This paper concludes that non-academic staff in Ghana's polytechnics are more likely to resign as compared to the

academic staff. In other words, academic staff seemed to enjoy more intrinsic and extrinsic motivational packages as compared to non-academics staff.

Additionally, among non-academic staff, those whose job requires much education are more likely to resign as compared to those whose job requires less education. That is to say those whose job requires less education are less opened to job opportunities and therefore less likely to resign.

However, the papers concludes that the major reasons for high labour turnover rate among staff in Ghana's polytechnic is highly attributed to the lack of advancement and further studies opportunities as well as lack of adequate financial reward schemes.

Recommendations

In relation to the key and major findings emerging from the study, the following recommendations are made for poly formulation:

Formulation of a Proper Innovative Retention Strategy

Management of polytechnics in Ghana should make an effort in terms of developing a proper innovative retention strategy. The retention strategy should specifically focus on people who have potential and those who have obtained their Bachelor's, Master's and Doctoral degrees through the institution's development programs.

A distinct difference should be made between administrative, support and academic staff when developing retention strategy. As such, the strategy should offer non-academic staff who have obtained a higher qualification an opportunity to apply their skills and knowledge. For academic staff members, the retention strategy should include: personal and professional development; flexible working hours (for academic staff S); and extra time for research activities. For non-academic staff, the retention strategy should include: career development; challenging tasks; autonomy; and more responsibilities. Implementing an innovative retention strategy will motivate staff members and commit them towards improving their qualifications, whilst encouraging them to share their newly gained knowledge with other staff members.

There is a need for a Comprehensive and Complimentary Staff Development Policy

The policy should take into consideration different development and training needs of staff, especially non-academics staff. Hence, before the policy is implemented, those in charge of developing the policy, should identify the problem that should be addressed and then determine the necessity for the policy. This should be done in consultation with appropriate sectional heads, Head of Departments (HoDs) and Deans in order to determine who should assist in the development of the proposed policy. Other educational institutions that have similar policies such as the Universities in Ghana should be consulted so that ideas can be compared. After assessing all views, the policy should be drafted and distributed to staff members to receive their comments and suggestions.

Recruitment

Since retention begins at recruitment, it is recommended that the conditions of service (thus, the prevailing working conditions) should always be explained in detail to new entrants at the point of recruitment. These previews would give new entrants more insight into the operations of the polytechnics.

References

- Armstrong, M. & Stephens, T (2005). *A handbook of employee reward management and practice*. London: Kogan Page.
- Barton, G. M. (2002). *Recognition at work*. Scottsdale: World at Work.
- Beer, M., Spector, B., Lawrence, P.R., Mills, D.Q., & Walton, R.E. (1984). *Managing human assets*. New York: The Free Press.
- Chartered Institute of Personnel and Development (CIPD) (2004). *Fact sheet on employee turnover and retention*.
- Curran, C. R. (2004). Rewards: respect, responsibility, relationship and recognition. *Nursing Economics*, 22(2), 57–59.
- Deeprase, D. (1994). *How to recognise and reward employees*. New York: AMACOM.
- Hoerr, T. (1998). A case for merit pay. *Phi Delta Kappan*, 80 (4), pp 326– 27.
- Huff, C. (2006). Hospital aims for culture where employees ‘Never want to leave’. *Workforce Management*. Retrieved 2/10/05 from http://www.workforce.com/section/06/feature/23/94/76/index_printer.html
- Institute of Development Studies (2000). Improving staff retention. *IDS Studies*, No. 692, July 2000.
- Institute of Development Studies (2004). Improving staff retention. *IDS HR Studies*, No. 765, Jan 2004..
- Lake, S. (2000). Low-cost strategies for employee retention. *Compensation and Benefits Review*, 32(4), 65–72.
- Lawler, E. E. (2003). *Treat people right*. San Francisco: Jossey-Bass Inc.
- Martin, C. (2003). Explaining labour turnover: Empirical evidence from UK establishments. *Labour*, 17(3), 391–412.
- Martocchio, J. J. (1998). *Strategic Compensation*. New Jersey: Prentice-Hall Inc. Metcalf, H., Rolfe, H, Stevens, P. & Weale, M. (2005). *Recruitment and Retention of Academic Staff in Higher Education*. Nottingham: National Institute of Economic and Social Research.
- Milkovich, G. T. & Newman, J. M. (1999). *Compensation*. Boston, MA: Irwin/McGraw-Hill.
- Mol, A. (1992). Motivating subordinates. *IPM Journal*, 11 (2), 19–22.
- Nelson, B. (1995). Motivating employees with informal awards. *Management Accounting*, 77(5), 30–35.
- Romano, L. (2003). Beyond reward: why cash is no longer enough. *Rewards*, 3(1), 12–13.
- Sarvadi, P. (2005). *The best way to reward employees. Solutions for growing*
- Solomon, L & Podgursky, M (2001). *The Pros and Cons of Performance-Based Compensation*. Milken Family Foundation, Pascadena.
- Tettey, W. J. (2006). *Staff retention in African Universities: Element of a sustainable strategy*. New York: The World Bank.
- Wilson, T. B. (1994). *Innovative reward systems for the changing workplace*. New Jersey: R.R. Donnelley & Sons Company.

FIELD DRYING OF CASSAVA IN A SOLAR TENT DRYER EQUIPPED WITH A SOLAR CHIMNEY

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This paper describes the investigation of the performance of a solar tent dryer equipped with a solar chimney in the drying of cassava, as against open sun drying. An initial no-load trial was done, followed by trials with the dryer loaded with cassava. Some cassava chips were spread outside the dryer with the same loading density, to serve as control drying in the open sun. The temperature profile in the no-load trial and the moisture contents of the crops at the beginning and end of each drying day, together with the environmental data overview of each drying process are presented. The temperature inside the dryer was found to increase with height during the no-load process. But the evaporation of moisture from the crops distorted this trend during the crop drying processes. The drying process inside the dryer always started more slowly but finished earlier than the open-sun drying, even when the dryer was fully loaded. The results for both the no-load and loaded trials follow similar trends to those obtained from earlier trials performed on only one half of the triangle of the tent dryer. Thus using both sides of the triangle to make the dryer more stable did not reduce the performance of the dryer.

Keywords: Crop drying, solar chimney, natural ventilation

Introduction

About 65% of Ghana's workforce is made up of rural-based farmers (Owusu-Baah, 2004). Yet the food in the Ghanaian markets is generally not enough. This is partly caused by post-harvest losses, which is being compounded by increase in Ghana's population. The farmers, who are mostly without storage facilities, continually face frustrating situations as they are forced to sell their produce at very cheap prices during harvest, after which food becomes scarce. This development makes farming increasingly unattractive. The youth then drift into the cities in search of non-existent jobs, leading to slum development with increased crime rate etc. in the cities. The farmers need to dry their crops to an appreciably low moisture content level so that the crops can be preserved and sold at remunerative prices in their prime marketable condition at the appropriate time. The farmers normally dry their crops by spreading them on mats in the open sun, sometimes even on bare ground by the road side (figure 1). This way of crop drying is not that efficient, and the crops are exposed to rain, pest, rodents and various forms of unhygienic conditions.



Figure 1 Open-sun drying on bare ground

Crop drying is the removal of moisture from crop. Generally, moisture evaporates from a porous material (e.g. crop material) into the surrounding air whenever the vapour pressure of moisture p_{cr} in the crop is higher than the partial pressure of vapour p_{air} in the air. The rate of evaporation is proportional to the pressure difference ($p_{cr} - p_{air}$). The vapour pressure of moisture in the crop increases with increase of crop temperature. On the other hand, the partial pressure of vapour in the air reduces as the relative humidity (RH) of the air reduces, and this can be achieved by increasing the air temperature (Rogers and Mayhew, 1993; Jain and Tiwari, 2004). Thus for effective absorption of moisture from the crop into the air, both the crop and the air must be of an appreciably high temperature. After moisture absorption, the air then becomes more humid and needs to be replaced with fresh and less humid air to maintain the desired drying rate. An effective crop drying process therefore requires a constant flow of considerably warm, low-humid air through the crop which is also warmed to the right temperature.

A crop dryer normally has a device to preheat the air to reduce the relative humidity en route to the crops which are housed in a drying chamber. The source of power for the heating device may be electricity, gas, diesel, biomass or solar energy. There are two main types of crop dryers; the forced-convection (or forced-ventilation) and the natural-convection (or natural-ventilation) types. The forced-ventilation dryer uses a blower, powered by electricity or some other mechanical means, to blow the drying air through the crop. The natural-ventilation dryer depends on the natural buoyancy flow of air created by the thermo-syphon effect through the system. The farmers live far away from the national electricity grid and the use of electricity is too expensive for them to power a blower or any heating device. Other heating sources like wood may also be expensive or unfriendly to the environment. Natural ventilation solar crop dryers can be used to help generate income for rural farmers and also to meet the present and future demand for food in the community. These dryers are normally not too expensive to construct, and all the parts are locally available. Developing these dryers in the rural areas would also provide jobs for artisans in the rural areas and help to curb the rural-urban drift among the youth. This could be a starting point for rural industrialisation.

There are three types of natural ventilation solar dryers. The indirect-mode type has a device to preheat the air en route to the drying chamber whose walls are opaque so that the crops have no contact with sunlight. The preheating device has transparent walls through which the sun's rays enter to fall on an absorber that converts the radiant energy to heat the drying air. The direct-mode dryer has no air preheater, and the radiant energy enters through transparent walls into the drying chamber whose content serve as the main absorber for heating the drying air which in turn dries the crops. The mixed-mode dryer has an air preheating device and also transparent drying-chamber walls to allow maximum radiant energy utilisation. Earlier reports indicate that the direct-mode type is highly inefficient due to poor ventilation which results in excessively high temperatures and high humidity in the drying chamber (Ekechukwu and Norton, 1997; Ekechukwu, 1999b). Unless the dryers are well designed, the crops at times end up partially cooked rather than properly dried. However, the low economic base of most rural farmers only enables them to patronise this type of dryer, which is the least expensive of all natural ventilation dryers. Singh et al (2004) however declared that the direct-mode dryer can be more efficient than the indirect-mode dryer; the only problem at times is the poor quality of the produce, especially those that are sensitive to sunlight.

Some reports on chimneys showed that, properly designed solar chimneys can boost the airflow through an enclosure (Chantawong et al., 2006; Chen et al., 2003; Ekechukwu, 1999a; Ferreira et al., 2008; Ong, 2003; Ong and Chow, 2003;). The solar chimney was combined with an appropriately inclined drying-chamber roof and a suitable inlet-exit area ratio to improve the ventilation in the direct-mode dryer (Afriyie et al., 2009; Afriyie et al., 2010). The resulting design from this combination is the chimney-dependent solar crop dryer (CDSCD). Figure 2 shows a schematic diagram of the laboratory model of this design. Afriyie et al. (2011a) performed simulation and optimisation of the ventilation process to provide an aid to designers of the structure, and validated the program with physical trials on the laboratory model. A field model of the design, schematically shown in figure 3, was tested in the field with promising results (Afriyie et al., 2011b).

The structure of the CDSCD that has so far been investigated represents one symmetrical half of the triangular tent dryer as indicated in figure 3. However, using the full triangle of the tent dryer enhances the stability of the structure against local winds and storms and also creates more room for the crop shelves without adding too much glazing and framework. The functional architecture of the full tent dryer is shown in figure 4.

