

MESSAGE FROM THE ORGANISING COMMITTEE

There are good reasons why we should celebrate over the successful and continuous organization of the Polytechnic's Annual Applied Research Conference. The Conference, the fourth in the series, is key player in the development of innovative solutions to our 21st century socio-economic and environmental dilemmas.

It is fortunate that this conference which is of outstanding importance, forms part of the lengthy efforts made by the Koforidua Polytechnic to give increasingly considered thought to contemporary topical issues, in order to foster research interest especially in the field of education, science and technology.

This conference which also comes in the wake of the discovery of oil and gas in commercial quantities in the country will undoubtedly make an outstanding contribution to the socio-economic development of the nation.

On behalf of the Organizing Committee, I express my most cordial greetings and a warm welcome to all the delegates assembled here. Your participation in the 4th Annual Applied Research Conference is evidence of your interest in the Polytechnic's activities. It is also a pleasure for me to welcome the attendance at this conference a delegation from our brother African nation, Nigeria. We hope your stay in Ghana will be pleasant.

Thank you.

NII ANNANG MENSAH-LIVINGSTONE

CONFERENCE CO-ORDINATOR

Papers were presented in the following areas:

- Ghana's Emerging Oil Economy and the Creative Art Industry
- Extraction of Oil and Industrial/Environmental Safety
- Emergence of Oil/Gas and the Energy Sector
- ICT Development and its Application in an Emerging Oil Economy
- The Emerging Oil Economy and the Hospitality and Tourism Industry
- Electrical/Mechanical Engineering Education and its impact on the Emergence of Oil
- An Oil Economy and the Building and Construction Industry
- The dynamics of Business Management and Development in an Oil Economy
- Legal and Social Policies on the Extraction/Management of Oil and Gas

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

Salutation

Mr. Chairman,
Honourable Regional Minister, Dr. Kwasi Akyem Apea-Kubi
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
Vice Rector of Koforidua Polytechnic
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 fourth (4th) in the series of the Annual Applied Research Conference of the Koforidua Polytechnic. On behalf of the Governing Council, Management Staff and Students of Koforidua Polytechnic, I warmly welcome the Guest of Honour, Hon. Dr. Kwasi Akyem Apea-Kubi, the Eastern Regional Minister, who has graciously accepted our invitation. We are assured that this will be the beginning of stronger relationship with the Regional Coordinating Council.

It gives me great pleasure to welcome all of you to the 4th Annual Applied Research Conference of the Polytechnic. We look forward to receiving all your contributions which will form part the reliable research data which is paramount to the achievement of national development strategies and sustainable development. Before I take my seat, permit to say a few words.

Significance of the Annual Applied Research Conference

One of the two objects of a Polytechnic as stated in the Polytechnics Act 2007, (Act 745), is the provision of opportunities for skills development, applied research and the publication of research findings. Therefore the holding of the Annual Research Conference by the Polytechnic is in fulfillment of this object.

From a humble beginning in 2008 when only ten (10) papers were received from only internal staff members, the 4th edition of the has received 32 papers, with presenters from both the Polytechnic and our sister Polytechnics.

First and foremost, this conference is significant as it affords members of the Polytechnic community the opportunity to publish their research findings as required by the Polytechnic Act.

Secondly, the Polytechnic seeks to remain relevant as through this Annual Conference the knowledge and ideas from a cross section of the academia, industry and research institutions on pertinent issues on national importance are pooled together and a communiqué to the Government and the Ghanaian community.

Commitment to Research and Development

Koforidua Polytechnic is committed to improved research output and total development of the staff of the Polytechnic and have thus since 2007 committed funds to the realization of this objective. It is worth noting that some of the presentations to be made during this Conference have been funded by the Polytechnic.

In line with this, an amount of sixty three thousand, four hundred and seventy six Ghana cedis (GH¢63,476.00) was earmarked to support twenty two (22) proposals that were approved by the Institution for the 2009/2010 academic year. This represents an increase of 11% over the 2008/2009 allocation of fifty five thousand, four hundred and thirty four Ghana cedis (GH¢55, 434.00), where seventeen (17) proposals were supported.

Conversant with the importance of research and publications to the tertiary sector, Management will continue to make annual budgetary allocations for applied research. However to sustain this support and ensure a lasting impact on the research culture of the Polytechnic, it has been directed that the Schools and Departments pool their expertise together to present common proposals for financial support.

To make meaningful impact on the staff, a workshop on proposal writing has been organized for the staff of the Polytechnic. In additions, each School has had the opportunity to hold a retreat at Dodowa, where the areas of common research have been identified. It is our conviction that the impact of this new directive will improve the research output of the staff of the Polytechnic, and help address pertinent problems facing our community in particular and Ghana as a whole.

I am mindful of one of my visions of High Academic Standards in Teaching and Research and will work tirelessly to continuously improve the research output through linkages with other institutions.

The Contribution of Polytechnics in Ghana's Emerging Oil Economy

In choosing the theme for this year's conference, ***Ghana's Emerging Oil Economy; the Contributions of the Polytechnics*** Management was mindful of the potential role the Polytechnics had to play and have therefore set the forum for the appropriate discourse through this conference.

We seek to position ourselves to be part of building the oil economy through proper applied research in collaboration and partnership with Government, Municipal, District Assemblies, private sector and NGOs.

The theme also seeks objective discussions on our roles in averting the negative practices associated with the areas where oils have been discovered.

The presence of all of us here signifies the importance of development of research in our country. I therefore wish to emphasize that, it is through collaboration among all stakeholders that research development agenda will be achieved. The Conference will also be concerned with the importance of the analytical quality of results, a topic of increasing awareness and investigation. As academic researchers, quality is something that we should be concerned with. We call on all and sundry to objectively contribute during the discussions and I hope all criticisms will be taken in good faith.

Conclusion

Once again you are all welcomed to the 4th Annual Research Conference. We look forward to lively and fruitful discussions these two days.

We hope you have a pleasant stay and fruitful discussions.

Thank you for your attention.

**OPENING SPEECH BY THE GUEST-OF-HONOUR,
HONOURABLE DR AKYEM APEA-KUBI, EASTERN REGIONAL MINISTER**

Nana Nkwantabisa III, Chairman, Koforidua Polytechnic Council

Executive Secretaries of National Council for Tertiary Education, (NCTE), National Board for Professional and Technicians Examinations (NABPTEx) and National Accreditation Board (NAB)

Rectors of Polytechnics

Distinguished Guests

Members of the Press

Ladies and Gentlemen

Salutation

I deem it a great privilege to be the Guest of Honour for the 4th Annual Applied Research Conference of the Koforidua Polytechnic. First and foremost, let me express my sincere appreciation for the honour I have been accorded to officiate the opening ceremony for this remarkable event. It is quite encouraging to know that this institution has been organizing these conferences during the last three years continuously. This has given ample chances for the academy to propel to a higher height and this is a tradition which we need to uphold at any cost.

I would like to take this opportunity to welcome all of you to Koforidua, the Eastern Regional capital for this important gathering. These fora give opportunity for stakeholders to discuss issues of common interest and thus share experience among them across the intellectual chain. Through these linkages academic relation is then built. I am grateful to the effort made by the Polytechnic to organize this important forum. I am informed that activities in the 4th Applied Research Conference will include, among other things presentation of several papers and it is my expectation that, these papers and materials will assist in generating ideas and activate live discussions among participants to explore key challenges and opportunities related to academia.

Government's commitment to the Educational Sector

I take this opportunity therefore to assure you that the Government of the Republic of Ghana is committed to supporting the educational sector in various aspects to ensure that the objective of increasing knowledge and productivity is achieved. At the same time, we highly appreciate continued co-operation and support by institutions and development partners in development through human training and technology sharing. Without adequate knowledge and technical support in this area, increase in knowledge and excellence would not be possible.

The theme of today's conference - "Ghana's Emerging Oil Economy; The Contribution of the Polytechnics" is both timely and relevant. In the wake of Ghana's oil find in commercial quantities, it is important we appreciate our oil find as a national asset whose management must be above sectional interests. It is also important to accept that revenue from the oil belongs to the people and not politicians or businesses. In this regard, every Ghanaian must feel the positive blessings of our new found fortune; the oil wealth.

Being fresh in the oil producing industry, we must take a cue from our closest neighbour, Nigeria, a leading producer of oil, which is the 10th largest producer of crude oil in the world and the fifth largest supplier of oil to the US since its oil discovery in 1956. Research information has it that Shell has shipped oil from Nigeria for over 50 years, leaving the Niger Delta undeveloped and in worst condition than it had found it in.

According to Ken Wiwa, the son of the late Ken Saro Wiwa, Nigeria earns about \$30Billion a year from oil (from 1990 to 2000), but the country has somehow managed to amass an external debt of \$40 billion without much to show for it in terms of capital investment or infrastructure. Sadly, despite being a heavy weight in the oil production, Nigeria's refining capacity is currently insufficient to meet local demand with queues forming everyday in a country saturated with oil reserves.

To refresh our memory, Ken Saro Wiwa was a Nigerian Environmental activist and a writer who was executed in 1995 for fighting for the rights of the Ogoni people, an ethnic minority in Nigeria whose homeland, Ogoniland, the Nigeria Delta had been targeted for crude oil extraction since the 1950s and which had suffered extreme [environmental damage](#) from decades of indiscriminate petroleum dumping.

We must not wait for this to happen here. This is an indication that Ghana needs to be very cautious with how it handles the emerging oil boom. Most importantly, the government is taking prudent measures to ensure that the oil companies take business and social responsibility seriously in order to avoid any social costs, such as pollution and land degradation, accruing to the people of Ghana.

The Polytechnics role in the Ghana's emerging oil therefore becomes important. The Polytechnics must take a more direct initiative through research and other means to identify and anticipate national needs and bring its influence to bear on government in setting goals and objectives. By including Polytechnics in the formulation and implementation of economic development policies, the nation will be able to fashion a focused shared vision approach to economic development, sustained growth, and stability.

The Polytechnics must also take a more direct initiative through research and other means, to identify and anticipate national needs, and bring their influence to bear on government in setting goals and objectives. Through continued dialogue, Polytechnic education will be in a better position to respond to economic and market trends through timely changes in enrollment by field and discipline as well as adapt its curricula to current and projected business and national manpower needs.

The Government of Ghana is committed to join all of your efforts to promote your contribution to the world of knowledge. The shared vision of all Ghanaians is to continuously create wealth to improve the worth and welfare of our people and to reduce poverty. We together, seek to build a society of free and disciplined individuals with a passion for excellence. Our long-term goal is to develop a society that is capable of achieving middle-income status. A significant milestone along the way to becoming a middle income country is attaining a per capita income of \$1000. The primary target will be to double our current national income within a decade. Our goal is predicated on doing things differently. Our success will also be predicated on doing special things than we have done in the past. This time around, our focus is to ensure that all our people have access to the basic necessities of life.

There are two sets of development objectives. The first objective is aimed at laying the foundation for accelerated growth. Running parallel will be the long-term programmes that will push our development path into a higher course, thus propelling the economy into a sustained accelerated growth mode. The national goal to significantly raise the standard of living of our people means steadily increasing the economic growth rate from its present level of between 4-5% to 7-10% in the medium term and 11-15% in the long term.

Ghana needs accelerated growth. However, the country cannot pursue accelerated growth without a strong and unshakable socio-economic foundation. The foundation building objectives and strategies, which have been referred to in the Ghana Poverty Reduction Strategy (GPRS), as the Medium Term Priorities include enhanced infrastructure, rural development based on modernized agriculture, enhanced social services, good governance and private sector development.

Discovery of Oil and Gas

The discovery of oil and gas will open up the country, introduce competition and create an enabling environment for the private sector. We will open up the country and link it up with the rest of the West Africa sub-region through the trans-West African highway project. It will ensure that Ghana is able to take advantage of the opportunities from West African economic integration and will lead to the creation of jobs. Major roads to productive areas in every region that link the rural areas to

the urban areas will be rehabilitated or developed to open up the rural areas for investment, productivity expansion and job creation through the acquisition of oil and gas revenue.

This will also lead to the construction of houses and other facilities for such critical groups as teachers, medical personnel and security services as well as for rural renewal. There will be an acceleration of access to telephones, internet, information and communications technology in general throughout the country. Necessary steps will be taken to increase the availability of energy derived from oil and gas to boost industrial growth and production.

Importance of Innovation and Enterprise

Rapid political and technological change around the world will pose new challenges at the same time as they generate new opportunities for the next generation of Ghanaians as we find ourselves in this oil and gas economy. Our young must be prepared for a more dynamic and unpredictable future that is fluid, borderless and highly competitive. They must learn to think for themselves, use their imagination, be prepared to try and have the resilience to bounce back when they suffer setbacks. Increasingly, they must also be motivated by their intrinsic passion and interests, and not just by seeking extrinsic rewards.

These are the innovation and enterprise attributes that we want our students to have and which we know will stand them in good stead for the future. As institutions of higher learning, I therefore charge Polytechnics to take advantage of the presence of oil and gas to develop in their students these innovations and enterprise attributes so that they will have the confidence and capacity to seize opportunities and bring Ghana to greater heights.

For Polytechnics to develop the innovative capacity of your students therefore, you must be innovative and be prepared to go beyond the tried and tested to potentially better ways of equipping our young for the future. They must demonstrate the same qualities of inquiry, creativity, initiative and risk-taking that you seek to nurture in your students.

For Polytechnics to succeed in their efforts to explore new ideas to improve the learning experiences of their students, in the wake of Ghana's emerging oil economy, they must first have a strong sense of what works, for whom and under what conditions. This is why rigorous research is vital. Your efforts must be based on sound evidence and knowledge, not fad or opinion. Solid educational research is an important part of our efforts to ensure that education in Ghana is always in time for the future.

Key Areas of Educational Research

We are therefore fortunate to have an active and vibrant educational research community that undertakes studies that have practical application and relevance to the educational needs of the day. This is reflected in the rich and diverse material that will be discussed at today's conference, where over 30 papers will be presented. These useful practical studies, offer fresh perspectives and answers. Looking ahead, we should permeate the salutary effects of rigorous research and scientific inquiry through the whole system, by encouraging teachers themselves to adopt the same frame of mind and rigour in research when they reflect on how they teach and experiment with new methods.

Our Polytechnic teachers should test their own programmes and pedagogies, understand what works and what doesn't, and find out how to do better. They need to formulate their own hypotheses and experiment so that they can go beyond current practice, to more effective learning strategies. Many of our teachers are already doing so. It is very heartening to note that the number of teachers involved in research papers presented at this conference has in the space of three years increased tremendously (from 9 teachers in 2008, 21 in 2009 and 42 in 2010). The quality of their work is high. Their engagement in research has yielded solid practical ideas for classroom teaching.

Moving forward, it would be useful if more of our teachers were trained to conduct small-scale action research especially in oil and gas to evaluate the effectiveness of some of their innovative strategies. Here, the Annual Research Conference can serve as the catalyst for nurturing a research culture in the classroom by training our teachers to undertake action research. These teachers will then be able to question assumptions and translate their findings into knowledge which can impact students' learning constructively. If our teachers are able to translate their ideas into productive pedagogies, they will be able to break away from the prevailing pathways of teaching and testing.

Stepping up co-operation among all stakeholders and improving information sharing are key drivers for change. The important task for academia will be to gather relevant information concerning oil and gas and be able to analyze it and disseminate the knowledge to those who need it. To increase information exchange and cooperation between stakeholders, we need to focus on a few important tasks on which we can build the activities for the forthcoming years.

Conclusion

In conclusion, I wish to commend the Koforidua Polytechnic for seeking to develop a spirit of conducting research, and promoting a culture of research in your lecturers and administrators. These represent excellent opportunities for the Polytechnic to add value to its research role and function. These efforts will have a fundamental impact on the outcomes of our Polytechnic education system. We have achieved very commendable outcomes over the years. With the findings from research, we can do even better and we will also be better informed on how we can do better.

Let me once again take this opportunity to express my sincere gratitude to the organizers of this event for inviting me to officiate the opening of this conference. My highest expectation is that participants will find the occasion useful and contribute to the discussions to be followed.

Ladies and Gentlemen, I wish to call upon participants to demonstrate a high sense of commitment and discipline during the conference. Your selection to participate in this remarkable exercise is a clear testimony of the confidence and trust that the organizers have in you. You should honour these organizers by living up to their expectations. This would ensure that the objectives set for this conference are achieved in a manner commensurate with lofty heights of academia. I wish you all a fruitful exercise.

Before I conclude, allow me, once again to welcome all the participants to Koforidua. Kindly feel at home and I hope you will spare sometime after the conference to visit some of the recreational places in the region. With these few remarks, it is now my singular honour and pleasure to declare the 4th Annual Applied Research Conference officially opened and wish you all a pleasant stay in Koforidua.

Thank you.

**KEYNOTE ADDRESS: SAFETY IN THE OIL AND GAS
INDUSTRY - (OFFSHORE & ONSHORE)**

Mr. Seth Foli

Petroleum Engineer-Ghana National Petroleum Council (GNPC)

Jubilee field was discovered in June 2007 by a consortium of companies. Kosmos Energy, Tullow Oil, Anadarko Corporation, EO Groups, Sabre Oil together with the national oil company. Jubilee field lies within the West Cape Three Points (WCTP) and Deepwater Tano (DT) blocks. It is approximately sixty-three Kilometers (63 Km) from the coastline in a water depth ranging from nine hundred (900) to thousand four-hundred (1400) meters.

The recoverable barrels from the field is determined to be two hundred and seventy-eight millions (278 mm). The main objective of the development plan for the phase one is to drill seventeen (17) wells. Nine (9) wells for producing hydrocarbons, six (6) for water injection and the last two (2) for gas injections. The wells were tied back to the via subsea infrastructure to Floating, Production, Storage and Offloading Unit (FPSO). The peak production for this phase is one hundred and twenty thousand barrels per day (120 M/day) with produced gas of 120 MMSCF. The phase two aims at doubling the peak production and the produced gas.

Ghana National Petroleum Corporation (GNPC) will play a leading role in the development of the Gas Infrastructure Project (GIP). Natural gas liquids for domestic use and export and the dry gas for power generation in Ghana. This will facilitate the economic development of Ghana due to the availability of reliable gas supplies.

Ensuring safety in a fast track complex project like jubilee is important to management. Some of the reasons for investing funds into safety management are:

- Protect workers from the suffering caused by accidents and ill health
- Reduce absence and sick leave
- Retain staff
- Maintain the organization's reputation
- Productivity and profits
- Reduce your insurance premiums and legal cost

The safety in the oil and gas industry is governed by regulations and standards. The Factories, Offices and Shop act, International Labor Organization (ILO) and Oil and Gas Producers Association (OGP). The upstream oil companies and GNPC have individual policy on safety. The policy can be divided into three (3) main parts; the statement of intent, organization and arrangement. The statement of Intent gives the

company's philosophy on safety, and its objective. The organization looks at how the company should structure and responsibilities allocated to each individual. Arrangement will aim at providing resources for the effective implementation of the company's policy. The policy is mostly signed by the Senior Man in the company. This shows authority and commitment on behalf of management. Safe policy should be living document meaning it should be reviewed and updated when condition changes. Some of the conditions which will bring about change in safety policy are:

- Change in legislature and regulation.
- Change in the nature of operation.
- As a reactive measure after an incident.
- Change in top management.

Risk assessment is very important tool in safety management. Risk Assessment can be carried out for the project and individual tasks within the projects. Risk Assessment helps to determine the probability and consequence of an unplanned event. Accessing risks associated with tasks is best conducted by a team made up of individuals undertaking the tasks and safety experts. The five main steps in Risk assessment procedure are:

- Identify the hazards
- Find out who is at risk.
- Find out the likelihood and consequence of the hazard occurring.
- Put control measures in place to reduce the risk to acceptable level.
- Review and updated the document

It is a formal written system used to control certain types of work which are identified as potentially hazardous. The important features of any P.T.W system are:

- Clear identification of who may authorise a particular job and who is responsible for specifying precautions.
- Training and instruction in the issue and use of the permit.
- Monitoring and auditing to ensure that the system works as intended.

Confined space can be any space of an enclosed nature where there is a risk of death or serious injury from hazardous substance or dangerous condition. Injuries can arise in confined space because of:

- Lack of oxygen
- Poisonous gas, fume or vapor
- Liquids and solids which can suddenly fill the space
- Fire and explosions
- Dust present in high concentration
- Hot conditions

The decision process for confined space is: Avoid entry into a confined space by doing the work from outside, if entry to a confined space is unavoidable, follow a

system of work and Put in place adequate emergency arrangement plan before the work starts. A system of for a confined should consider the following:

- Tasting of toxic gases within the confined space. The gas tester should be certified.
- Opening up the confined space for venting.
- Emergency response plan for the task should include medical arrangement, pulling man out of the confined space.
- Isolating valves and pipes.
- Conducting tool-box talks for the workers.

Emergency response plan helps the company to react to any unplanned event. ERP brings together resources to reduce damage to people, environment and property.

Key features of an emergency response plan are:

- An effective organizational structure for implementing the plan.
- A good command and control structure for managing incident.
- Suitable training and competency assessment
- Allocating staff to roles within the emergency plan.
- Clear and well rehearsed procedure which include human reliability and error issues.
- Prepare an emergency response room
- Prepare a checklist for each allocated role
- The emergency response plan should become a living document

Some specific situations which need an Emergency Plan are; Building evacuation plan, Bomb threat response plan, offshore medical evacuation plan and Mass causality response plan.

After putting all this safety measures in place, it is worth measuring the performance of this measure. These are some of the reasons for measuring safety:

- You can't manage what you can't measure
- Measurement is an accepted part of the plan-do-check-act management process
- Providing information on how the system operates in practice
- Identify areas where remedial action is required
- Providing basis for continual improvement
- Providing feedback and motivation
- It is legally required
- Best practices

**BEGINNING OF
TECHNICAL PAPERS
PRESENTED**

SAFETY PRACTICES IN THE OIL, GAS AND RELATED ENERGY INDUSTRIES IN GHANA

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Abstract

In spite of its enormous positive impact towards the development of the economy and society, there are also lurking risks associated with the operations of the oil, gas and related energy industries. As a result the operations of these industries require adequate monitoring and control to ensure continuous operations in a safe environment. This study was undertaken to contribute to this effort. Issues investigated include the appreciation of managers and operators of plants of hazards associated with the operation of their facilities, the adequacy of hazard control and intervention measures at these plants and the regulatory regimes within which these plants operate in Ghana vis-a-vis the best practices worldwide. The study revealed that there are peculiar safety hazards inherent in the operations of the oil, gas and related energy industries that have the potential to cause havoc on the environment and citizenry if not eliminated, controlled or properly managed. It was observed that whilst pockets of regulations exist that address aspects of occupational health and safety in industry in Ghana, there is no comprehensive national safety regulations that guide the operations of the oil, gas and related energy industries. It is therefore recommended that the nation develops an occupational health and safety guidelines to guide the operations of these industries. It is further suggested that the relevant regulatory agency in the country, namely, Factories Inspectorate Department, be properly resourced to enable it adequately discharge its monitory role.