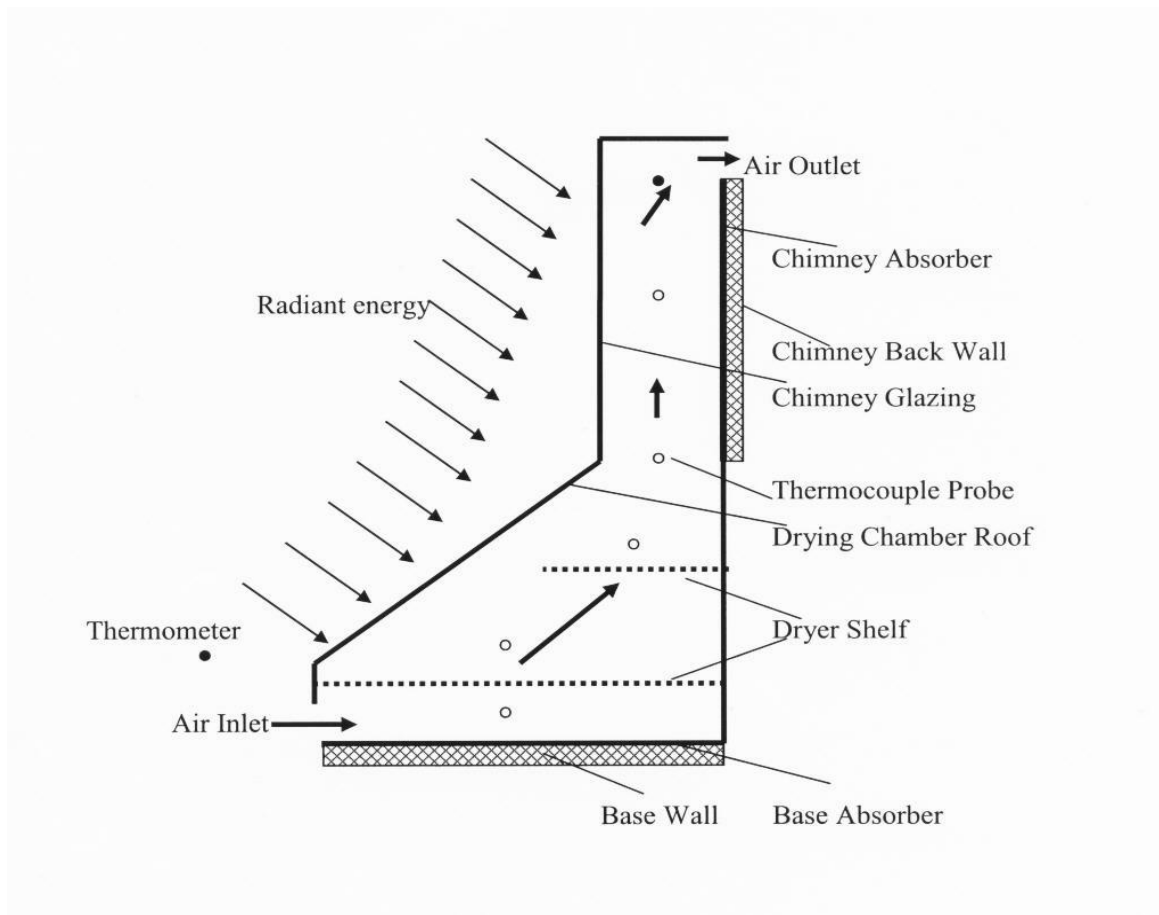


Figure 2 Schematic diagram of a laboratory model of Chimney-dependent Direct-mode Solar Crop dryer

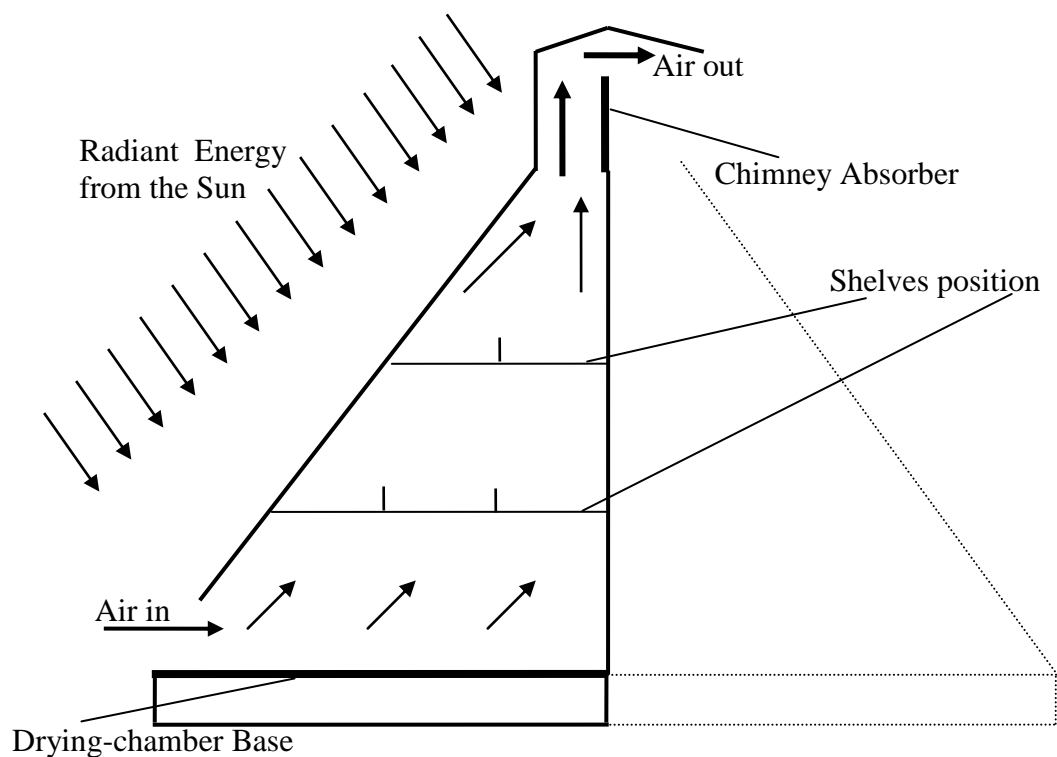


Figure 3 Sketch of the laboratory model of the chimney-dependent direct-mode dryer (built similar to the laboratory model)

In operation, air enters the dryer through the bottom inlet, absorbs heat from the base and walls of the drying chamber and dries the crops inside the chamber. The air then enters the solar chimney where it continues to absorb heat to become less dense to ensure continuation of flow, and exit through the top vent into the surroundings. The objective of the current work is to examine the performance of the fully triangular cross-sectioned CDSCD in the drying of cassava on the field in relation to open-sun drying.

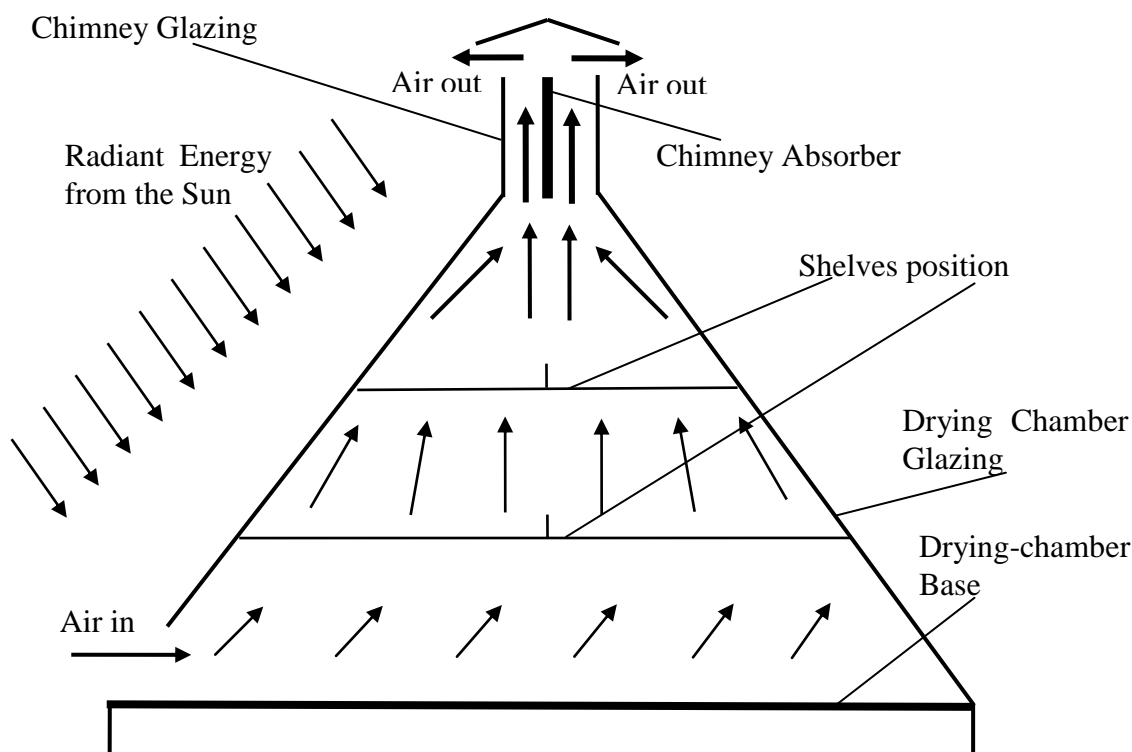


Figure 4 Functional architecture of the tent dryer equipped with a solar chimney

Materials and methods

Experimental set up

The solar tent dryer with the solar chimney was built to the dimensions shown in table 1. The dryer had a wooden framework. The wooden base of the drying chamber was covered with a black polythene sheet to act as absorber. Along the base perimeter were beams of wood that extended downwards to limit the airflow and the heat loss underneath the base. The chimney absorber consisted of a sheet of steel which runs across the width of the dryer. The glazing of both the drying chamber and chimney was made of transparent polythene sheet. The pictorial view of the dryer can be found in figure 5.

Part of dryer	Dimension
Width of drying chamberbase (perpendicular to inlet airflow)	150 cm
Length of drying chamber base (in the direction of inlet airflow)	180 cm
Height of drying chamber	170 cm
Thickness of drying chamber base	3 cm
Roof angle of drying chamber to the horizontal plane	65 ⁰
Dryer inlet width	144 cm
Dryer inlet gap	30 cm
Height of chimney walls (glazed)	30 cm
Height of chimney roof (glazed)	10 cm
Height of chimney absorber	30 cm
Chimney gap	25 cm
Chimney roof angle to the horizontal	38 ⁰

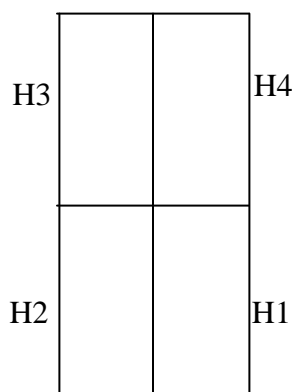
Exit gap	6 cm
Height of lower shelf from the base of drying chamber	60 cm
Height of upper shelf from the base of drying chamber	120 cm

Table 1 Dimensions of the solar tent dryer equipped with a solar chimney

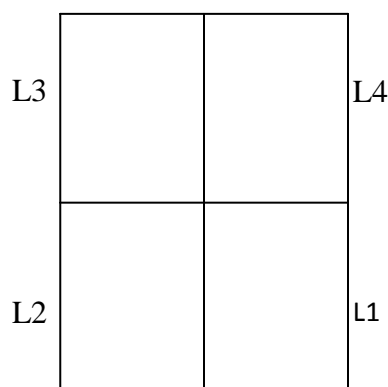


Figure 5 Pictorial view of a solar tent dryer equipped with a solar chimney

Three clocks (SAKURA QUARTZ CLOCK), each with a hygrometer and a thermometer as integral unit, were positioned in the drying chamber to measure the relative humidity and temperature at various time intervals during the day. The measuring positions were 25 cm above the base of the dryer, 15 cm above the lower shelf (i.e. 75 cm above the base) and 15 cm above the upper shelf (or 135 cm above the base). A fourth SAKURA unit was used outside to measure the environment and inlet relative humidity and temperature. The inlet data were taken in the middle (i.e. at 15 cm above the base at inlet). A hand-held liquid-in-glass thermometer was used to measure the chimney air temperature (185 cm above the base). The liquid-in-glass thermometer was also used to check the thermometer readings on the SAKURA clocks for consistency. As can be found in figure 4, there were two shelves for the drying crops; the lower and upper shelves. The crops were spread on trays to be arranged on the shelves as shown in figure 6.



a) Trays arrangement on the upper shelf



b) Trays arrangement on the lower shelf

Figure 6 Arrangements of trays for the crops on the shelves in the dryer

Determining the moisture contents

A sample of the crop was sent to a nearby Chemical Engineering Laboratory of Kumasi Polytechnic to determine the initial moisture content on wet basis ($MC_{w.b.}$). An oven (wagtech; model GP-100-SLAD-250-HYD) and a precision weighing scale (METTLER TOLEDO AL 204 wagtech; Max 210, e = 0.001, Min 0.01, d = 0.0001g) were used for determining the $MC_{w.b.}$ according to the formula

$$Initial\ MC_{w.b.} = \frac{Initial\ mass\ of\ sample - Final\ mass\ of\ sample}{Initial\ mass\ of\ sample} \times 100\% \quad (1)$$

The dry solid mass of crop m_s on each tray was then determined from the initial $MC_{w.b.}$ as

$$m_s = \frac{100 - Initial\ MC_{w.b.}}{100} \times Initial\ m_t \quad (2)$$

where m_t is the total mass of crop (together with the moisture) on the tray. The moisture content on dry basis $MC_{d.b.}$ on each tray at any instant was obtained from

$$MC_{d.b.} = \frac{m_t - m_s}{m_s} \times 100\% \quad (3)$$

The $MC_{d.b.}$ is normally used for engineering calculations, as the denominator m_s remains constant throughout the drying process. The conversion back to $MC_{w.b.}$ was done through the equation

$$MC_{w.b.} = \frac{100MC_{d.b.}}{100 + MC_{d.b.}} \quad (4)$$

A mechanical kitchen weighing scale with a capacity of 5 kg, whose accuracy was verified to two decimal places with the laboratory precision weighing scale, was used for determining the mass of crop in the field.