Keywords: Safety practices, oil and gas industries, occupational health and safety, regulatory agencies

Introduction

Safety practices in the oil, gas and related energy industries continue to be of interest to industry players, governments and community activists in view of the vastness of the industry and the crucial role it plays in the economies of nations worldwide. Also, there are inherent hazards associated with operations of these industries which when not checked can have severe adverse consequences on the health and safety of workers, equipment and on the economies of the nations in which they operate. The principal chemical materials of these industries, namely hydrocarbons, are known explosion and fire hazards at every stage of the processing and handling chain, right from the wellhead where they are extracted to the point where they are converted into energy or other forms. Additionally, some of the hydrocarbons themselves and the products of their combustion have been established to affect the health of employees, flora, fauna, and communities in which these industries are cited (EPA, 1980). Inorganic and organic compounds associated with the crude oil from which the hydrocarbons are extracted such as heavy metals and sulphur compounds are injurious to personnel and can affect the health and welfare of workers engaged in the industries if not controlled or properly disposed off. These and other effects of products and wastes from the oil, gas and related energy industries necessitates that the operations of these industries be monitored, managed and controlled in order to protect personnel, property, the livelihood of dependants of these industries and indeed the economies at large.

A number of regulatory frameworks already exist to guide the operations of these industries at the international, national and local levels. Bodies like the International Labour Organization (ILO, 1981), funding agencies like the World Bank (World Bank Group, 2004) and industry groupings like Society of International Gas Tanker and Terminal Operators (SIGTTO, 2000) all have regulatory regimes to guide industry players so as to ensure safety to humans and property. Others like the American Petroleum Institute (API, 2010), National Fire Protection Agency of USA (NFPA, 2006), although regional in character, have standard regulations that have been adapted internationally to guide and ensure the safety in industry.

The fire outbreak that occurred at the Tema Shipyard in 2005 (Ghana News Agency, 2005) and a more recent one at Tema Oil Refinery fire [Ghana News Agency, 2010] has suddenly turned the focus on safety in the oil industry in Ghana. In Ghana a comprehensive regulatory framework established under the Environmental Protection Act, 1992 (EPA Act, 1994), exists to regulate the environment in relation to the activities of individuals and industries including the oil, gas and related energy industries. Additionally, specific guidelines exist that regulate the operations of specific potentially hazardous industries. These include the guidelines for the operations of the LPG industry and the mining industry (NPA, 2008). The situation is however different where industrial safety in Ghana is concerned. There appears to

be no comprehensive policy document that guides the practice of occupational health and safety in industry. There is the Factories, Shops and Offices Act 1970 that provides the regulatory framework, albeit narrow in scope, to control and safeguard the safety of workers and property in industry. This document, however, severely lacks details on how specific safety problems should be regulated in specific industries; as such it is hugely limited in its applicability. Moreover, since its establishment the science of occupational health and safety has developed and broadened its reach so as to be abreast with current developments in this area and to achieve the required impact. It is noteworthy that there are certain industry groupings for which there exist national safety regulatory frameworks. Examples are mining industry (Mining & Minerals Regulations, 1970) and the health sector (Ghana Health Services and Teaching Hospital Act 526, 1999). However, besides the guidelines for the LPG industries, there appears to be no such industry specific regulations that exist for the oil, gas and related energy industries in general. The result is that these industries operate based on in-house developed guidelines or are guided by the rather inadequate Factories, Offices and Shops Act of 1970.

Yet, the oil, gas and related energy industries in Ghana is a growing industrial sector and has suddenly assumed a critical role in the economy, especially, with the recent discovery of oil and gas in commercial quantities. Attendant of this recognition is the fact that these industries also have adverse impact on the economy, environment, safety of workers and communities in the catchment areas of these industries. As such, increasingly, the need to monitor and regulate the activities of these industries has become imminent.

In this study the authors use questionnaires, interviews, industrial and institutional visits to investigate the occupational health and safety practices of the oil, gas and related energy industries in Ghana. The study seeks to assess the adequacy or otherwise of the existing national regulatory framework for these industries vis-à-vis international standards. It also attempts to identify gaps in the application of the existing regulations and to make recommendations for improving occupational health and safety practices in the oil, gas and related energy industries.

Methods and Materials

The study covers downstream processes and activities of the oil and gas processing and distribution activities. It also covers those principal industries that convert oil or gas into energy on commercial basis. National regulatory agencies, namely, the Environmental Protection Agency (EPA) of Ghana and the Factories Inspectorate Department of Ghana were also included in the study. Questionnaires planned, designed and were administered to the requisite companies and institutions. Additionally, management personnel, technical staff and safety and environmental officers from these companies were interviewed. Separate questionnaires were

administered to the regulatory agencies and industry entities. Planned visits to the plants of the selected industries were also undertaken during which a thorough walk through the facilities of the industries were carried out. Observations were made of equipment, staff, and general operations and organization of the plant. Lastly, safety literature and the legislative environment regarding Occupational Health in and Safety in the country were also reviewed.

Results and Discussions

Table 1 lists the industry groupings and regulatory agencies that were visited, interviewed or whose responses were solicited using questionnaires. For the interview, questionnaires were prepared and administered to the interviewees to solicit the responses. During plant visits, tours were conducted through the plants, equipment and other facilities of the companies during which questions were asked and explanations sought. The choice of industry groupings for the study was done to get a complete picture of safety practices in the oil, gas and related energy industries sector, starting from the well head where the oil or gas is first extracted to the point where it is finally converted either into energy or other chemical products. The study did not include companies that retailed oil and/or gas or stored oil and/or gas for subsequent retailing. Four groupings in the sector were identified, namely, crude extraction companies, crude processing companies, oil and gas bulk storage companies, and finally those that converted oil or gas into electricity on commercial basis. No company was found in Ghana that directly converted oil or gas into chemicals or other products. Within the above groupings the selection of companies for the study was done arbitrary. On the other hand, those monitoring and regulatory agencies were visited that by legislation have the mandate to oversee aspects of safety in the industries studied and who have power to sanction or prosecute defaulting entities. The institutions in this category that were visited were the Environmental Protection Agency of Ghana (EPA, Ghana) and the Factories Inspectorate Department.

Table 1. Relevant Companies and Institutions Visited or Interviewed

Industry Visited	Number Visited	Number in Ghana	Percentage (%)
Crude Processing	1	1	100
Bulk Oil Storage	1	4	25
Electricity Generation from Gas or Oil	2	4	50
Monitoring Agencies	2	2	100

The practice of safety in industry is motivated by legislation, ethics and economics. The need for legislation arises from the responsibility nations carry to protect their nationals who are employees in these industries, to protect national assets, and to forestall the possibility of disruption of their economies in the event of major catastrophes in the economically crucial industries. No legislative instrument was identified that caters uniquely to safety in the oil, gas and related energy industries. Rather a number of legislative instruments were identified whose area of coverage included aspects of safety practices of the industries in this study. These are listed in Table 2 together with the specific areas of safety practice that they govern. These legislations apply to industry in general and hence to the oil, gas and related energy industries as well.

Table 2. Legislation Relevant to Safety Practices in the Oil, Gas and Related Oil Industries

Legislation	Jurisdiction	Administering Body
National Building Regulations, 1996 (LI 1630), [12]	All physical structures	Ministry of Works and Housing
Factories, Offices and Shops Act 1970 (Act 328) [9]	Factories, Offices & Shops	Factories Inspectorate Department
Labour Act 2003 (Act 651) (Section 118), [13]	Employer & Employee responsibilities	Labour Commission
Ghana National Fire Service Act, 1997(Act 537)	Fire prevention and protection	Ghana Fire Service
Fire Precaution (Premises) Regulations, 2003(LI 1724)	Fire prevention and protection	Ghana Fire Service
EPA Act 1994 (Act 490)	Protection of the environment	EPA at all levels
Workman's Compensation law 1987	Compensation during breach of safety of employees	Labour Commission
Boilers and Pressure Vessels Safety Regulations, 1970. L.I. 663	All manufacturers, operators and importers of boilers and pressure vessels	Ministry of Emp. & Social Welfare
Petroleum (Exploration and Production) Law, 1984.	All petroleum operations	Ghana National Petroleum Company
National Road Safety Commission Act 1999, Act 567	Safety in road use	Road Safety Commission
The 1992 Constitution of Ghana	Safety of all Ghanaians	The Judiciary

Notable among the legislations listed in Table 2, except for the Factories, Shops and Offices Act (1970) is that they touch on aspects, albeit, a small part of the subject of Occupational Health and Safety (OH&S) & Welfare in Ghana. For instance Section 118-121, Act 651 of the Labour Act (2003) only spells out the responsibilities of the employer, the employee and the Minister responsible for labour in ensuring safe and healthy working environment. Similarly the Fire Precautions Regulations, (2003) and the National Fire Services Act, (1997), focus on prevention and control of fire in the work place. Similarly, the EPA Act (1994), The Workman's Compensation Law (1987), the National Building Regulations (1996), and the 1992 Constitution of Ghana all touch on brief but different aspects of safety, health and welfare in work place.

Unlike the other legislative instruments, the Factories, Offices and Shops Act (1970), by its contents, seeks to tackle all aspects of occupational safety, health and welfare. The Act is administered by the Factory Inspectorate Department under the Ministry of Employment and Welfare. It is the single broad legislative instrument that attempts to tackle occupational safety, health and welfare issues across industry and other occupational entities in Ghana. Indeed, it addresses portions of the issues that the other legislations have sought to address. However, in a great many instances, its edicts are much narrower and less detail than that of the other legislative instruments. For instance, whilst it directs industry what ends must be achieved to ensure safety, in many cases, it fails to provide specific guidelines to achieve those ends. Furthermore, the Act is limited in scope and is obsolete. For instance, the enactment and promulgation of such statutes as the Boiler and Pressure Vessels Act (1970) and others such as the Mining Regulations (Mining and Minerals Regulations, 1970) were for the most part to fill gaps in the Factories, Offices and Shops Act of 1970. Another deficiency of the Act is that it fails to incorporate new developments in the Occupational Safety, Health and Welfare science since its enactment.

Safety Practices

Table 3 lists standards and/or guidelines used by the companies as the basis in ensuring safety in their plants. All the plants investigated had recourse to their own standards to guide safety practice. This situation is as a result of lack of industry specific standards for these companies. Moreover, Ghana as a country does not have national or generalized standards to guide OH&S practice. The country, even though a member of the International Labour Organization (ILO, 1981), has not yet ratified the ILO Convention (ILO, 1981) that requires member countries to establish and implement OH&S systems. Thus in the absence of national or industry specific standards these industries have chosen standards based on their operational or management policies and needs. The problem with this state of affairs is that it

becomes difficult for monitoring agencies to hold these companies to any measure. Indeed, none of the companies investigated reported of any safety monitoring agency visiting their premises. What this means is that these companies play the multiple role of designers, implementers, monitors, and evaluators of the safety practices in their plants at the same time. Nonetheless the study revealed that these companies operated their plants using advanced safety standards comparable to the prescriptions of such standards as the OHSAS 80001:2007 (Aniagyei, 2011). Tables 3 & 4 lists some key elements of the safety practices adopted in these companies. The assessments on the tables used OSHAS 18001: 2007 Standards (Aniagyei, 2011) as a guide. The observation during the plant visits and the responses from safety officers, managers and other key personnel of the organizations using questionnaires and personnel interviews served as the basis of assessment. Table 3 lists some of the parameters used and the organizations rating in these areas. The parameters are selected from the four key areas of planning, checking, accident investigation, and nonconformity, corrective and preventive actions of the OHSAS 18001: 2007 Standard. On Table 4 are the observed safety practices of the companies.

Table 3. Documented Safety Practices of Investigated Plants

Assessment Parameters	Industry Groupings		
	Crude Processing	Oil/Gas Storage	Oil/Gas Conversion
Organizational Safety Policy	Yes	Yes	Yes
Identifiable Safety Standard	Yes	Yes	Yes
Knowledge of Plant Hazards	Yes	Yes	Yes
Safety Planning	Yes	Yes	Yes
Process Safety Management System	Yes	Yes	Yes
Safety Audit	Yes	Yes	Yes
Safety Manual	No	No	Yes
Worker Access to Manual	No	No	Yes
Emergency Procedure	Yes	Yes	Yes
Recent Oil Spillage	None	None	None
Knowledge of Standards	Yes	Yes	Yes
Safety Officer	Yes	Yes	Yes
Safety Training	Yearly	Regularly	Weekly
Employee Training of First Aid	No	No	Yes
Fire and Explosion Preparedness Plan	Yes	Yes	Yes
Strategies to Prevent & Control Fire	Yes	Yes	Yes
Training in Fire Fighting	Yes	Yes	Yes
Most Recent Fire Outbreak in Plant	Yes	No	No

Safety Monitors-External	None	None	None
Safety Inspection-Internal	Daily	Daily	Monthly
Emergency Drills	Yes	Yes	Yes
Risk Assessment	Yes	Yes	Yes
Accident Reporting & Investigation	Yes	Yes	Yes
Recent Fatalities	Yes	None	None
Awareness of local legal regime	Yes	Yes	Yes

Table 4. Rating of Observed Safety and Health Practices

Assessment Parameter	Industry Groupings		
	Crude Processing	Oil/Gas Storage	Oil/Gas Conversion to Energy
Crude Extraction			
Safety Information	Excellent	Average	Good
Safety Officer	Yes	Yes	Yes
Management Commitment	Average	Average	Excellent
Use of Safety Gadgets	Excellent	Excellent	Excellent
PPE Use	Good	Average	Good
Emergency Shut Down Systems	Excellent	Excellent	Excellent
Casual-Worker Safety Training	Average	Average	Good
Tolerance for mishap	Average	Average	Good
Safety Training for Visitors	Average	Average	Excellent
Record keeping accidents/injuries	Average	Average	Excellent
Housekeeping	Average	Average	Excellent
Emergency Assemble Areas	Good	Excellent	Good
Presence of firefighting Equipment	Excellent	Excellent	Excellent
Availability of Clinical Services	Yes	No	Yes
Availability of Passive Fire Protection	Poor	Poor	Poor

The results on Table 3 clearly indicate that these organizations have implemented aspects of all the four broad areas of the OHSAS 180001: 2007 Standards (Aniagyei, 2011). This seems to suggest that not only are these companies aware of the OHSAS standard but concrete efforts are have been made to implement aspects of the internationally recognized standard. Importantly, these organizations understand the

need for the incorporation of safety management as an integral part of the cooperative organization of their plants.

To a large extent, the manner these organizations practiced safety at their plants as evidenced on Table 4 further strengthens the position that indeed occupational safety and health standards have been made part of the operations of these plants. From Table 4, fire prevention and control was one area where all the organizations were observed to fare excellently. This is understandable in view of the fire hazard posed by the products, raw materials, and the services of these organizations. The study observed that in all the assessable parameters of the study, except the provision of passive fire protection facilities, the organizations performed average or better. This suggests that safety is taken quite seriously by these organizations. Indeed in the last two years there has been only one fatal accident in just one of the companies. Yet, there is a lot of room for improvement in the safety practices of the organizations. For instance, put together they were rated average in 35.8% of the assessable parameters. The oil & gas storage facility had the worst rating in this category scoring as high as 61.5% average. The oil processing facility scored 46.2% whilst the energy production facility scored better than average in all instances except in the area of provision of passive fire protection facilities. The figures indicate that some of the organizations are ahead of others in the manner safety is practiced in their facilities. Another notable point is the poor rating of all the plants visited in the utility of passive protection barriers. The implication of this situation is that when there is an incident of fire at one part of the plant, it could easily spread to the other parts. Lastly, none of the organizations had an excellent rating in everyone of the assessable areas, implying that there is room for improvement for all the studied entities even if some have a greater task to sort out than others.

The Role of the Monitoring Agencies

The Factories Inspectorate Department (FID) mandated under the Factories Offices and Shops Act of 1970 was identified as the national agency with the specific mandate to monitor the safety practices in industries and units mentioned under the Act. Crucially, DIF did not list any of the industries studied in this report among those facilities that it monitors on regular basis. This was corroborated by the responses received for the organizations as each responded that no national safety monitoring agency has visited their plant. Even though the Factories, Offices and Shops Act of 1970 did not single out for mention the industries covered in this study, as indeed no industry was given a specific mention under the Act, the definition of a 'Factory' as spelt out in the Act suggests that the activities of the oil, gas and related industries make them part of those entities whose safety practices are supposed to be monitored by the FID. The FID cited lack of personnel and,

monitoring equipment and vehicles as the challenges that it faced in discharging its duties. This could account for its non-monitoring of the organizations of this study.

Conclusion

The studies reported herein investigated the safety practices of the important industries in the oil, gas and related energy sector of the Ghanaian economy with a view of identifying the state of these practices. The results suggest that even though there are a number of legislative instruments whose area of coverage included aspects of the operations of the oil, gas and related energy industries, no legislation exists that exclusively caters for the unique safety practices of that sector of industry. Further, it was found that in spite of the absence of specific national safety standards for the industry, the organizations studied have adopted practices that are in line with some internationally accepted safety standards. The Factories Inspectorate Division that have the national mandate to monitor safety practices in the industries in this study was found not to be exercising that function. The companies that converted oil or gas into energy were identified to have the best safety practices amongst the companies investigated. Finally, the results indicate that even though the organizations in the study were rated better than average in almost all assessable of the study, a lot more room exist for these industries to improve on their safety practices.

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PERSPECTIVES OF POLYTECHNIC STUDENTS TOWARDS THE OIL FIND IN GHANA. A CASE STUDY OF TARKORADI AND SUNYANI POLYTECHNICS

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Abstract

Polytechnics are supposed to be the breeding grounds for the critical middle and higher level manpower required by the nation to build its industry base to ensure growth and comprehensive development. The role of the polytechnic graduate (as a provider of practical oriented manpower needs of the country in areas of technology) is undeniably crucial in the growth of Ghana's economy especially with the discovery of oil in commercial quantities. To ascertain the perspectives of major stakeholders of the oil industry such as the polytechnic graduate that has propelled this study. A survey was conducted to assess the perspectives of polytechnic students towards the oil find in Ghana. Takoradi polytechnic which is located in the vicinity of the oil fields was chosen because of its proximity to the site while Sunyani polytechnic was chosen since it is in the central part of the country (in geographical terms) to represent the opinions of all other institutions in the country. Primary data was collected using structured questionnaires administered to 561 students (304 for Sunyani Polytechnic and 257 for Tarkoradi Polytechnic) who were randomly selected using random numbers generated in excel. The data was analyzed to elicit opinions on various themes using frequencies tables. The data analysis revealed interesting trends from both sides of the divide. Key among them was the fact that the knowledge levels of students who live in the vicinity of the find the same as those who live outside the find. It is suspected that media propaganda could have narrowed this knowledge gap. All other themes discussed affirmed the same trend where difference in opinions did not exist much between the supposed on-site Takoradi Polytechnic students and the supposed off-site Sunyani Polytechnic students. The authors wish to pronounce that the role of the polytechnic students in the national development and for that matter the growth of the oil find is indispensable. It is critical to establish that though geographically students might be separated, the fundamental ideology of their inputs to national development is consistent and the same.

Key words: Perspectives, Polytechnic students, Oil, Ghana

Introduction

In 2007, discovery of oil in Ghana in commercial quantities, between 500 million and 1.5 billion barrels, in the Tano Basin at Cape Three Points in Western region was announced by Kosmos Energy Group, who had undertaken oil exploration in collaboration with the Ghana National Petroleum Corporation (GNPC). The potential for future government revenues is estimated at US\$1–1.5 billion annually ([Osei and Domfe, 2008](#)). The oil reserve is likely to generate government revenues greater than those received from gold and cocoa. The International Monetary Fund (IMF) forecasted government revenues from oil and gas could reach a cumulative \$20 billion between 2012 and 2030 (IMF, 2008). This certainly was good news, considering the numerous unsuccessful attempts in the past. Though Ghanaians at home and abroad have received the news with excitement, the perspectives of the polytechnics (as a provider of practical oriented manpower needs of the country in areas of technology) towards the oil find is unknown at the moment, hence this study. The Polytechnics are supposed to be the breeding grounds for the critical middle and higher level manpower required by the nation to build its industrial base to ensure growth and comprehensive development (Baah-Boakye, 2005).

Most people believe that finding a treasure is a fortunate event that promises future happiness, though others are skeptical. However, experiences from other African countries such as Nigeria and Zambia show that properly managing resource windfalls remains a challenge for many developing countries and that misguided allocation strategies can harm the process of economic development instead of accelerating growth.

Categorically, the objectives discussed are to identify the level of knowledge among students of Takoradi Polytechnic (T-Poly) and Sunyani Polytechnic (S-Poly) on the oil find. Secondly, the study examined the potential problems associated with the oil find and finally assessed the potential ‘blessings’ of the oil find.

Overview of the oil industry

Approximately 115 countries produce oil in significant barrels a day (The-World-Factbook, 2011). The 12 current member nations of the Organization of Petroleum Exporting Countries (OPEC) (Algeria, Angola, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela) accounted for about 76% of the world’s proven oil reserves and 43.5% of world oil production in 2005 (British Petroleum, 2007). Ghana is a much less significant producer, accounting for around 50,000 barrels of oil per day (bopd) and is expected to ramp up to around 120,000 bopd, according to Tullow Oil ([NewsArchive, 2010](#)). Ghana’s production would be less than 0.2% of the world’s production (*ibid*).

The operation of the oil industry is grouped into the following three major phases; the *oil exploration, drilling and extraction* (the “upstream” phase), *transportation* and *refining*. The upstream phase involves remote sensing and satellite mapping techniques with seismic testing to identify potential oil reserves. Companies then drill exploratory wells to channel the oil to the surface. Transportation of crude oil occurs with tankers, barges, trucks and pipelines. Oil now accounts for more than half of the annual tonnage of all sea cargoes, and by 1997 there were more miles of oil pipelines than railways (Burger, 1997). Oil refining involves “cracking” where intense heat and pressure is applied to crude oil to separate and refine it into products such as gasoline and distillate fuels.

The oil industry has provided considerable social and economic benefits. Oil contributes significantly to foreign exchange earnings in many nations. Doyle (1994) noted that, roughly US \$2 billion a day exchanged hands in worldwide petroleum transactions. This amount now stands at close to \$5 billion per day. Furthermore, oil taxes are a major source of income in close to 100 nations. British Petroleum (2000) has estimated that the global oil industry accounted for 4% of the world’s gross domestic product (GDP) in 2000. The price of oil has more than doubled since that time; this contribution may now be as much as 7% or 8%. The global oil industry is also a significant employer. According to the International Labour Organisation (ILO), the industry directly employed more than 2 million workers in production and refining in 2002. This represented about 0.1% of the total global employment (ILO, 2002). The ILO (2002), further estimated that each job in oil production or refining generates between one and four indirect jobs in industries that either supply needed inputs or benefit from value added activities.