The Trials

A no-load trial (with no crop in the dryer) was first performed on the 9th of January 2012 for the whole day when measurements were taken from within and around the dryer, to examine the temperature and relative humidity profile. This was followed by an under-load trial with the lower shelf loaded with trays of cassava (Under-load Trial 1) from 10th to 14th January 2012. A second under-load trial was performed with the dryer fully loaded, using both the lower and upper shelves (Under-load Trial 2) from 18th to 22nd January, 2012. Each under-load trial included the drying of some crops outside the dryer on a tray at the same level as the lower shelf, as control drying in the open sun, and the results were compared with the performance of the dryer under the same environmental conditions (figure 7). The inlet of the dryer, as well as the top of the control, was covered in the night and at any time there was rain.

Readings of relative humidity and temperature were taken at two-hourly intervals. The first drying day of each process began at noon due to the preparation of the crops whilst subsequent days of the process started at 08 hrs. All processes ended at 18 hrs. local time. The crops were weighed at the beginning and end of each drying day. Each drying process continued daily until the crops got to the desired moisture content (MC) for safe storage which is 22% db (or 18% wb) or lower.



Figure 7 Control Drying in the open sun

Results

As the experiments took place in January, the sun was always southwards from the dryer in a place like Ghana which is in the Northern Hemisphere. Thus the rays came from south-east in the morning, and in the afternoon the rays were coming from south-west. The environment and inlet temperatures and relative humidity varied from morning till evening on each day of the experiments. There was a heavy storm in the evening after the third day of the under-load trial 2. The control tray was taken away to safety. However the control crops were found to be infested with ants the following morning. The dryer with its contents however withstood the storm with the inlet covered.

Figure 8 (a and b) shows the variation of temperature and relative humidity with height inside the dryer during the no-load trial. On the abscissa axis, the heights have been normalised over the total height of the dryer to Height Ratios between zero and one. The graphs generally show increase in temperature with height especially for the local times 10, 12 and 14 hrs. However, the margin of increase in temperature was reduced for the local times 16 and 18 hrs. At local time 08 hrs the temperatures inside the dryer at height ratios 0.125, 0.375, 0.675 and 0.925 (corresponding to heights 25, 75, 135 and 185 cm respectively above the base) were lower than that of inlet (represented by the height ratio 0.075 or height 15 cm above the base), and there was no increase in temperature with height for this local time. The relative humidity at various heights, measured only up to the top of drying chamber at height ratio 0.675 (135 cm above the base) showed an opposite trend to that of the temperature variations. The relative humidity decreased as the air rose up the dryer, with the exception of the trial at local time 08 hrs.

For the first day of under-load trial 1 (figure 9a) the local times 12 and 14 hrs followed similar trends as their corresponding no-load trials but with only slight temperature rise from the height ratios 0.125 and 0.375 (i.e. below and above the lower drying shelf). For the local times 16 and 18 hrs, the temperature fell slightly towards the top. The relative humidity variations from height ratio 0.125 to 0.375 in figure 9b did not exhibit the trend of the corresponding no-load variations in figure 8b. For instance during the local time 12 hrs, the relative humidity (RH) rose from 30% to 48% after the air passed through the crop shelf (figure 9b). The RH at local time 18 hrs rose from the bottom to the top of the drying chamber.

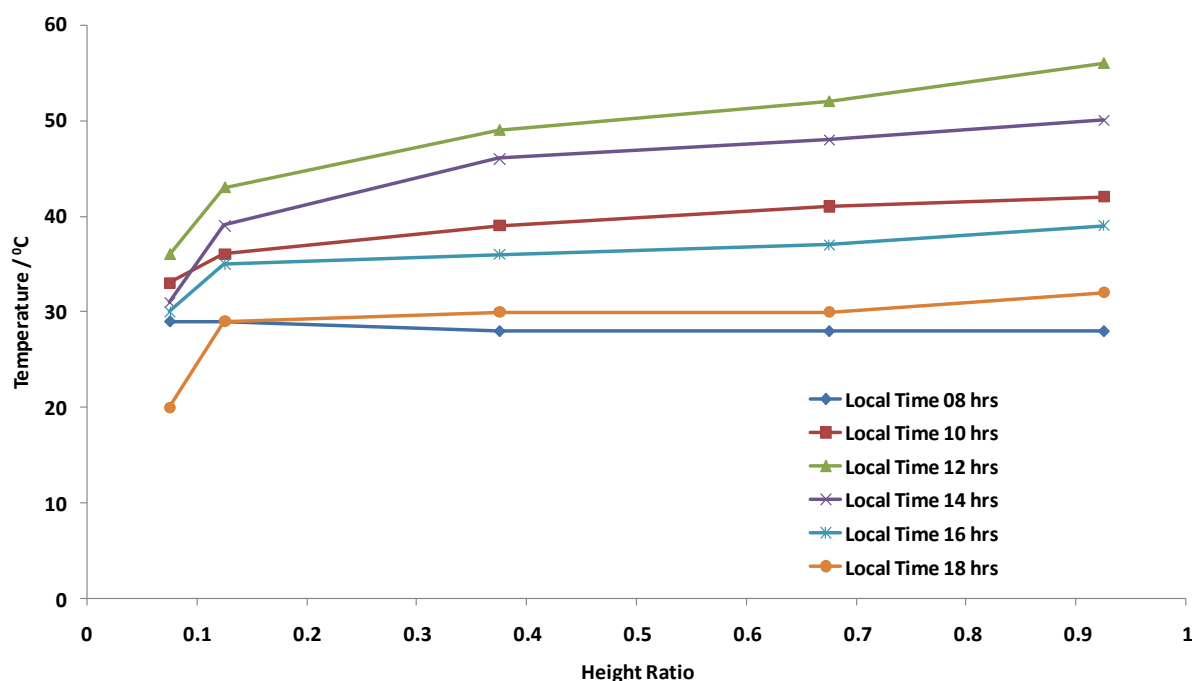
On day 2 of trial 1 (figure 10a), the temperature dropped in the local times 10, 12 and 14 hrs from the height ratio 0.125 to 0.375 before rising again in the top of drying chamber (at height ratio 0.675) and in the chimney (at

height ratio 0.925). In the local times 08 and 18 hrs the temperatures generally fell as the air rose up the drying chamber and chimney. The RH values generally rose as the air passed from the height ratio 0.125 through the crops to height ratio 0.375, and then fell as the air moved up to the top of drying chamber (height ratio 0.675 in figure 10b).

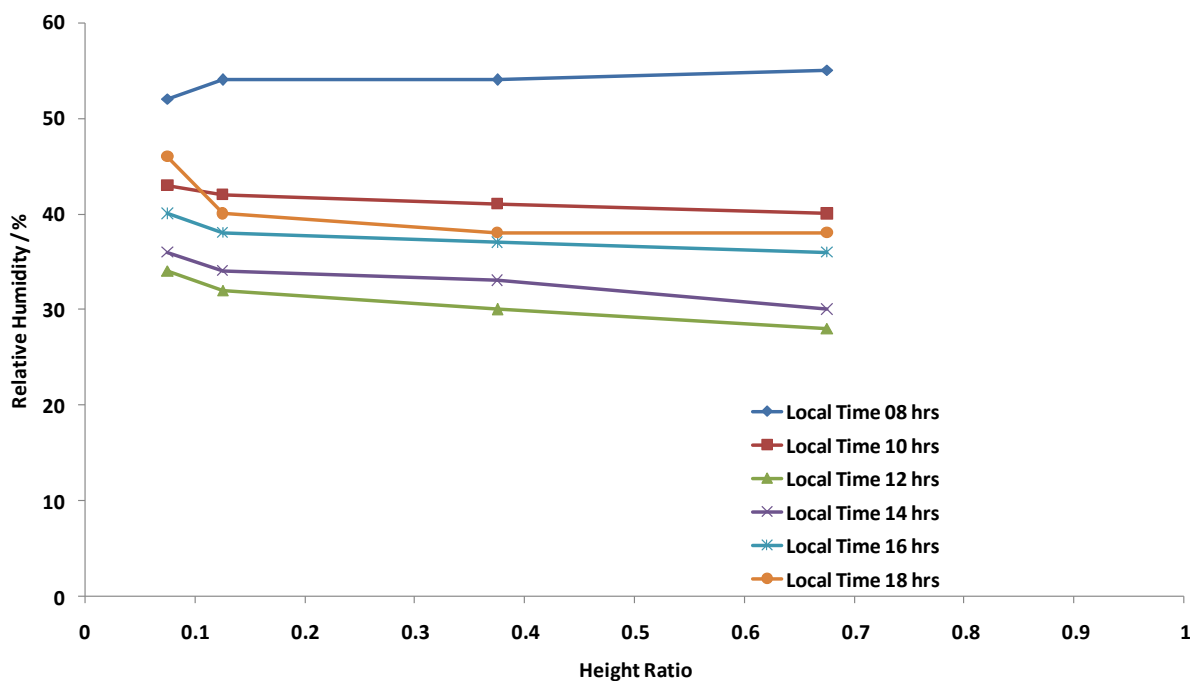
Table 2 shows the temperature and RH values of the third and fourth days of trial 1. On the third day, the temperature rose with increase in height especially from the local times 10 hrs onwards, thus tending to follow the trend of the no-load temperature profile in figure 8a. The RH however rose as the air moved from the height ratio of 0.125 through the crops to 0.375, after which the RH fell as the air moved towards the top of drying chamber at height ratio 0.675. The temperatures variations for the fourth day followed similar trends to that of the no-load more closely, with respect to increase in temperature with height. The RH graphs look flat for the local times 12 and 14 hrs, but the values rose with height for the times 08, 16 and 18 hrs.

The temperature and RH data for under-load trial 2 can be found in figures 11 and 12 for the first two days and table 3 for the third and fourth days. Unlike the processes in under-load trial 1, there was no significant rise in temperature when the air moved up from height ratio 0.375 to 0.675 at the top of drying chamber. Furthermore, there was no general downward trend in RH for these heights as was observed in trial 1 or in the no-load trial, especially for the local times 10, 12 and 14 hrs.

In all the trials the temperatures inside the dryer were generally higher than the environment or inlet temperature (represented by height ratio 0.075) apart from few instances of local times 08 and 18 hrs.