The Oil Industry in Ghana

According to Article 257 Clause 6 of the 1992 Constitution, the ownership of all resources including the crude oil in Ghana is vested in the hands of the state or the Republic of Ghana. Until the offshore discovery of crude oil in commercial quantities in July 2007, Ghana's oil industry featured more prominently in the downstream sector. However, with the commencement of crude oil production in the last quarter of 2010, Ghana's oil and gas industry can now be categorized into the upstream and downstream sectors. The upstream sector covers the exploration, development and production of crude oil and natural gas. Currently, this involves the consortium of Kosmos Energy, Tullow Oil Plc, Ghana National Petroleum Corporation (GNPC), Anadarko Petroleum Corporation, Sabre Oil and Gas and E.O. Group. According to GNPC, the Jubilee oil fields straddle two deep water blocks, i.e. the Tano Deep-Water Basin, and the west cape three points Deep-water basin, offshore the Western Region of Ghana. Jubilee is a discovery that is estimated by the Ministry of Energy to hold recoverable reserves of about 800 million barrels of light

crude oil, with an upside potential of about 3 billion barrels. The discovery is said to contain significant quantities of associated natural gas. The downstream sector covers the refining, storage, internal transportation, marketing and sale of petroleum products. This is what Tema Oil Refinery (TOR) Ltd., Ghana National Petroleum Corporation (GNPC), Bulk Oil Storage and Transportation Company Ltd. (BOST), Bulk Transporters and the Oil Marketing Companies (OMCs) have been doing over the past fifty years or more (<http://www.modernghana.com/news/287883/1/ghanas-oil-gas-industry-part-1.html> Date Accessed 31/01/2011).

Methodology

The study adhered to best practices in research methods based on deductive reasoning. A survey-based methodology was used for the data collection using simple random sampling. To enhance the validity and reliability of the data a three-tier approach was adopted. First the instruments (questionnaires) were developed using structured format, this was to minimize problems associated with reliability and consistency of questions posed to respondents. In addition, issues relating to survey biases that might be introduced by the wording of questions relating directly to the notion of construct validity (Paulhus, 1991 as cited in Mbarika, Tsuma, and Wilkerson, 2008) were controlled by pre-testing the instruments and re-wording some parts of the questions. Finally, to avoid problems with the survey data (improper sampling procedures and non-sampling errors are typical to poorly designed survey instruments, vague, inconsistent or misleading administration procedures) the study randomized respondents as per the simple random sampling technique employed. Microsoft excel was used to create a list of random numbers from 1 to 1000, a sample of 561 students was obtained comprising of 304 from Sunyani Polytechnic and 257 from Tarkoradi Polytechnic. The sample size was as a result of the inclusion and exclusion criteria used in the random number list. All numbers either starting or ending with an odd number were included in the study and thus were interviewed. Those who had both digits been odd were excluded from the survey as well as those whose numbers did not end with or start with an odd one. The sample is representative of the population and thus the results were a good opinion of the target population.

The Data was collected using structure questionnaires predominantly categorical scaled questions. In addition, to elicit more information, open-ended questions were included to record factors not anticipated and to provide further explanations to some questions.

The statistical procedure adopted for this study was fundamentally frequency tables which conform to analysis of categorical data type. The software used for the data analysis was SPSS 16.0.

Results and Discussion

Key insights from the analysis of the data for the two groups are discussed next. The statistical tool used in this analysis is frequency table. The response rate of the two schools approximate 100 % since random numbers were used. The high response rate could be attributed to the fact polytechnic students are informed of the oil find and the need for their input in this industry.

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Demographic Distributions of Respondents

Table 1.0: Program/ Course of Respondent

T- Poly	Frequency	Percent
Department of graphic design	2	.8
Department of sculpture	22	8.6
Department of textiles	35	13.6
Department of ceramics	12	4.7
Department of painting	24	9.3
Department of fashion	162	63.0
Total	257	100.0

S- Poly	Frequency	Percent
AGRIC	33	10.9
SMS	1	.3
ICAG	1	.3
B/C	13	4.3
PURCHASING % SUPPLY	2	0.7
CTC	2	0.7
LCM	1	0.3
HND ACCOUNTANCY	124	40.8
HND MARKETING	51	16.8
HND EEE	32	10.5
MVT	6	2.0
DBS	14	4.6
RSA	3	1.0
HND BT	6	2.0
EET	15	4.9
Total	304	100.0

Source: Survey Instrument, December, 2010

Table 2.0: Gender Of Respondent

	S-POLY		T-POLY	
	Frequency	Percent	Frequency	Percent
Male	219	72.0	173	67.3
Female	85	28.0	84	32.7
Total	304	100.0	257	100.0

Source: Survey Instrument, December, 2010

Table 3.0 Age of Respondents

	S-POLY		T-POLY	
	Frequency	Percent	Frequency	Percent
20-25	254	83.6	239	93.0
26-30	46	15.1	16	6.2
31-36	4	1.3	1	.4
37+	0	0.0	1	.4
Total	304	100.0	257	100.0

Source: Survey Instrument, December, 2010

Table 4.0 Academic Level of Respondents

Year	S-POLY		T-POLY	
	Frequency	Percent	Frequency	Percent
1	121	39.8	185	72.0
2	124	40.8	62	24.1
3	59	19.4	10	3.9
Total	304	100.0	257	100.0

Source: Survey Instrument, December, 2010

Table 5.0 Marital Status of Respondents

	S-POLY		T-POLY	
	Frequency	Percent	Frequency	Percent
Single	287	94.4	248	96.5
Married	17	5.6	9	3.5
Total	304	100.0	257	100.0

SOURCE: SURVEY INSTRUMENT, December, 2010

KNOWLEDGE OF OIL FIND

Table 6.0: Have you heard of the Oil Discovery in Ghana?

	S-POLY		T-POLY	
	Frequency	Percent	Frequency	Percent
Yes	300	98.7	254	98.8
No	4	1.3	3	1.2
Total	304	100.0	257	100.0

Source: Survey Instrument, December, 2010

The above table (6.0) is the frequency distribution of the various opinions of the two samples on their knowledge level of the oil find in Ghana. The percentage indicate very close figures since 98.7% and 98.8% of S-Poly and T-Poly students respectively acknowledge they had heard of the oil find. Hence, geographic difference could not be a major variable in the determination of the knowledge level of respondents about the find.

Probing about the geographical location of the find revealed that the majority 84.5% and 99.2% of S-Poly and T-Poly respectively indicated it was in the Western region. However, 4.3% and 3.6% of the respondents from S-Poly pointed that the find was in the Central and Eastern regions correspondingly, the remaining regions were spread in addition by the S-Poly respondents.

To add up views on the company that discovered the oil was skewed to one direction by both groups of respondents. The data showed that 52.6% of S-Poly and 57.2% of T-Poly students attributed the discovery of the oil to Cosmos energy groups while a very appreciable 39.5% and 28.0% of S-Poly and T-Poly students denied any knowledge of the company that discovered the oil.

Table 7.0: Will the oil get finished in the future?

	S-Poly		T-Poly	
	Frequency	Percent	Frequency	Percent
Yes	113	37.2	66	25.7
No	91	29.9	118	45.9
Dont know	100	32.9	73	28.4
Total	304	100.0	257	100.0

Source: Survey Instrument, December, 2010

There was an remarkable trend in the opinions of the two group of respondents about whether the oil find will one day they extinct or not. Interestingly, 32.9% and 28.4% of S-Poly and T-Poly students respectively did not know what will happen. However, 37.2% of S-Poly students consented that the find will extinct and 25.7% of T-Poly respondents affirmed this claim. In addition, 29.9% of S-Poly students contended the extinction of the oil find and 45.9% of T-Poly students supported this claim of non-extinction of the find. The data reveals an inconsistency in the view of the two groups. Whiles the majority of the S-Poly students think that the find will not get finished, the T-Poly group had a contrary view, the majority 45.9% were of the opinion that the find will not finish. The response to this question was quite unfortunate because many respondents didn't know the difference between renewable and nonrenewable resources. It is relevant to emphasize that a renewable resource is one that may be replaced over time by natural processes, such as fish populations or natural vegetation, or is inexhaustible, such as solar energy. Nonrenewable resources are those in limited supply that cannot be replaced or can be replaced only over extremely long periods of time. Nonrenewable resources include fossil fuels and mineral deposits, such as iron ore and gold ore (Microsoft Encarta, 2009)

The spread of the response from both groups about the year of discovery was quite even among the years (2006, 2007, 2008 and 2009) in considerations. Though in both groups they acknowledge 2007 (the correct response) as 37.5% of S-Poly and 32.7% of T-Poly respondents admitted.

Table 8.0: In which year was the oil discovered?

	S-Poly		T-Poly	
	Frequency	Percent	Frequency	Percent
2006	53	17.4	43	16.7
2007	114	37.5	84	32.7
2008	61	20.1	44	17.1
Dont Know	21	6.9	38	14.8
2009	55	18.1	48	18.7
Total	304	100.0	257	100

Source: Survey Instrument, December, 2010

Table 9.0: Will the oil find be a blessing for Ghana?

	S-Poly		T-Poly	
	Frequency	Percent	Frequency	Percent
Yes	129	42.4	112	43.6
No	15	4.9	3	1.2
Dont know	13	4.3	3	1.2
It depends	147	48.4	139	54.1
Total	304	100.0	257	100.0

Source: Survey Instrument, December, 2010

The survey also assessed the views of students about the connotation of the oil to the country. Questioning on whether the oil is a blessing or not, there was a unanimous assertion from both groups. The majority (48.4% and 54.1% from S-Poly and T-Poly respectively) of the respondents said it was dependent on so many factors. Howbeit, 42.4% of the S-Poly and 43.6% of the T-Poly respondents supported that the find was a blessing whiles very few 4.9% and 1.2% of S-Poly and T-Poly consequently said the find was not a blessing.

Table 10.0: What do you consider to be some of The Potential Advantages/Benefits associated with Oil Find?

	S-Poly		T-Poly	
	Frequency	Percent	Frequency	Percent
Economic growth	66	21.7	57	22.2
Infrastructural development	8	2.6	1	0.4
Job creation	62	20.4	26	10.1
Others	3	1.0	59	23.0
No Response	165	54.3	103	40.1
Total	304	100.0	11	4.3

Source: Survey Instrument, December, 2010

Further, analyzing the issues of merits and opportunities offered by the oil find excavated interesting trends. It appeared the majority of the respondents from both sides of the divide established that the find had come to create high economic growth. As shown in Table 10.0, 21.7% of the S-Poly respondents and 22.2% of the

T-Poly respondents all consented to the point that it was a major source of economic growth. Secondly, 20.4% of S-Poly respondents and 10.1% of the T-Poly respondents asserted that it is a major source of job opportunities. Interestingly, finding out about other issues related to the find, only 1.0% of the S-Poly respondents commented while 23.0% of the T-Poly respondents also commented.

It is worth noting that revenues from newly found oil resources provide an opportunity to increase government investment to support economic growth. In fact, public investments that facilitate private-sector led growth has been identified as an important component for many countries that rapidly transitioned from low to middle income country status (Breisinger and Diao, 2009). According to the Ghana Statistical Service (2010) the country's economy stands at GH¢44 billion and per this new figure Ghana is deemed to have attained a middle income status. Ghana is now in a lower middle income and would need to work harder to break into the higher middle income status. (www.myjoyonline.com/Ghana, Date accessed 16/01/11). Besides, the production rate is expected to supply more than \$400 million to the government's 2011 budget and around \$1 billion per year into the country in the early years. The oil is expected to contribute to 6% of revenue to the GDP in 2011 according to the 2011 Budget Statement.