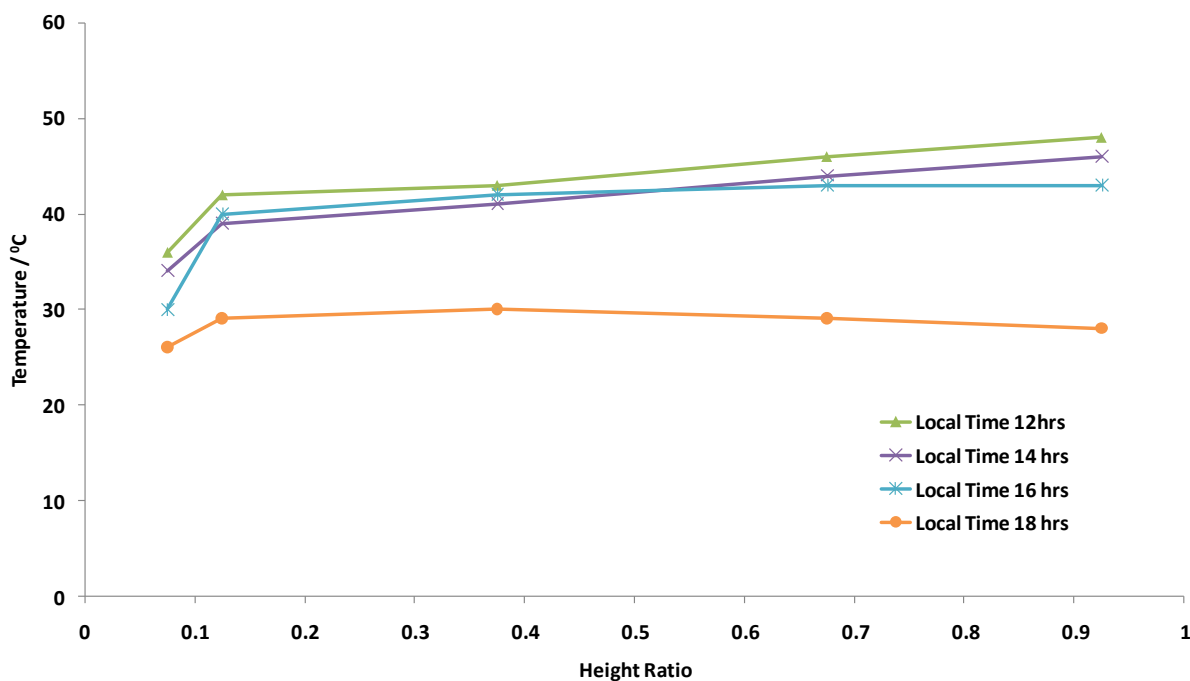


a) Temperature vs height ratio

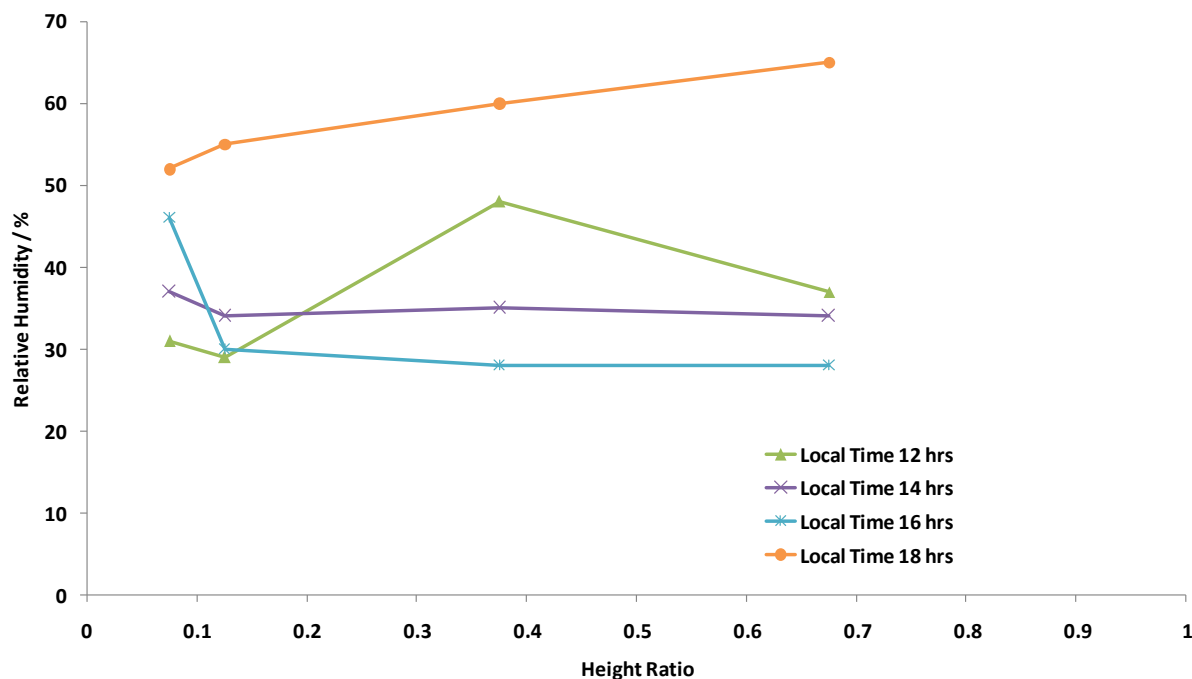


b) Relative humidity vs height ratio

Figure 8 Variation of temperature and relative humidity with height inside the dryer for the no-load trial

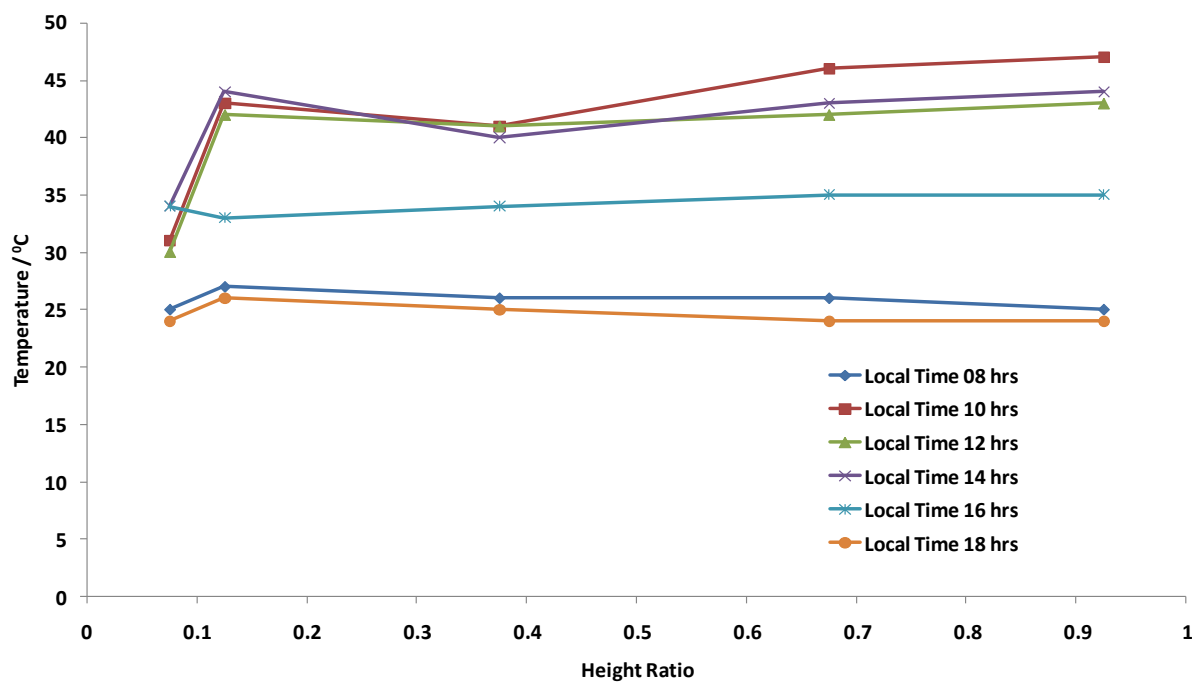


a) Temperature vs height ratio

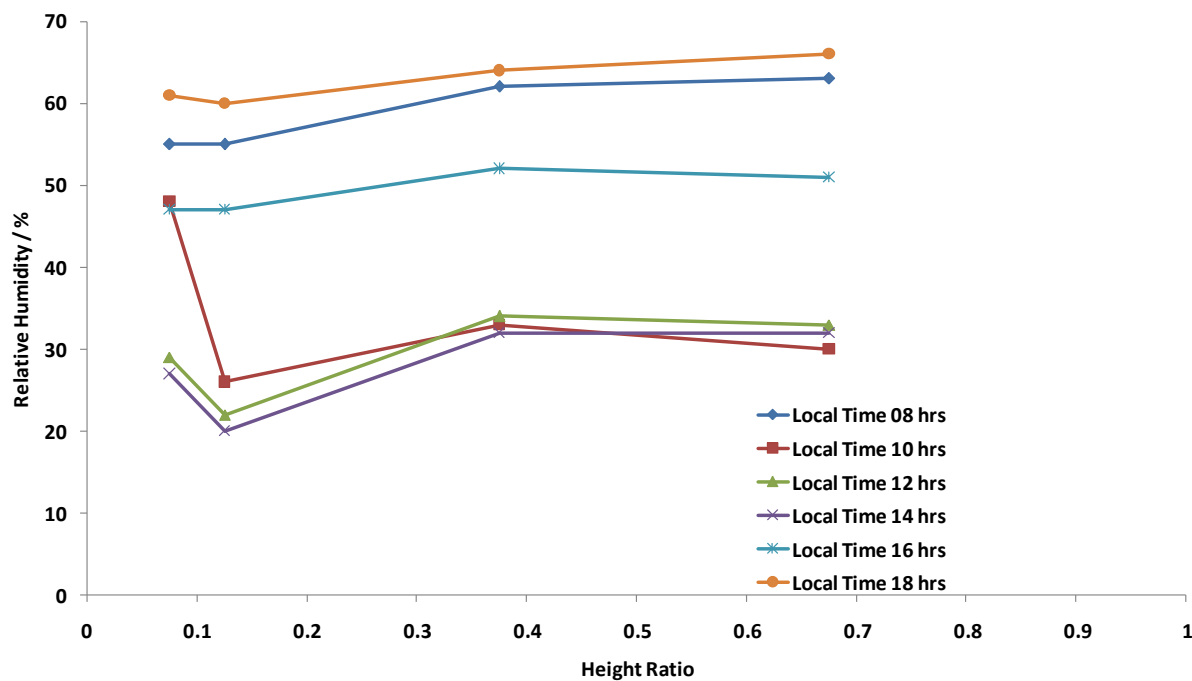


b) Relative humidity vs height ratio

Figure 9 Variation of temperature and relative humidity with height inside the dryer for the under-load trial 1; Day 1

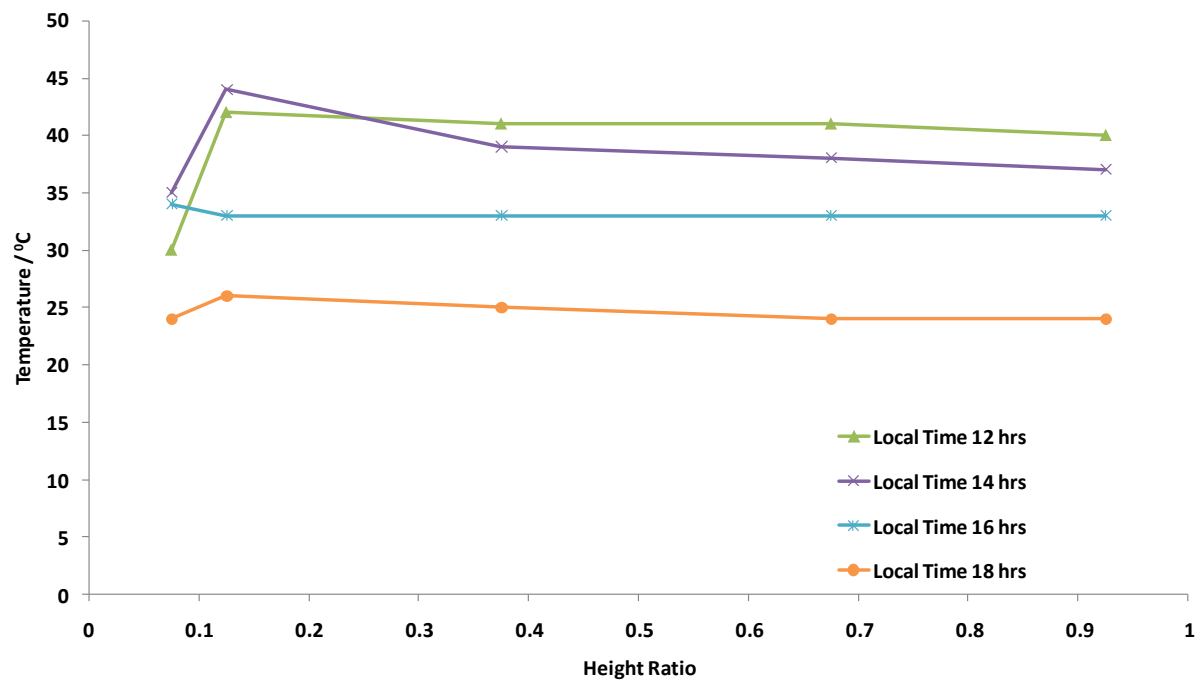


a) Temperature vs height ratio

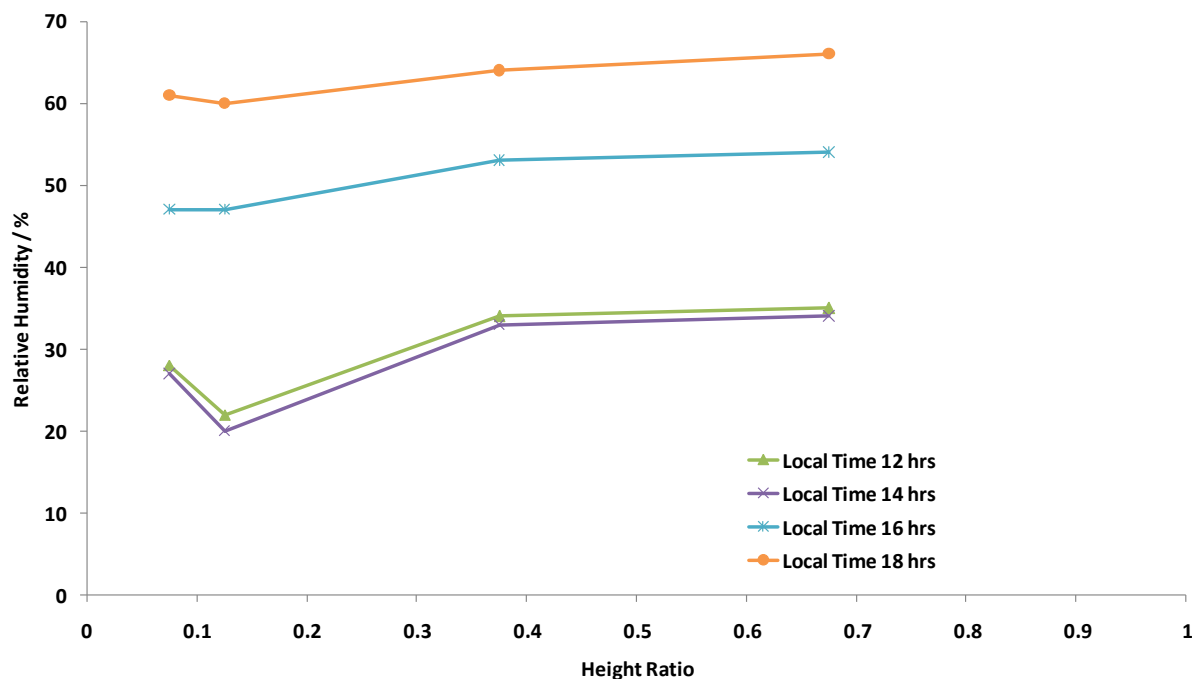


b) Relative humidity vs height ratio

Figure 10 Variation of temperature and relative humidity with height inside the dryer for the under-load trial 1; Day 2