Table 11.0: Will Ghana start catching-up with developed countries after having found oil?

	S-POLY		T-POLY	
	Frequency	Percent	Frequency	Percent
Yes	68	22.4	43	16.7
No	25	8.2	14	5.4
Dont know	11	3.6	7	2.7
It depends	199	65.5	192	74.7
Total	304	100.0	257	100.0

Source: Survey Instrument, December, 2010

Discussing issues of economic growth also unraveled similar trends as above, the swing was on the same side for both groups. Respondents when questioned about Ghana catching-up with developed worlds as a result of the oil find indicated that it depended on a lot of factors, such as sound management, prudent investment and good legal frameworks. In support of this claim 65.5% of respondents from S-Poly suggested so and 74.7% of respondents from T-Poly also supported this claim. Secondly, they still pointed that it was possible we catch-up with the developed as shown by 22.4% and 16.7% of S-Poly and T-Poly respondents respectively. According to Larsen (2004) Norway did continue its relative growth after oil had

permeated the economy and believe that this helps to identify oil as the cause for the acceleration leading to catch-up.

Table 12.0: Should the Government mortgage (collateral) the funds realized from the oil find?

	S-Poly		T-Poly	
	Frequency	Percent	Frequency	Percent
Yes	103	33.9	93	36.2
No	124	40.8	91	35.4
Dont know	76	25.0	73	28.4
Total	304	100.0	257	100.0

Source: Survey Instrument, December, 2010

This question was motivated by the debate by sections of Ghanaians with respect to the collateralisation of the funds to be realized from the oil find. Commenting on national application of the oil find contradicted the consistent trend that had emerged previously, while the predominant 40.8% views of the S-Poly students was not to collateralise the funds from the oil, 36.2% of the T-Poly students supported the idea of converting the funds into collaterals. In addition, the percentile difference between the supporting and the contradicting groups of T-Poly was very small just like it happened in S-Poly. The neutralist groups also attracted a good percentage with 25.0% of S-Poly students saying they don't know and 28.4% of T-Poly students saying same.

Table 13.0: Do you know of any legislation (law) concerning the oil find?

	S-Poly		T-Poly	
	Frequency	Percent	Frequency	Percent
Yes	61	20.1	38	14.8
No	242	79.6	218	84.8
Total	304	100.0	257	100.0

Source: Survey Instrument, December, 2010

Table 14.0: Will Ghana continue its relative growth after oil had permeated the economy?

	S-Poly		T-Poly	
	Frequency	Percent	Frequency	Percent
Yes	108	35.5	84	32.7
No	19	6.3	4	1.6
Dont know	26	8.6	7	2.7
It depends	150	49.3	162	63.0
Total	304	100.0	257	100.0

Source: Survey Instrument, December, 2010

Unilateral observations stand out from the frequency Table 14.0 above on issues of Ghana continuing its relative growth after the discovery of the oil. The majority 49.3% of the S-Poly respondents indicated that it depended on a lot of factors. In a similar response 63.0% of the T-Poly respondents said same.

Sachs and Warner (2001) puzzled that, countries with great natural resources tend to grow slower than countries that have fewer natural resources at their disposal. Gylfason (2001) supported this assertion using the situation of Nigeria, stating that despite its oil riches, she has the same gross national product as 40 years ago. Similarly, oil nations such as Iran and Venezuela grew at 1% per year from 1965 to 1998. A little considerable increase is recorded in the case of Iraq and Kuwait who recorded growth rates of 3% annually in the same period as Iran and Venezuela. It is thus critical to point that oil finds do not come to change economies radically as conceived by most Ghanaians within and abroad. However, according to Larsen (2004) Norway did continue its relative growth after oil had permeated the economy, given that the period in question was limited to a quarter of a century. This modification was needed because Norway appeared to grow fast for an extended period, but experienced a relative slow-down sometime after 25 years, which opens up the possibility that even industrialized countries may catch the curse after the political and popular pressure has eroded the resistance of economic institutions.

TABLE 15.0: Should the Government set a special fund for the place the oil was discovered?

	S-Poly		T-Poly	
	Frequency	Percent	Frequency	Percent
Yes	217	71.4	213	82.9
No	49	16.1	26	10.1
Dont know	37	12.2	18	7.0
Total	304	100.0	257	100.0

Source: Survey Instrument, December, 2010

Setting aside a special fund for the inhabitants of the find area also appeared to follow the same common trend where 71.4% and 82.9% of the S-Poly and T-Poly respondents respectively supported this idea. Probably, the western chiefs may feel vindicated with this finding, though a small percentage (16.1% and 10.1%) of S-Poly and T-Poly respondents respectively opposing the setting up of a special fund for the area. Approximately 55 respondents from both sides remained neutral on this issue.

Table 16.0: What do you consider to be some of the potential problems associated with the oil find?

	S-Poly		T-Poly	
	Frequency	Percent	Frequency	Percent
Economic impact	36	11.8	41	16.0
Social impact	78	25.7	69	26.8
Total	304	100.0	257	100.0

Source: Survey Instrument, December, 2010

Several factors contribute to problems that might be associated with the oil find in the western regions of Ghana. Categorizing them into two (economic been anything relating to income and expenditure or resources utilization and social been anything that had a direct bearing on the environment and society at large), the majority of the respondents were of the view that social negative impact of the oil was going to be greater than the economic negative impact of the oil. The observed frequencies of 2.57% and 26.8% from S-Poly and T-Poly respectively were confirmations of these views by the respondents. Generally, comments as per the S-Poly students was the fact that the find has come to promote the development of the country which was affirmed by students of T-Poly as well.

In fact the source of the curse or problem may be in threefold; first the environmental impact, second the negative economic and social impacts - inflation, migration, damage to other parts of the economy - and third the really disastrous and catastrophic consequences of misuse of the revenue and the corruption which many a times goes in parallel with that. A paper by Robinson et al. (2006) builds a theoretical model in which they find that 'resource booms, by raising the value of being in power and by providing politicians with more resources which they can use to influence the outcome of elections, increase resource misallocation in the rest of the economy'. However this outcome critically depends on the initial quality of institutions (political accountability): indeed, these authors argue that countries without such institutions may suffer from a political resource curse.

Table 17.0: With the discovery of oil, where should the concentration of the Government be?

	S-Poly		T-Poly	
	Frequency	Percent	Frequency	Percent
Agriculture Sector	46	15.1	18	7.0
Oil Sector	40	13.2	33	12.8
Service Sector	9	3.0	9	3.5
Dont Know	209	68.8	197	76.7
Total	304	100.0	257	100.0

This question was informed by the fact that some countries have suffered and continue to suffer from the Dutch disease. Unfortunately, majority of the respondents-68.8% for S' Poly and 76.7% for T' Poly had no idea as to where the concentration of the government should be.

The phrase “Dutch disease” was coined by The Economist in 1976 to explain the negative effects that North Sea oil and gas revenues had on Dutch industrial production. In essence, the Dutch disease simply denotes an economy that features “the coexistence within the traded goods sector of progressing and declining, or booming and lagging, sub-sectors” (Corden and Neary, 1982, p. 825). As it is generally applied in cases where the booming sector is resource extractive and the lagging sectors are manufacturing and agriculture, the Dutch disease results from the hard currency inflows associated with surging resource exports leading to an appreciation of the real exchange rate. This coincides with a sectoral reallocation of economic resources. Capital and labor are drawn away from agriculture and manufacturing and they flow into the extractive sector. The prices of non-tradable goods such as construction and many other services also rise. The end result is higher costs and reduced competitiveness in the tradable agricultural and manufacturing sectors which face competitive international prices for their goods. Natural resource booms, in effect, crowd out other important sectors of the economy and render them uncompetitive. This results in countries with resource-dependent economies that are heavily exposed to the inherent volatility of commodity prices (Davis and Tilton, 2005, p. 236; Mogotsi, 2002, p. 132). Ghana needs to learn from countries like Indonesia and Chile, where public investments in agriculture and rural development financed by oil revenues have played important supporting role in the countries’ transformation.

Economically, the country must continue to focus her attention on the non-oil sector of the economy, particularly agriculture, small, medium and micro enterprises, mining and manufacturing sectors, which, hitherto, have been the backbone of the economy. A major challenge will be how the oil revenues will be used to transform the economy and accelerate growth without sacrificing macro-economic stability and accentuating income inequalities.

Conclusions, Recommendations and Limitations

The study has unearthed the indispensable need for the polytechnic graduates. Key issues identified included their knowledge levels which appear to be very high. In addition, there is a consistent view of this middle level manpower class of people on the blessing and problems of the oil find. In conclusion the polytechnics in Ghana would have to strategize in order to position themselves in the oil industry, but for now their perspectives on the oil find leave a lot to be desired.

The researchers therefore recommend that:

- The polytechnics should mount oil related courses to train the middle and higher level manpower base of the oil industry. Practically, polytechnics, especially Tarkoradi Polytechnic should partner with the oil companies to reap synergistic results.
- Conferences, seminars and symposia should be organized for the polytechnic students to build their capacities in the various phases of the oil chain and upgrade their knowledge on the oil industry as technocrats. In lieu of this, the polytechnic would have to position themselves strategically (by mounting oil-related courses) in the oil industry since the respondents appear to be limited in their understanding of the technical aspect of the oil find.
- The government's goal to ensure that the building blocks for accelerated growth and development, namely, social, economic and physical infrastructure should not be a 'cosmetic talk' and it is hoped the Petroleum Revenue Management Bill would help in this direction. Thus prudent measures must be put in place in order to register a sustained economic growth and development.

Research is undeniably inexhaustible, the study was limited by the use of the simple random sampling technique since it involved all groups of students, this could also be explained as setting the pace for further qualitative studies. Another issue that limited this study was the unbalanced sample size used for the two groups. Future studies could consider similar studies that are more quantitative using hypothesis test to ascertain the statistical significance of the difference in views of the two

groups. In addition, it is recommended that studies on the views of polytechnic students should include other institutions nationwide.

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ENVIRONMENTAL MANAGEMENT FOR TOURISM DEVELOPMENT IN AND AROUND THE OIL CITY OF SEKONDI-TAKORADI IN GHANA

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Abstract

The excitement and euphoria that characterized the discovery of oil in commercial quantities on Ghana's continental shelf off Cape Three Points in 2007, was climaxed with the inauguration of the first flow of Ghana's crude oil on December 15th 2010. Questions then on the lips of many Ghanaians were: Will this important resource be a blessing or a curse to us? Will Ghanaian leaders be able to manage the oil wealth to benefit all Ghanaians as the Norwegians have done? or, Will oil bring misery to communities in the Cape Three Points area in the Western Region as has happened to communities in the Niger Delta in Nigeria, that have been unfortunate to have this black gold located in their vicinity? The objectives of this paper, which is based on a primary research work conducted in three communities in Sekondi-Takoradi in the first quarter of 2011, were to trace the history, discovery and exploitation of crude oil in Ghana and examine the perceptions as well as expectations of people in the metropolis regarding the oil find. A major finding of the study was that the people have high expectations about benefits from the oil find, so the paper concludes that proper management of the people's expectations as well as prudent environmental management in the exploitation of Ghana's crude oil could enhance tourism development in the oil city of Sekondi-Takoradi for the benefit of communities in and around the metropolis in particular, and Ghana in general.

Key words: Petroleum, on shore, off shore, environment, tourism development

Introduction

Crude oil as a fossil fuel is one of the most important resources that man has enjoyed on the planet earth. It is from crude oil that various types of fuel such as gasoline, diesel, aviation oil and numerous lubricants needed to power machines for industries and all vehicles that make transportation possible, are produced. Countries that have this resource in abundance include those in the Organisation of Petroleum Exporting Countries (OPEC) such as Saudi Arabia, Iran, Kuwait, Iraq, Venezuela, Libya and Nigeria, all of whom produce over 75% of global petroleum. Other countries such as Russia, (which produces over 10 million barrels a day and is the largest producer of petroleum in the world) USA, Canada, Norway and Britain, which are not members of OPEC, produce a total of about 25% of petroleum in the world.

These petroleum producing countries control much of the global economy therefore many countries have sunk millions of dollars in prospecting for crude oil. Ghana is one of such countries. Prospecting for oil in Ghana dates back to the colonial period

when the country was ruled by Great Britain. It really took Ghana fifty years after independence (i.e. in 2007) to hit oil in commercial quantities. As Ghana begins to produce oil in commercial quantities, some questions that people have begun asking include the following: Can oil revenues be managed to benefit Ghanaians? Will oil production not affect the environment negatively to increase the woes of the local people? Can revenues from oil be used to beautify the environment and provide resources that will attract tourists into the areas where this black gold is mined in Ghana?

The main purpose of this research was to find out what could be done with the oil wealth to ensure efficient environmental management for tourism development in the country. The specific objectives were four-fold. Firstly, it was to trace the history of prospecting and discovery of crude oil in Ghana. Secondly, it examined the perceptions of people in communities in the Sekondi-Takoradi Metropolitan area regarding the costs and benefits of oil production there. Thirdly, it discussed expectations of the people regarding benefits to be derived from the oil find. Finally, it proposes measures that could be taken to ensure tourism development emanating from prudent environmental management in and around the oil city of Sekondi-Takoradi.

Background to Prospecting for Oil in Ghana

Ghana began prospecting for crude oil in 1896, following the discovery of oil seepage on-shore of the Tano Basin, near Half-Assini in the Western Region (Edjekumhene et al, 2010). Not very serious effort was put into crude oil prospecting by the British colonial government, which was more concerned with colonization, until Ghana attained political independence in 1957. A year before then, crude oil was discovered in commercial quantities in neighbouring Nigeria by Shell, although prospecting for crude oil in that country dates back to 1908 (Ezi, 2008). With Ghana's western neighbour, the Republic of la Cote d'Ivoire, also producing some amount of crude oil, it stood without reason that Ghana must also be having crude oil either off, or on-shore.

After independence therefore, the government of Ghana started a vigorous search for crude oil as some foreign companies came to start prospecting for oil, on and off shore. These countries included Israel, Russia and Romania. The Romanians were seriously prospecting for oil in Ghana when Dr Nkrumah's government was overthrown in 1966. Oil prospecting companies from these countries left a huge amount of seismic data for the country. After Nkrumah, successive governments have continued prospecting with not very successful results until the Saltpond oil fields were discovered and started producing some amount of crude oil in the 1970s. However this was not found to be commercially viable.

Oil was discovered in commercial quantities in the Jubilee Fields, which is a stretch across two blocks at the Western part of Ghana's marine zone, in 2007 (Fig. 1). Ghana's initial oil reserves discovered by Tullow and its allied companies (including Kosmos Energy, Anadarko WTCP, E. O. Group, Sabre Oil and Gas Holding Ltd. and Ghana National Petroleum Company (GNPC)) located in the deepwater Tano block off Cape Three Points, were estimated to be in the region of 1.8 billion barrels (Daily Graphic, December 14th 2010).



Fig 1: Location of the Jubilee Field off-shore in the Atlantic Ocean.
Source: Hufstader (2008)

Since then, some other important discoveries have been made by Tullow Oil Ltd that will boost Ghana's oil and gas production. Later discoveries have estimated Ghana's gross oil potential at about four billion barrels (Okine, 2011). Production of crude oil from the Jubilee Field began in early December 2010 at a daily flow of up to 55,000 barrels. Since then, pumping of oil has continued to increase daily and was around 70,000 barrels a day, by the end of April, 2011. On March 13th 2011, on behalf of the government of Ghana, the GNPC lifted about 995,000 barrels of crude oil from the Jubilee Oilfield. The oil was shipped to the USA to be refined by Sunoco Incorporated, one of the largest independent petroleum and petrochemical products refiners in the United States. At that time it was known that that since production began, 3.6 million barrels of oil have been shipped out of the country.

Ghana was expected to earn approximately a hundred and ten million dollars from the sale of its first share of crude oil from the Jubilee Field. By the end of August 2010, Ghana's oil production was projected to peak at 120,000 barrels a day. This

would make Ghana the 49th highest producer of crude oil after Japan, which produces 132,700 barrels of crude oil a day ([http://en.wikipedia.org/wiki/List, 9/05/2011](http://en.wikipedia.org/wiki/List,9/05/2011)). Experts have projected the nation to produce about 500,000 barrels of oil a day by 2014 (www.ghanaoilinfo.com/index, 10/05/2011). This shows how important crude oil production is going to be to the nation's economy, hence the need for this study.

Methodology

This study was based on both primary and secondary data. The secondary data included documented information and review of literature on crude oil production in Ghana and elsewhere as well as information from the Environmental Protection Agency (EPA). The primary data consisted of information obtained by the use of structured questionnaires administered to 124 respondents in three communities at the urban periphery of the Sekondi-Takoradi metropolis. The questionnaires which were administered between January and February 2011, were also supplemented with interviews conducted with respondents from each of the year groups into which they were put. The communities selected for the study were Anaji Estate, Effiakuma and Essikadu, which is located near the Western Regional Administration in Sekondi.

One would have expected that such a study would be undertaken in settlements located very close to Cape Three Points such as Dixcove and all the villages up to Princess Town in the west, which may relatively be nearer the oil wells of the Jubilee Field. However, as all the workers of the oil companies and almost all of their offices are located in the Sekondi-Takoradi Metropolis and considering the possibility of much of the oil wealth being used for the development of the metropolis, it was decided that the survey be conducted there. Moreover as the oil production is off shore, its environmental effects would not be felt very much close at the beach. Only in the case of oil spillage and pollution would life at the beach be negatively affected. Hence the decision to concentrate the research activity in some selected communities in the Sekondi-Takoradi.

The Study Area, Sampling Method and Variables

Purposive sampling technique was used to select the respondents involved in the study. The three communities were chosen because they represented settlement areas in the metropolis where people within the high, middle and low income groups in the metropolis resided. In addition the communities are among those likely to attract immigrants into the metropolis as it would be very difficult for such immigrants to find accommodation in the Central Business District (CBD) area of the metropolis. The small nature of the sample was also due to inadequate time and resources at the disposal of the researcher, therefore application of the results of the study to the

whole of the Sekondi-Takoradi metropolis, should be done with care. Nevertheless, the findings represent the views of majority of residents in the metropolis.

Variables used for the analysis of data collected included the age and educational background of the respondents as these have a major influence on people's decision-making. The ages of the respondents ranged between eighteen and sixty-five. Another variable of importance was the employment status or occupational background of the respondents. According to Cooper et al (2008) income and employment are important socio-economic variables that directly influence perceptions of individuals on various phenomena affecting them. The most common occupations of the respondents involved in the study were trading, office clerical work, housewife, driving, wood processing and student. Eleven of the young women involved in the study were however, unemployed.

Results

The study revealed that people in the study area have high expectations from the wealth to be made from the oil find. Majority of the respondents expected increase in employment opportunities in the metropolis, no wonder the number of immigrants to the metropolis from other parts of the nation and some neighbouring countries, keep on increasing. In addition, they expected the development of the metropolis to be accelerated. On the other hand, they expressed worry at the increase in the cost of living that is usually associated with mining areas in the country. Of particular concern was increase in the cost of rent, cost of food items and cost of transportation. However, respondents who were either landlords or taxi drivers were happy that increase in the number of people attracted by the oil find into the metropolis has led to an improvement in their business transactions. The following results are presented:

Table 1 shows that 53% of the respondents were males, whilst 47% were females. From this it could be seen that more males were involved in the study than females. Whilst 35% of the respondents were selected from Anaji Estate, each of the other two settlements of Effiakuma and Essikadu had 32.5%.

Table 1: Distribution of respondents according to settlement and gender

Settlement	Male	Female	Sample size	Percentage
Anaji Estate	24	20	44	35
Effiakuma	22	18	40	32.5
Essikadu	20	20	40	32.5
Total	66	58	124	100
Percentage	53	47	100	

Source: Field work, Jan/Feb 2011

All the 124 respondents involved in the study were put into seven year groups. This is shown in Table 2. The 21-30 year group had a higher percentage of 27%, whilst respondents who were 60 years or more were only 6%. The study covered more respondents in the active working population group, which is between 21-60 years, with a total percentage 68% of the respondents. The responses of this group was very pertinent to the study due to their beneficiary status to oil production as they were important in the labour needed for employment in the direct and indirect jobs to be created by the oil.

Table 2: Distribution of respondents according to age

Age group	Male	Female	Total	Percentage
<20	6	4	10	8
21-30	18	16	34	27
31-40	14	10	24	20
41-50	12	14	26	21
51-60	10	12	22	18
>60	6	2	8	6
Total	66	58	124	100

Source: Field work, Jan/Feb 2011

The next result presented, is the expectations of the respondents regarding the oil find such as employment to be created, social amenities to be developed, beautification of the area and others (Table 3). Being a new economic activity and considering how oil and gas have turned the economies of countries such as Libya and Equatorial Guinea around, the people's expectation from the oil find seemed to be very high. There is therefore the need to manage such expectations so that people would not be disillusioned if such expectations are not realized in the long run.

Table 3: Respondents' perception of benefits from oil production

Expectations from Oil Production	Responses		
	Yes (%)	No Opinion (%)	NO (%)
1. Employment creation	110 (89)	0	14 (11)
2. Provision of more social amenities	98 (79)	6 (5)	20 (16)
3. Beautifying the environment for tourism development	24 (19)	20 (16)	80 (65)
4. Development of the area	104 (84)	6 (5)	14 (11)
5. Attraction of tourists	50 (40)	16 (13)	58 (47)
6. Pollution of the environment	70 (57)	4 (3)	50 (40)
7. Increase in cost of living (rent & transport)	110 (89)	4 (3)	10 (8)

Source: Field work, Jan/Feb 2011

Employment creation from oil topped the expectations of the people in the study area. Eighty nine percent of the respondents expressed this expectation. Only 11% of them said they did not expect many people to be employed directly in the oil industry, which some said required highly skilled labour, which was absent in communities found in and around the Sekondi-Takoradi Metropolis. Similarly, higher percentages of the respondents had higher expectations of provision of more social amenities leading to the development of the area. However, the employers in the oil industry interviewed were content with salaries given them although they admitted the risky nature of their jobs.

On the negative side, 89% of the respondents expressed the fear of the oil find leading to increases in the cost of living in the metropolis. All the respondents including workers in the oil industry cited increases in rent charges and transportation fares. Whilst 57% of them expected the oil to pollute the environment, 40% said pollution of the land was not envisaged as the oil production was off shore. About 3% of the respondents expressed no opinion about possible pollution of the environmental. Although the respondents did not agree on whether the oil find will attract tourists to the area, majority of them (80%) did not think that oil production can lead to beautification of the area.