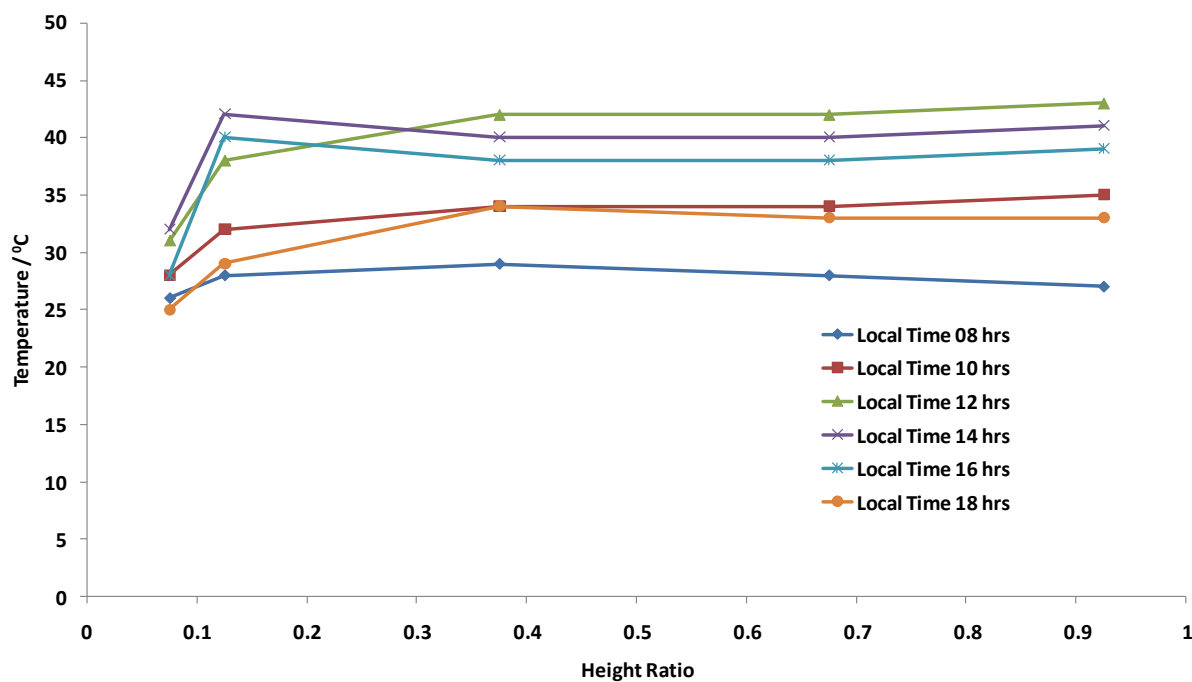


a) Temperature vs height ratio

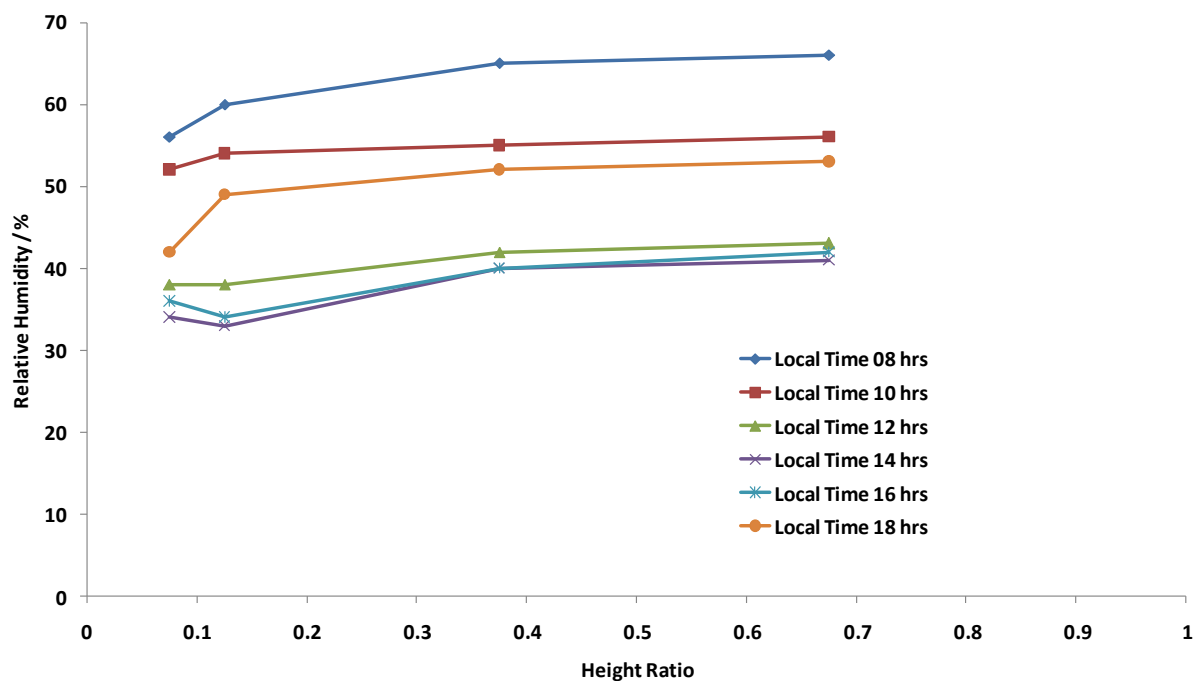


b) Relative humidity vs height ratio

Figure 11 Variation of temperature and relative humidity with height inside the dryer for the under-load trial 2; Day 1



a) Temperature vs height ratio



b) Relative humidity vs height ratio

Figure 12 Variation of temperature and relative humidity with height inside the dryer for the under-load trial 2; Day 2

Total Height / cm		200								
		Temperature Measurement					Relative Humidity Measurement			
Height /cm		15	25	75	135	185	15	25	75	135
Normalised Height		0.075	0.125	0.375	0.675	0.925	0.075	0.125	0.375	0.675
Drying Day	Local Time	Temperature / °C					Relative Humidity (%)			
		T _{env}	T _{bot}	T _{mid}	T _{top}	T _{chim}	RH _{env}	RH _{bot}	RH _{mid}	RH _{top}
Day 3	08 hrs	26	28	29	32	30	56	60	64	62
	10 hrs	28	32	35	37	38	52	54	55	47
	12 hrs	30	38	43	47	50	38	38	42	38
	14 hrs	32	42	47	49	53	34	33	37	34
	16 hrs	28	40	41	46	50	36	34	39	34
	18 hrs	25	29	34	35	37	42	49	52	45
Day 4	08 hrs	20	22	23	21	21	64	63	68	86
	10 hrs	26	35	42	43	44	50	41	38	38
	12 hrs	33	41	48	49	53	35	32	32	32
	14 hrs	35	43	51	53	57	33	28	29	29
	16 hrs	31	40	44	44	46	35	28	33	36
	18 hrs	28	33	34	33	34	42	46	54	61

Table 2 Variation of temperature and relative humidity with height inside the dryer for the under-load trial 1; Day 3 and Day 4

Total Height / cm		200								
		Temperature Measurement					Relative Humidity Measurement			
Height /cm		15	25	75	135	185	15	25	75	135
Normalised Height		0.075	0.125	0.375	0.675	0.925	0.075	0.125	0.375	0.675
Drying Day	Local Time	Temperature / °C					Relative Humidity (%)			
		T _{env}	T _{bot}	T _{mid}	T _{top}	T _{chim}	RH _{env}	RH _{bot}	RH _{mid}	RH _{top}
Day 3	08 hrs	21	22	23	21	21	64	63	68	86
	10 hrs	26	34	40	39	40	50	41	40	42
	12 hrs	33	41	47	47	49	35	32	32	33
	14 hrs	35	43	50	50	52	33	28	27	30
	16 hrs	31	40	43	43	45	35	28	33	33
	18 hrs	28	33	34	33	34	42	46	54	63
Day 4	08 hrs	26	27	26	27	27	55	55	62	62
	10 hrs	31	43	41	42	44	48	26	33	33
	12 hrs	36	42	43	44	47	31	29	38	38
	14 hrs	34	39	44	45	47	37	34	35	34
	16 hrs	31	40	42	43	44	46	30	29	28
	18 hrs	26	29	29	29	30	52	55	60	62

Table 3 Variation of temperature and relative humidity with height inside the dryer for the under-load trial 2; Day 3 and Day 4

Table 4 shows the $MC_{d.b.}$ of the crops on various days of the under-load trial 1. Initially, the crops on the control tray dried faster, as its MC dropped faster than the average MC in the dryer. The cassava in the dryer became brownish at these initial stages. However, the average MC in the dryer fell below that of the control by the end of

the second day with MC of 44.91% when that of the control was 46.24%. The control cassava had then become more brownish than the cassava inside the dryer. After overtaking that of the control, drying inside the dryer continued to be quicker so that, by the end of day 3, the average $MC_{d.b.}$ of crops inside the dryer had fallen to 19.38% which was within the desired $MC_{d.b.}$ of 22% d.b. for storage. The MC of the control was then at 32.35%, and the open-sun drying had to continue for two more days for the MC to fall below the desired storage value. Inside the dryer, the drying of tray L2 was fastest, followed by that of L1, whilst drying of L3 was the slowest. Most of the drying occurred within the first two days with the MC dropping from around 178% to about 45%, d.b.

The $MC_{d.b.}$ of the crops on various days of under-load trial 2 can be found in table 5. Again the control performed better initially but the MC in the dryer dropped below that of the control by the end of day 3 at 27.61% whilst that of control was 39.66%. By the end of the fourth day, the average MC in the dryer was already below the desired level with 17.17% d.b., with that of the control at 28.16. The control drying proceeded till the end of day 5 for the MC to fall to 20.77%. The crops on the upper shelf dried faster than those on the lower shelf. On the individual trays, crops on H2 dried fastest, and again, those on L3 were slowest in drying. Like that of trial 1, most of the drying occurred within the first two days during which the moisture contents dropped from 179 % to 69% and 55% in the dryer and control respectively.

Drying Day	Local Time	Dry wt / kg → Tray →	Initial Moisture Content (% , w.b.)				64.00				Average	Control
			1.40	1.39	1.39	1.39						
			L1	L2	L3	L4	H1	H2	H3	H4		
Day 1	12 hrs	Mass (kg)	3.90	3.85	3.85	3.85					15.45	3.40
		MC (% , d.b)	177.78	177.78	177.78	177.78					177.78	177.78
	18 hrs	Mass (kg)	3.22	3.17	3.20	3.19					12.78	2.55
		MC (% , d.b)	129.34	128.72	130.88	130.16					129.77	108.33
Day 2	08 hrs	Mass (kg)	3.00	2.95	2.97	2.96					11.88	2.43
		MC (% , d.b)	113.68	112.84	114.29	113.56					113.59	98.53
	18 hrs	Mass (kg)	2.03	2.00	2.02	2.01					8.06	1.79
		MC (% , d.b)	44.59	44.30	45.74	45.02					44.91	46.24
Day 3	08 hrs	Mass (kg)	1.92	1.89	1.91	1.90					7.62	1.75
		MC (% , d.b)	36.75	36.36	37.81	37.09					37.00	42.97
	18 hrs	Mass (kg)	1.67	1.64	1.67	1.66					6.64	1.62
		MC (% , d.b)	18.95	18.33	20.49	19.77					19.38	32.35
Day 4	08 hrs	Mass (kg)	1.63	1.60	1.63	1.62					6.48	1.60
		MC (% , d.b)	16.10	15.44	17.60	16.88					16.50	30.72
	18 hrs	Mass (kg)										1.52
		MC (% , d.b)										24.18
Day 5	08 hrs	Mass (kg)										1.51
		MC (% , d.b)										23.37
	18 hrs	Mass (kg)										1.47
		MC (% , d.b)										20.10

Table 4 Moisture contents at the beginning and end of various drying days with only the trays on the lower shelf loaded: Under-Load Trial 1

Drying Day	Local Time	Dry wt / kg → Tray →	Initial Moisture Content (% w.b.)				64.20				Average	Control
			1.40	1.38	1.38	1.38	0.67	0.67	0.67	0.66	8.21	1.22
			L1	L2	L3	L4	H1	H2	H3	H4		
Day 1	12 hrs	Mass (kg)	3.90	3.85	3.85	3.85	1.88	1.88	1.88	1.85	22.94	3.40
		MC (% d.b)	179.33	179.33	179.33	179.33	179.33	179.33	179.33	179.33	179.33	179.33
	18 hrs	Mass (kg)	3.24	3.18	3.35	3.26	1.56	1.55	1.56	1.53	19.23	2.66
		MC (% d.b)	132.06	130.72	143.05	136.52	131.78	130.30	131.78	131.01	134.15	118.53
Day 2	08 hrs	Mass (kg)	3.10	3.06	3.10	3.11	1.50	1.49	1.50	1.47	18.33	2.57
		MC (% d.b)	122.03	122.01	124.91	125.64	122.87	121.38	122.87	121.95	123.20	111.14
	18 hrs	Mass (kg)	2.34	2.30	2.60	2.32	1.10	1.08	1.09	1.05	13.88	1.89
		MC (% d.b)	67.60	66.87	88.64	68.32	63.44	60.47	61.95	58.54	69.01	55.27
Day 3	08 hrs	Mass (kg)	2.20	2.16	2.24	2.18	1.05	1.04	1.04	1.02	12.93	1.86
		MC (% d.b)	57.57	56.71	62.52	58.17	56.01	54.52	54.52	54.01	57.44	52.81
	18 hrs	Mass (kg)	1.79	1.75	1.82	1.77	0.85	0.84	0.84	0.82	10.48	1.70
		MC (% d.b)	28.21	26.97	32.05	28.42	26.29	24.81	24.81	23.81	27.61	39.66
Day 4	08 hrs	Mass (kg)	1.75	1.72	1.78	1.75	0.84	0.83	0.83	0.81	10.31	1.68
		MC (% d.b)	25.34	24.79	29.14	26.97	24.81	23.32	23.32	22.30	25.54	38.02
	18 hrs	Mass (kg)	1.63	1.60	1.67	1.63	0.78	0.77	0.78	0.76	9.62	1.56
		MC (% d.b)	16.75	16.09	21.16	18.26	15.89	14.41	15.89	14.75	17.14	28.16
Day 5	08 hrs	Mass (kg)										1.55
		MC (% d.b)										27.34
	18 hrs	Mass (kg)										1.47
		MC (% d.b)										20.77

Table 5 Moisture contents at the beginning and end of various drying days with the dryer fully loaded: Under-Load Trial 2

Discussions

The increase in temperature with height observed in the no-load trial in figure 8a during the local times 10, 12 and 14 hrs was caused by air heating inside the dryer. The air heating induces a buoyancy flow of air up the dryer (Incropera et al., 2007). The warm, less dense air is displaced upwards by cold, denser air from outside so that the lower part of the chimney remains colder than the upper part. The radiant energy from the sun was intense in those local times. The energy intensity from the sun reduced around the local times 16 to 18 hrs, and so the margin of increase in temperature reduced. In the morning around 08 hrs the intensity of radiant energy was very low and the whole system functioned like a normal chimney in which the temperature fell as the air rose up the chimney without enough heating, as noted by Ekechukwu and Norton (1997) and observed by Afriyie et al. (2009). The absolute humidity of air inside the dryer remained constant during the no-load trial, so that the RH generally fell as the air temperature rose, as was observed in figure 8b. For the local time 08 hrs, the RH showed an upward trend in response to the downward temperature trend.

In the under-load trial 1, part of the energy was used to dry the crop on the lower shelf. So, in the first two days during which most of the drying occurred (table 4) the air temperatures fell or did not rise any significantly as the air moved from height ratio 0.125 to 0.375 (figures 9a and 10a). On day 1, the RH did not fall so much as in the corresponding local times of the no-load trial, and there were significant increase in RH above the lower shelf. These are attributable to the high moisture absorption from the crops into the air, and the temperature was not high enough to lower the RH right above the crops (figures 9b and 10b). There was however some slight drop in RH as the air moved toward the top of drying chamber with the temperature increasing without any further addition of moisture in this region. On the third and fourth days, moisture movement into the air had reduced so that the temperature variations in table 2 approached those of the no-load trial (figure 8a). However, as shown in table 2, the

RH values on those days did not follow similar variations to those of the no-load as some moisture was still being absorbed into the air.

With the higher shelf positioned between heights 75 cm and 135 cm (or height ratios 0.375 and 0.675 respectively) during the under-load trial 2, some energy needed for heating the air was used for crop drying. This prevented the temperature from rising and the RH from falling as the air flowed from height ratio 0.375 to 0.675.

The control tray (in the open sun) always dried faster than the dryer on the first and second days of drying. Similar results were observed by Jain and Tiwari (2004) and Afriyie et al. (2011b). In the initial stages of the drying process when the *MC* is high, the binding energy (or the energy of moisture removal) of a starchy crop like cassava is generally lower than the heat of vaporisation of water (Mujundar, 1997; Okos et al., 1992). Normal local winds can therefore do a good job in removing the unbound and free moisture from the crop in these periods (Ekechukwu, 1999a). At later stages, the moisture becomes more strongly bound to the crop so that more heating, rather than airflow, is required to remove the bound moisture. With more heating inside the dryer than outside, the dryer then performs better and overtakes the performance of the control at later stages of the drying process. The greatest moisture drop that occurred in the two under-load trials within the first two days for both the control and inside the dryer is also attributable to the ease of the removal of the unbound and free moisture at high *MC*. The performance of the dryer could possibly be much better if the drying process started earlier than noon on the first day.

The discoloration of the crop inside the dryer at the initial stages is attributable to effect of the water activity which is normally prominent at high *MC* and high temperature (Mujundar, 1997). The combination of high temperature and high moisture content increased the water activity which caused fast deterioration of the crop inside the dryer. At later stages, there was still some considerable amount of moisture in the control (open-sun) crop which continued to cause discoloration so that the control crop became more brownish than that inside the dryer. This browning phenomenon was also observed by Afriyie et al. (2011b).

Conclusion

A solar dryer tent equipped with a solar chimney was used to dry cassava and the drying performance was compared with that of open-sun drying. The tent dryer, which hitherto used only half the triangular cross-section, was extended to use the whole triangle to make it more stable on the field. The normal upward temperature gradient with height was distorted as the drying process competed with the heating process for the solar energy supplied. There was also increase in absolute humidity of air during the drying process and so the fall in relative humidity reduced as the air rose up the dryer. Early in the morning, with low energy intensity, the system functioned like a normal chimney where the temperature fell as the air rose up the chimney. As cassava drying requires more airflow than air heating at the initial stages, the open-sun drying did better than the dryer at the initial stages. However the performance of the dryer overtook that of the open-sun drying at later stages to finish the process earlier, even at full load. With only the lower shelf loaded, the dryer finished two days earlier, whilst the fully loaded dryer finished a day earlier, than the open-sun drying. Thus the structurally stable full tent dryer equipped with a solar chimney dried the cassava faster in the end than open-sun drying, in addition to the fact that it is more hygienic.

References

- Afriyie, J.K., Nazha, M.A.A., Rajakaruna, H., Forson, F.K., 2009. Experimental Investigations of A Chimney-Dependent Solar Crop Dryer. *Renewable Energy* 34 (1), 217–222.
- Afriyie, J. K., Bart-Plange, A., 2010. Performance Of A Direct-Mode Solar Crop Dryer With A Solar Chimney. Sunyani Polytechnic Lecture Series VI, Sunyani, Ghana, 14th – 17th November.
- Afriyie, J.K., Nazha, M.A.A., Rajakaruna, H., Forson, F.K., 2011a. Simulation And Optimisation Of The Ventilation In A Chimney-Dependent Solar Crop Dryer. *Solar Energy* 85, 1560-1573.

- Afriyie, J.K., Dadzie, J.E, Forson, F.K., 2011b. Field Investigations On A Chimney-Dependent Solar Crop Dryer, Conference Of Entrepreneurship Educators, Researchers And Entrepreneurs In Africa (CEEREA), 28th To 30th November, Kumasi Polytechnic, Kumasi – Ghana
- Chantawong, P., Hirunlabh, J., Zeghamati, B., Khedari, J., Teekasap, S., Win, M.M. Investigation On Thermal Performance Of Glazed Solar Chimney Walls, *Solar Energy* 80 (2006) 288–297.
- Chen, Z.D., Bandopadhyay, P., Halldorsson, J., Byrjalsen, C., Heiselberg, P., Li, Y., 2003. An Experimental Investigation Of A Solar Chimney Model With Uniform Wall Heat Flux. *Building And Environment*, Vol. 38 Pp 893-906.
- Ekechukwu O.V., 1999a. Review Of Solar-Energy Drying Systems I: An Overview Of Drying Principles And Theory. *Energy Conversion And Management*, 40: 593-613.
- Ekechukwu, O.V., 1999b. Review Of Solar-Energy Drying Systems II: An Overview Of Solar Drying Technology. *Energy Conversion And Management* 40, 616–655.
- Ekechukwu, O.V., Norton, B., 1997. Design And Measured Performance Of A Solar Chimney For Natural Circulation Solar Energy Dryers. *Renewable Energy* 10 (4), 81–90.
- Ferreira, A.G., Maia, C.B., Cortez, M.F.B., Valle, R.M., 2008. Technical Feasibility Assessment Of A Solar Chimney For Food Drying. *Solar Energy* 82, 198–205.
- Incropera, F.P., De Witt, D.P., Bergman, T.L., Lavine, A.S. (2007). *Introduction To Heat Transfer*, Fifth Ed., John Wiley & Sons, Inc., Hoboken, New Jersey.
- Jain, D., Tiwari, G.N., 2004. Effect Of Greenhouse On Crop Drying Under Natural And Forced Convection I: Evaluation Of Convective Mass Transfer Coefficient. *Energy Conversion and Management*, Vol. 45 Pp 765-783.
- Mujumdar, A.S., 1997. Drying Fundamentals. In: BAKER, C. G. J. *Industrial Drying Of Foods*. Blackie Academy and Professional. ISBN 0-7514-0384-9. Pp. 7-30.
- Ong, K.S., 2003. A Mathematical Model of a Solar Chimney. *Renewable Energy* 28, 1047-1060
- Ong, K.S., Chow, C.C., 2003. Performance of A Solar Chimney. *Solar Energy*, Vol. 74 Pp 1-17.
- Okos MR, Narsimhan G, Singh RK, Weitnauer AC, 1992. Food Dehydration. In: Heldman DR, Lund DB, Editors. *Handbook Of Food Engineering*, New York, Basel, Hong Kong: Marcel Dekker, Inc, P. 437-562
- Owusu-Baah K, Workshop On ECOWAS Policy (Accessed From The Ghana Homepage: [Http://www.ghaweb.com](http://www.ghaweb.com) On 30/11/2004)
- Rogers, G.F.C., Mayhew, Y.R., 1992. *Engineering Thermodynamics, Work And Heat Transfer*. 4th Edition ISBN 0-582-04566-5
- Singh, S., Singh, P.P., Dhaliwal, S.S., 2004. Multi-Shelf Portable Dryer. *Renewable Energy*, Vol. 29. Pp 753-765.

THE USE OF ICT BY SELECTED SMALL AND MEDIUM-SIZED HOTELS IN AGONA SWEDRU

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While the Internet is having a profound effect on the hospitality and tourism industry, there is less evidence of its benefits to hotels. This study examines managers' perceptions on the use of ICTs in the hotel operations. The areas explored were: the context of information and communication technology, types of ICT used in the hotel; factors responsible for ICT adoption; and, business application of ICT. A structured questionnaire was used to gather the data and a sample size of 14 hotels was used. The study revealed that hotels in Agona Swedru do not extensively use facilities such as the GDS, PMS, Video Conferencing and other facilities and tools. Furthermore, the study showed that facilities commonly used in the hotels of Agona Swedru are the Television, Telephone, Radio, and some other facilities. In addition, Customer demand, Nature of management systems and other factors are the factors that influence the hotels propensity in adopting ICT in the hotel's operations. This study is one of the first to examine the challenges of ICT use in Agona Swedru hotels, and in particular, how this affects its extensive use. It then offers suggestions to the hotels on how they can utilize ICT more effectively.

Keywords: Information; Communications Technology; Property; Management Systems; Intellectual Capacity; Hotels.

Introduction

Information and Communications and Technology (ICT) and tourism are two of the most dynamic motivators of the emerging global economy (Buhalis, 2003). Both tourism and ICT increasingly provide strategic opportunities and powerful tools for economic growth, the redistribution of wealth and the development of equity around the world (Buhalis, 2003). Also Buhalis (2003) noted that the rapid development of the internet has intensified, thanks to the information marketplace, e-commerce and online marketing; the internet is becoming more sophisticated across all of these areas. ICT is also a sector that has the capacity to impact negatively upon host environments and cultures, the raw materials of the many tourism products. As a result, increased prominence has been given to tourism and ICT in the United Nations World Summit such as the 1992 Rio Earth Summit and the World Summit on Sustainable Development in Johannesburg in 2003 (Cooper, Fyall, Gilbert and Wanhill, 2008).

In many respects, technology has permitted the creation of highly labour-efficient and quality budget or economy units by centralizing all non-customer contact functions (reservation, marketing, and finance) and allowing the property to concentrate on the delivery of a limited but consistent product (Cooper et al., 2008). Furthermore, hotels have resorted to the use of ICTs in order to improve their operations, manage their inventory and maximize their profitability (Cooper et al., 2005, 2008). Property Management Systems (PMSs) coordinate front office sales, planning and operational functions by administering reservations and managing hotel inventory. Also, hotels utilize ICT and the internet extensively for their distribution and marketing functions. Understandably, hotel chains gain more benefits from PMSs as they can introduce a unified system for planning, budgeting, controlling and coordinating their properties centrally (Cooper et al., 2005, 2008). Murphy et al. (2006) also used diffusion of innovations and configurational theories to investigate how website features and e-mail responses reflect evolving internet adoption. They said internet adoption evolves from static to dynamic use as organizations add website features and provide quality responses to customers' e-mails. Chan and Law (2006) also suggested that hotel websites are a basic requirement to an increasing number of communication and business strategies. The usability of a website, effectiveness of its interface as well as the amount of information carried, and ease of the navigation and user-friendliness of its functions are central to the success of these strategies.

Notwithstanding all the benefits that hotels stand to gain from the use of ICT, however, many small and medium-sized independent, seasonal and family hotels find it extremely difficult to utilize ICT due to: the lack of capital for the purchasing hardware and software, lack of standardization and professionalism, insufficient marketing and technological training and understanding, small size of the hotel which makes it difficult to use the central reservation system to deal with each property, and finally, the unwillingness of proprietors to lose control over their property. These properties are increasingly placed at a major disadvantage as they cannot be represented in the electronic marketplace and so jeopardize their future existence. However, they cannot afford to ignore the rapid development of ICT opportunities and therefore should take advantage of the emergent ICT opportunities and its decreasing cost to enhance their competitiveness (Cooper et al., 2008).

From the foregoing, the adoption of ICT in hotel operations has been very necessary for the competitiveness, profitability, and survival of hotels in contemporary times. For example, it has been a very effective way of communicating with potential guests and has helped functions of hotels to be quickly carried out (Bhatia, 2002). A research conducted by Organization for Economic Co-operation and Development (OECD) in 2004 shows that there are a number of industries including the hotel industry that are using ICT in different ways; some for business to business (b2b) interaction, and others for business to consumer (b2c) interaction. Survey by the National Computer Board (2002) in Mauritius confirmed that hotels purposely use ICT for making reservations, communication, research and accounting.

However, studies on the adoption of ICT use in hotel operations have not received as much empirical attention in the context of hotels in Ghana, even though one major study was cited by the researchers, which was conducted by Ayeh (2005). Also, the researchers have not seen any studies conducted on the use of ICT by hotels specifically in Agona Swedru, which is a very important commercial centre in the Central Region. And thus, the aim of this study was to assess the use of ICT by hotels in Agona Swedru. The specific objectives were to determine the extent of the use of ICT in the hotels of Agona Swedru, ascertain the perceived benefits of the use of ICT, find out the factors responsible for adopting ICT use in the operations of the hotels, and, assess the challenges of the use of ICT in the hotels.

Methodology

An exploratory study design was adopted for the study in order to establish the state of ICT use among hotels in Agona Swedru because relatively little is known about their use among hotels in the municipality. Leedy and Ormrod (2005) have asserted that, when little information exists on a topic, when variables are unknown, among other issues, a qualitative study, of which exploratory studies are a part, can help to define what is important. DePoy and Gitlin (1998) and Kumar (1999) also asserted that exploratory studies are carried out when little to nothing is known about a topic. The study area, sources of data, sampling and sample size, instrument used in collecting the data, problems encountered in data collection and data analysis are discussed.

Study Area

Agona Swedru is a town found in the Agona West Municipality. It has a land area of 540 sq. km. The population size according to *The 2010 Population and Housing Census* was 166,000 people as of 2010 (Ghana Statistical Service (GSS), 2011). The town lies between latitude 5.30 and 5.50 north and longitude 03.5 and 05.5 west. It is bounded to the east and west by the Efutu Municipality and Asikuma-Odoben-Brakwa respectively. Agona Swedru is about 40 km off the main Accra-Takoradi highway, just on the left turn of the Winneba round about.

The location of the township makes it a commercial centre or a nodal point from which roads radiate to the cocoa growing countryside of the Central Region. Agona Swedru is known for its busiest market centre for petty trading

called Mandela Market. Aside the market, it is also known by the primary and secondary occupations of the area such as banking, hospitality operations and other businesses (www.ghanadistrict.com).

Sources of Data

Primary and secondary sources were used for this study but predominantly, data were collected from primary sources which comprised the management of the hotels in Agona Swedru. The secondary sources of data were from books, journals, government publications, and the internet. The managers/owners of hotels in Agona Swedru were selected as the target population or the primary sources of data because they are in charge of the daily operations and management of their hotels and thus, are in the best position to give valid and reliable responses/answers on the use of ICT tools and facilities within their hotels.

Sampling and Sample Size

According to the Ghana Tourist Board (2009a, b), there are 14 registered hotels in Agona Swedru. Table 2 shows the categorisation of these registered hotels with their respective grades and percentages. Because the target population was not large enough, the researchers administered questionnaire to all of them.

Table 2. Categorisation of Registered Hotels in Agona Swedru

Grade	Frequency	Percent
1 star	2	14.3
2 star	2	14.3
3 star	2	14.3
Budget	4	28.6
Guesthouse	4	28.6
Total	14	100.0

Source: Fieldwork, June 2011

Research Instrument and Data Collection

The research employed questionnaire for collecting data from the managers, who were the target population for this study. There were twelve questions in all, eleven of which were close-ended questions, with the twelfth question being an open-ended question. The questionnaire was divided into five sections, namely: biographical data, organizational characteristics, ICT tools/facilities used in the hotel, factors responsible for ICT adoption in the hotel, and challenges of ICT use in the hotel.

Data collected under biographical data were on gender, age of management respondent, and how long the respondent had worked for the hotel. Under organizational characteristics, data were collected on the grade of the hotel, its size, and types of clientele; whereas under ICT tools/facilities used in the hotel, data were gathered on whether the hotel used radio, television, fax, telephone, emails, voice mail, video conferencing, a wireless browser, a CentralReservation System (CRS), which Cooper et al. (2008) also refers to as Computer Reservation Systems, a Global Distribution System (GDS), a Property Management System (PMS), and on how the hotel stored its information. With respect to the factors responsible for ICT adoption in the hotel, data were collected on whether the hotel was influenced by the grade of hotel, customer demand, geographical location, size of the hotel, level of competition, or some characteristic of management, as well as, the impact of the use of ICT on the hotel's operations. The final section of the challenges of ICT use in the hotel gathered data on whether inadequate training and skills, no strategic plan incorporating the use of electronic distribution in hotel operations, limited financial resources to maintain the ICT facility, the small nature of the hotel, and nature of the management systems were challenges of ICT use in the hotel. In all, fourteen questionnaires were administered by the researchers to the managers of the hotels in Agona Swedru and all were retrieved.

Data Analysis

The data collected from the questionnaires were edited, coded and processed with the Statistical Package for the Social Sciences (SPSS) version 16 software programme. The data were summarised into frequencies and percentages to provide answers to the research objectives. No complex statistical analysis could be carried out on the data collected because of the smallness of the sample size and the qualitative nature of the data collected, which meant that the data did not meet most of the assumptions of carrying out complex statistical tests.

Results

Socio-Demographic Characteristics of Managers

Table 2 provides information on the gender, age and the years worked in the hotel by the managers (Table 2). Nine (64.0%) management respondents were males; and four (28.6%) were between 36-45 years. Nine (64.3%) were 36 years and above, which shows they are relatively matured for their jobs. Though, six (42.9%) managers surveyed had worked for their hotels from 1 to 5 years whereas seven (50%) had worked for their hotels from 6 to 15 years, which clearly demonstrates the experience they have gained on their jobs as hotel managers. Thus, they could be expected to give us valid and reliable answers on ICT use in the hotels.

Table 2: Socio-Demographic Characteristics of Managers

Socio-Demographic Characteristics	Frequency	Percentage
Gender		
Male	9	64.0
Female	5	36.0
Total	14	100.0
Age(years)		
20-25	2	14.3
26-30	1	7.1
31-35	2	14.3
36-40	4	28.6
41-45	2	14.3
46+	3	21.4
Total	14	100.0
Length of Service (years)		
Less than 1	1	7.1
1-5	6	42.9
6-10	5	35.7
11-15	2	14.3
Total	14	100.0

Source: Fieldwork, June 2011

N=14

Organizational Characteristics

The characteristics of the hotels surveyed are shown in Table 3. Four (28.6%) of the hotels each were budget and guest houses respectively, which is not surprising as in Ghana hotels in the two categories dominate (Akyeampong, 2007). Also, thirteen (92.9%) of the hotels had rooms of 29 rooms and below. This confirms what Morrison and Thomas (1999) noted in a study carried out in the UK that, most commonly found hospitality enterprises are small. Similarly, Akyeampong (2007) emphasised that the vast majority of tourism-dependent businesses in Ghana are small in size.

Table 3: Organizational characteristics of the hotels surveyed

Organizational characteristics	Frequency	Percentages
Hotel grade		
1 star	2	14.3
2 star	2	14.3
3 star	2	14.3
Budget	4	28.6
Guest house	4	28.6
Total	14	100.0
Hotel size (No. of rooms)		
Under 10	3	21.4
10-19	5	35.7
21-29	5	35.7
30-39	0	0.0
40-49	0	0.0
50+	1	7.2
Total	14	100.0

Source: Fieldwork, June 2011

N=14

ICT tools/facilities used in the hotels

This section focuses on ICT tools/facilities used in the hotels ranging from the common one to the sophisticated ones (Table 3). The ICT facilities that all (100.0 %) of the hotels were using were television, telephone, and email. The second set of ICT tools used by the hotels were radio (42.9%) and fax (42.9%); followed by CRS (28.6%), and wireless browsers (21.4%). The ICT tools that were not being used by any of the hotels were the more sophisticated facilities and systems such as property management systems, global distribution systems, voice mail, and video conferencing facilities. With respect to how the hotels stored their information, 57.1% of them, constituting 8 hotels, used both computer and manual systems in storing their information, whereas six (42.9%) used only a manual system for storing their information. None of the hotels use a computer storage system alone, shown by the fact that, those that use a computer system of storing information back it up with a manual system.

Table 4. ICT tools/facilities used in the hotels

ICT tool/facility	Frequency	Percentage
Radio	6	42.9
Television	14	100.0
Fax	6	42.9
Telephone	14	100.0
E-mail	14	100.0

Voice mail	0	0.0
Video conferencing	0	0.0
Wireless browser	3	21.4
CentralReservation Systems	4	28.6
Global Distribution systems	0	0.0
Property management systems	0	0.0

Source: Fieldwork, June 2011

N=14

Note: Multiple responses, therefore total percentage will not necessarily add up to 100%

Factors responsible for ICT adoption in the hotels

Table 5 shows the results of their responses using a likert scale, in order to distinguish among the hotels, with respect to their evaluation of the factors responsible for the adoption of ICT in the hotels.

Table 5. Factors responsible for ICT adoption in the hotels

Factors	SA (%)	A (%)	D (%)	SD (%)	Total (%)
Customer demand	14.3	78.6	7.1	0.0	100.0
Geographical location	14.3	42.9	42.9	0.0	100.0
Size of the hotel	28.6	50.0	21.4	0.0	100.0
Level of competition	42.9	35.7	21.4	0.0	100.0
Grade of the hotel	7.1	64.3	14.3	14.3	100.0
Management characteristics (e.g., perceived benefit, age)	35.7	50.0	7.1	7.1	100.0

Source: Fieldwork, June 2011

N=14

Note: SA=Strongly Agree; A= Agree; D = Disagree; and SD =Strongly Disagree.

Majority (92.9%) of the hotel managers, constituting thirteen managers, said customer demand was a factor for their adoption and use of ICT in their hotels, followed by size of hotel (86.6%), management characteristics (85.7%), level of competition (78.6%), grade of the hotel (71.4%), and geographical location (57.2%). The hotel managers were predominantly in agreement with all the factors stated as being responsible for their adoption and use of ICT in their hotels.

With respect to what the impact of the use of ICT on their hotels had been, all managers agreed that ICT usage had increased the ease with which they process their paper work; it had also enhanced significantly fast access of their hotels to relevant information; and also that they could make confirmations and reservations instantly.

Challenges of ICT Use in the Hotels

Majority of the hotel managers said the nature of their management or ownership (92.9%) and inadequate training and skills of hotel staff (92.8%) were the greatest challenges that affected their hotels' extensive use of ICT in their operations. The other challenges they faced were as follows: No strategic plan incorporating the use of electronic distribution systems in their hotel operations (71.4%); the small nature of the hotels (71.4%); and, limited financial resources to maintain the ICT facilities used in their hotels (50.0%). Again, hotel managers were predominantly in agreement with all the challenges stated as affecting their hotels from using ICT extensively in their operations.

Table 6. Challenges of ICT Use in the Hotels

Challenges	SA (%)	A (%)	D (%)	SD (%)	Total (%)
Inadequate training and skills	71.4	21.4	0.0	7.1	100.0
No strategic plan incorporating the use of electronic distribution	57.1	14.3	7.1	21.4	100.0
Limited financial resources to maintain the ICT facilities	35.7	14.3	21.4	28.6	100.0
The small nature of the hotel	57.1	14.3	14.3	14.3	100.0
The nature of the management system	50.0	42.9	7.1	0.0	100.0

Source: Fieldwork, June 2011

N=14

The challenge of inadequate training and skills for hotel staff affecting the use of ICT facilities in the hotels is true because most hotel managers who do not want to pay their employees adequate salaries go for unskilled labour, who are most often not ICT literate; and also some managers themselves lack training and skills in the use of ICT. The study further established that the small nature of the hotels do not encourage the extensive use of ICT tools and facilities in the hotels which finding is supported in the literature on ICT usage in hotels (Buick, 2003). For example, in a study of small hotels surveyed in Scotland, it was found out that there was limited use of Property Management Systems and other sophisticated ICT facilities used in bigger hotels because most managers of small hotels did not see the requirement for them to operate their hotels with these ICT facilities, and also felt that the capital costs associated with the adoption and use of these ICT facilities were too high (Buick, 2003), in terms of cost benefit analysis..

Interestingly too, seven (50.0%) hotel managers did not think that limited financial resource to maintain the ICT facilities was a challenge affecting hotels' adoption and use of ICT facilities. Their reason was that some hotels have the financial means to purchase these ICT facilities; but due to some factors such as small size of the hotel, management characteristics and other factors they do not use ICT extensively

Discussion

Information and communication technology has been found to be very important in our world today (Bhatia, 2002). The benefits anticipated from the introduction of ICT facilities and tools can only be realized once the user have adopted and used the facility or tool. Numerous benefits such as the speed, reliability, accuracy, and effectiveness have accrued to the adoption of ICTs and have also made it necessary for many organisations to employ it (Bhatia, 2002). There is also evidence suggesting that there are many innovative hotel operators who have taken advantage of ICT facilities and tools; and for that matter are profiting accordingly. These are hotels who advertise their products on the internet and it is believed that they receive 60% of the daily reservations on the internet (Buhalis, 2004).

The study investigated ICT adoption propensity in the hotels in Agona Swedru. The rapid development and commercialization of Information and Communications Technologies (ICTs) for the travel and tourism industry has prompted hotels and other enterprises in this sector to increasingly adopt these technologies. This is based on the expectation that the new ICT based technologies and processes would lead to an improvement in their operating efficiencies and customer service levels. According to Connolly and Olson (2000), information and communications technology is the single greatest force affecting change in the hospitality industry. Buhalis (1998) attributes this trend to both the rapid advances in technology as well as the increasing demands of the customers who look forward to flexible, specialized, accessible and interactive products and communication with principals. ICT based products and processes help hotels to enhance their operating efficiency, improve the service experience as well as provide a means to access markets on a global basis. While ICTs were used in the hotel industry from the late seventies in the

form of Computerized Reservation Systems and Global Distribution Systems, it was only in the 1990s that the ICTs began to make a difference in the hospitality sector (Cooper et al., 2008).

However, as in the case of other sectors, the rate of adoption of ICTs has been found to be quite uneven across hotels because of the challenges of their adoption for different hotels. The findings on the challenges are consistent with the literature available on the subject. For example, Buhalis (2003) made the point that, in spite of the numerous advantages and opportunities associated with the use of ICT facilities in hotels, there are inherent challenges with their use. Firstly, the installation and usage costs are borne by the user (that is, the hotel). Also, most of the software and the navigation keys lack user-friendliness and are biased in favour of the vendor. The Organization for Economic Co-operation and Development (OECD) (2000; 2001) asserts that the cost of purchasing ICT equipment and network is very high. This results in hotels having to generate more resources to cover the cost of maintaining these ICT tools and applications. Again, it is known that ICT facilities are an ever changing phenomena or tools; thus, they are always being upgraded. For this reason, hotels must be ever ready to bear the cost of training staff to upgrade their competences and skills to be able to handle effectively and efficiently these ever changing ICT tools and facilities.

Conclusion

The study has shown that most hotels in Agona Swedru are budget and guesthouses (57.2%), and their managers are predominantly male. Also, the majority were 36 years and above; and half of them had worked for their hotels from 6 to 15 years. Again, most of the hotels had 29 rooms and below, confirming what Morrison and Thomas (1999) noted, that most commonly found hospitality enterprises are small. Akyeampong (2007) has also emphasized that the vast majority of tourism-dependent businesses in Ghana are small in size. With respect to the regular customers or clientele of the hotels, it was found out that business travellers and religious travellers constituted the dominant clientele.

With respect to the extent of the use of ICT facilities, from the study it was found out that all the hotels made use of ICT tools such as television, telephone, and email which were the commonest ICT facilities used by a majority of Ghanaian businesses, as well as individuals. Thus, it was not surprising that all the hotels were using these facilities. It was however discovered that all the hotels do not use ICT facilities such as Voice mail (0%), video conferencing, GDS, and PMS, which could enhance their productivity and communication with their actual and potential guests. Also, less than half of them were using ICT facilities such as Central Reservation Systems, faxes, and wireless browsers, which could be regarded as more sophisticated ICT facilities. Thus, it can be said that, the hotels had challenges adopting the more sophisticated ICT facilities because of such factors as the size of the hotel, the geographical location, management characteristics and so on. The hotels also used both computer and manual systems in storing their information, as a means to have a manual back up of information, in case there was a failure of the computer storage system, as often happened in the country due to the unreliable power supply or the intermittent and often unannounced disruption in electricity supply.

With respect to factors responsible for ICT adoption and use in the hotels, a majority of the hotel managers said customer demand was the major factor for their adoption and use of ICT in their hotels, followed by size of hotel, management characteristics, level of competition, grade of the hotel, and geographical location. It was not surprising that customer demand was the key factor in the adoption of ICT use, since without customers, the hotels would not be in business, and thus certainly, when customers demand the use of ICT facilities in the hotels, it would likely compel any serious management of an hotel, which is interested in its hotel staying competitive and in business to adopt the demanded ICT facilities.

With respect to what the impact of the use of ICT on their hotels had been, all managers agreed that ICT usage has increased the ease with which they process their paper work. It has also enhanced significantly fast access of their hotels to relevant information; and also that they could make confirmations and reservations instantly. These

benefits derived by hotels in Agona Swedru from their adoption and use of ICT facilities in their hotels was consistent with what was found out from the literature on ICT usage in hotels and other businesses.

Lastly, on the challenges affecting the extensive use of ICT in hotels, it was found out that the nature of management or ownership of the hotels and inadequate training and skills of hotel staff (92.8%) were the greatest challenges, among the other factors. The inadequate training and skills of hotel staff in the use of ICT tools could be attributed to the fact that most hotels employ unskilled workers such as people who just finished their senior high education and are awaiting their results. Again, it is also because high labour turnover problem in the hospitality and tourism industry makes their management afraid to train their staff for them to acquire new skills for them to leave for another hotel.

Again, it was not surprising that the nature of the management or ownership of the hotels was a challenge to the extensive use of ICT in hotels because for the majority of small and medium-sized enterprises, including hotels, their management exert a lot of influence in the management of the enterprises because of their direct involvement in the day to day operations of their businesses, as well as the relative lack of formal systems in SMEs, compared to the management and formal systems of large businesses.

We hope this study has been able to establish the use of ICT in hotels in Agona Swedru, and that the lessons learnt from the study would help hotels in Agona Swedru in particular, and Ghana in general, to improve upon their use of ICT facilities and tools for their hotels so they can reap all the enormous benefits to be gained in doing so.

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References

- Akyeampong, O. A. (2007) *Tourism in Ghana: The accommodation sub-sector*. Accra, Ghana: Janel Publication.
- Ayeh, J. K. (2005). *Information Communication Technology (ICT) and Tourism Promotion in the Greater Accra Region: The Use of the Internet in Ghanaian Hotels* (Unpublished M.Phil Thesis). University of Cape Coast, Cape Coast, Ghana.
- Bhatia, A. K. (2002). *Tourism Development: Principles and Practices*. New Delhi: Sterling.
- Buhalis, D. (1998). Strategic Use of Information Technologies in the Tourism Industry. *Tourism Management*, 19, 409-421.
- Buhalis, D. (2003). *eTourism: Information Technology for Strategic Tourism Management*., London: Prentice-Hall.
- Buhalis, D. (2004). eAirlines: Strategic and Tactical Use of ICTs in the Airline Industry. London: Cassell.
- Buhalis, D. and Law, R. (2008). Progress in Information Technology and Tourism Management: Twenty Years on and 10 years after the Internet—the State of e-Tourism Research. *Tourism Management*, 29(4), 609-623.
- Buick, I. (2003). Information Technology in Small Scottish Hotels: Is it Working? *International Journal of Contemporary Hospitality Management*, 15(4), 243-247.
- Chan, S., and Law, R. (2006). Automatic Website Evaluations: The Case of Hotels in Hong Kong. *Information Technology & Tourism*, 8, 255–269
- Connolly D. J., and Olsen M. D. (2000). An Environmental Assessment of How Technology is reshaping the Hospitality Sector. *Tourism and Hospitality Research*, 3 (1), 73-93.
- Cooper, C., Fletcher, J., Fyall, A., Gilbert, D. and Wanhill, S. (2005) *Tourism: Principles and Practice*, 3rd ed., Harlow: Prentice Hall.

- Cooper, C., Fletcher, J. Fyall, A., Gilbert, D., and Wanhill, S. (2008). *Tourism: Principles and Practice*, 4th ed., Harlow: Prentice Hall.
- DePoy, E., & Gitlin, L. N. (1998). *Introduction to research: Understanding and applying multiple stages*. St. Louis, MO: Mosby.
- Ghana Statistical Service (2011). *The 2010 Population and Housing Census: Provisional Results*. Accra: Author.
- Ghana Tourist Board. (2009a). *2006 Licensing Programme: List of Recommended Accommodation Establishments*. Accra: Author.
- Ghana Tourist Board. (2009b). *Ghana Tourist Board Directory 2009*. Accra: Author.
- *Internet World Statistics Report* (2009). Retrieved from <http://www.internetworldstats.com>
- Knowles, H., Fotos, S., and Henry, N. (2000, September). Q & A from the Internet: Implementing SAP. *The Controllers Update*, 184, 2000, 3-4.
- Kumar, R. (1999). *Research Methodology: A Step-by-Step Guide for Beginners*. London: Sage.
- Leedy, P. D., and Ormrod, J. E. (2005). *Practical Research: Planning and Design*, 8th ed. Upper Saddle River, NJ: Pearson.
- Morrison, A., and Thomas, R. (1999). The Future of Small Firms in the Hospitality Industry. *International Journal of Contemporary Hospitality Management*, 11(4), 148-154.
- National Computer Board Mauritius (2002). *ICT Usage Survey 2001: A survey on the ICT adoption of businesses in Mauritius*. Port Louis: Author.
- Organisation for Economic Co-operation and Development (2000). *A New Economy? The Changing Role of Innovation and Information Technology in Growth*. Paris: Author.
- Organisation for Economic Co-operation and Development (2001). *Science, Technology and Industry Scoreboard*. Paris: Author.
- Organisation for Economic Co-operation and Development. (2004). *The Economic Impact of ICT: Measurement, Evidence and Implications*. Paris: Author.
- www.ghanadistricts.com