It could be noted from Table 3 that only 19% of the respondents agreed that funds from the oil could be used to develop tourism in the metropolis, although over 84% of them agreed that the oil wealth could be used for development of the area, which may include its tourism potentials. Although 40% of the respondents thought that tourists may be attracted to the metropolis because of the oil find, 47% of them thought otherwise. It could then be concluded that opinions of the people were divided regarding oil being used for tourism development in the metropolis.

Discussion

The following discussions based on the analysis of the data obtained are presented below:

Crude Oil and Employment Creation

The first export of crude oil from Ghana totaling about 650,000 barrels was lifted by Tullow in January 2011. Ironically, around that time the prices of petroleum products in Ghana were increased at an average of 30% by the National Petroleum Authority (NPA). Ghanaians accepted these increases calmly because the expectations of benefits from crude oil such as employment for the people and subsequent reduction of prices of petroleum products as Ghana's oil production increased were still very high. When responding to a question on the level prices of petroleum products, as high as 95% of the respondents claimed that the prices were too high and that they expected the prices of fall as the country has started producing crude oil in commercial quantities.

Although crude oil production is more capital intensive and may not provide direct employment for very many people, the study revealed that the expectation of the people regarding employment to be created from oil was very high. Only fourteen out of the one hundred and twenty-four respondents were not certain of more employment to emerge from the oil production. A few of them however noted that indirectly, the numerous allied, upstream petro-chemical industries associated with oil and gas production are expected to create employment avenues for hundreds of people in and around Sekondi-Takoradi. Such allied industries include production of fertilizer, solvents for production of foam mattresses, pesticides and plastics. With the initial 20-year life span of the Jubilee field likely to be extended as a result of more oil finds by Tullow and its allies in the Enyenra and Tweneboa and Teak 2 Oil Wells off the Jubilee Fields announced in early 2011, more employment avenues will be opened as a result of the creation of downstream oil and allied industries. The sustainability of such employment avenues associated with Ghana's oil and gas industry is assured. The only problem left is prudent management of the oil resources by stakeholders including the government and the GNPA, so as to ensure that all other stakeholders benefit from this important resource located in the environment.

Tourism and Environment Relationships

The environment is an essential resource for tourism development, because all activities of tourism happen in the physical environment. According to [Pigram \(1995\)](#) tourism can contribute to environmental degradation and be self-destructive, but also has the potential to bring about significant enhancement of the environment.

Important relationships therefore exist between the environment and tourism development. This relationship between tourism and the environment is a complex one. Budowski (1976) identified three different relationships between those promoting tourism and those supporting environmental conservation. These are: first, tourism and environmental conservation can remain in isolation, second, tourism and the environment can be in a conflict situation and third, tourism and environmental conservation can be in a symbiotic or supportive relationship.

Commenting on these relationships, Mathieson & Wall (1982) opined that the first relationship is unlikely to remain for long because of the substantial changes in the environment which are apt to occur with the growth of mass tourism. According to them, the second type of relationship where tourism and environment are in conflict occurs when tourism induces detrimental effects to the environment or when tourism declines due to degradation of the environment. In this case, negative impacts from tourism occur when the level of visitor use is greater than the environment's ability to cope with this use within the acceptable limits of change. On the other hand, tourism has the potential to create beneficial effects on the environment by contributing to environmental protection and conservation. This is the third relationship where environmental features and conditions are kept as close as possible to the original state, but at the same time they provide benefits to the tourists who view and experience them. This in turn helps to sustain tourism in the environment.

The third tourism-environment relationship looks to be very important. It has to do with prudent management of environmental resources for tourism development. Tourism resources in the environment of the southern tip of the Western Region of Ghana where oil production is taking place include the sea, the land, the rivers, pristine beaches, the vegetation and wildlife as well as human beings living in the area (Mensah, 2006). For this area to be well developed to attract more tourists, these environmental resources must all be developed. The land should be used efficiently and well linked with the beach and sea with good roads, the beach must be made clean with resting places prepared for the tourists, the vegetation and wildlife should be conserved, while the water courses are also protected from pollution. While tourists pay monies to be used for environmental conservation, the local people, who are the most important resources, must be well educated to earn better living and also appreciate the conservation of the other resources.

Regarding the environment in and around the metropolis, creation of beautiful residential apartments by the oil companies as well as the development of recreational facilities such as club houses, golf courses and children playgrounds can enhance beautification of the environment. This could also attract tourists who have initially been visiting some tourist attractions in the metropolis, such as the harbour.

Oil Production, Environmental Pollution and Tourism Development

Crude oil is known to contain many constituents; however among its most problematic ones are polycyclic aromatic hydrocarbons (PAHs), which are highly toxic materials. When they are released into water, it becomes polluted. Pollution is a major problem associated with oil production. The literature is inundated with stories about environmental pollution associated with oil production, which occur both off-shore and on-shore (Cooper et al, 2008; Nsiah-Gyabaah, 2008; Woode, 2008). A recent case in point is the spillage of million barrels of oil by British Petroleum (BP) in the Gulf of Mexico off the shores of Florida, Mississippi, Alabama and Louisiana all in the USA that killed thousands of marine creature and migratory birds.

When massive off shore spillage of oil leads to mass destruction of marine life, not only does it affect the economic activities of fishermen whose livelihood depends on the sea, tourism is also negatively affected. The beach becomes flooded with carcasses of dead marine creatures and migratory birds. In such a case, bird watching scuba diving, angling, surfing and sea bathing, which are all tourism activities, are rendered impossible. Such pollution on a large scale can lead to the extinction of certain bird and marine creatures, which are sought after by ecotourists, thereby affecting tourism development.

When a massive spillage of oil occurs on shore, it affects negatively the physical environment. The land is destroyed and as such becomes less productive as farming is made impossible. When this happens it negatively affects the socio-economic activities of the people. Pollution associated with on shore exploitation of oil could also be very destructive to water bodies such as rivers and streams, vegetation and wildlife. It could lead to deforestation, loss of biodiversity and livelihoods of the people as they may not get potable water for their domestic chores. Presently, as Ghana's oil is being produced from off shore wells, their degradation of property on the land is quite remote. However, there is the need to be mindful of this problem as on shore discovery of oil especially in the Keta Area, is possible.

Benefits of Oil Production

Oil production is known to bring a lot of benefits to major stakeholders such as the government, oil companies, land owners, and the local people. The government receives a lot of money in oil revenues, taxes and royalties, land owners receive income in land sales and rent, oil companies receive foreign currencies in the sale of petroleum and its products whilst the local people receive income through direct and indirect employment.

For oil to be more beneficial to the government, revenue from this important resource should be managed prudently. The legal framework for management of oil resources should be the major concern of all the arms of government to ensure that the necessary institutions are established and functional before substantial resources enter the oil fund. The passing of the Petroleum Management Bill in 2010 by the National Assembly was in the right direction. This bill will ensure that oil revenues are prudently managed in the interest of the government and people of Ghana. The GNPC, which has experts in matters regarding petroleum exploration and production, could be entrusted with transparency in the computation of revenues from the nation's share of oil revenues.

The oil companies, which have invested millions of dollars in oil exploration, should be well protected by the laws of the land for them to enjoy profits from their investment as this could encourage more direct investment in further prospecting for oil both on and off shore. The passing of the Petroleum Exploration and Production Bill (2010) will ensure that exploration of oil in the country will be a win-win activity for both the government and the oil companies. Due to this, the oil companies would be prepared to implement all contractual obligations they have entered into before commencement of operations.

When the oil production is on shore, land owners receive substantial rent and compensation for their land and property on it that are removed or destroyed for the oil activities to commence. Other landowners who rent living apartments to workers and immigrants, who are drawn to the oil production communities, receive high rent charges from the prospective occupiers of the rooms and apartments. On the part of the people, employment avenues are opened for those who have the basic skills such as carpentry, welding and mechanics, who would be needed for the mainstream oil production as well as the allied industries that will emerge from the oil production.

Costs of Oil Production to the People and the Environment

Prospecting and production of crude oil are most of the time undertaken at a great cost to the people and the environment. When the oil production is onshore, this problem could be exacerbated when petroleum is released on to the land through spillage through intentional tampering of oil pipes. As has been discussed earlier, when oil wells are located on shore, its production can lead to loss of vegetation cover or deforestation. Oil spills that are associated with this primary activity can also destroy the land making it less fertile and even unsuitable for the growing of crops and animal husbandry. This affects negatively the livelihoods of people in such communities.

Another major cost of oil production to the environment is gas flaring, which is the burning of gas, an important by-product of crude oil that is not harnessed for use. Gas flaring produces intensive heat in the primary production areas and is known to have negative consequences on the growth of humans and animal life in those areas (Ampadu Sasu and Okyere-Boateng, 2008). The burning of gas on a larger scale releases greenhouse gases such as methane and carbon dioxide into the atmosphere to contribute to global warming, which could eventually enhance climate change.

Oil production and Environmental Improvement for Tourism Development

Resources from oil could be used to develop tourism in the study area. The creation of facilities for sports tourism is an area that is worth noting. An example is the development of facilities for golf tourism, which is increasing in popularity in West African countries. In Ghana, golf is played only in Accra, Tema, Kumasi and to some extent, in the mining areas of Obuasi and Tarkwa, where it is a past time for some of the expatriate staff. The Sekondi-Takoradi Metropolis will be the next community to develop such golf facility with a remarkable green environment that is associated with golf, to be developed.

In addition, the creation of dual carriage ways for smooth transportation of people and goods in and around the metropolis will help in the development of tourism there. Presently the traffic congestion between Sekondi and Takoradi is unimaginable. This is affecting businesses negatively as people have to waste a lot of time in commuting in the twin city. Considering the importance of transportation, creation of a dual carriage in the Oil City as well as linking the city with Accra through Cape Coast with a dual carriage way, will result in the development of the Oil City for tourism.

As oil production in the metropolis progresses, there will be the need to enlarge the Takoradi Harbour, which is a tourist attraction. The further development of the area around the harbour such as the Harbour View as well as its numerous hotels will ensure that tourists visiting the area would be well accommodated. Finally, another facility that will enhance tourism development in the Oil City will be expanding the air strip of the Takoradi Air Force. The enlargement of the air strip could facilitate the creation of a domestic airport to give impetus to tourism development in the Oil City.

Recommendations

Based on the research work, and the realization of the importance of crude oil in the economic development of the nation, the following recommendations are made:

Management of the People's Expectations on Benefits from the Oil

From the study, the local people as well as a large number of the Ghanaian population have high expectations about expected revenues from the oil find, employment opportunities to be created, poverty reduction and reduction in the prices of petroleum products. There is the need therefore for the government and other agencies such as the Sekondi-Takoradi Metropolitan Assembly to manage these expectations by education, so that the people will not be disillusioned if their expectations are not met. Successfully doing so could avert possible rebel activities that have occurred in some parts of Africa such the Niger Delta that have given the bad name to the people in the Niger Delta, who may be fighting for their right. The people must be made to understand that oil could not be the only panacea for the economic malaise of the country.

It is estimated that Ghana consumes about 60,000 barrels of crude oil per day (www.indexmundi.com/energy). Considering that the nation's oil production which stood at 70,000 barrels a day by the end of April, 2011, could peak at 120,000 per day by the end of August 2011, and Ghana's share of the oil is 13½%, then the nation could boast of only 16,200 barrels of crude oil per day. This leaves the nation with a shortfall of 43,800 barrels of crude oil to be bought a day. The only consolation is that when the nation's giant oil refinery Tema Oil Refinery (TOR) is ready to use the nation's oil, transportation cost of crude oil would be greatly reduced as the nation could have the option to buy oil from local oil companies. The people in Ghana should know these realities.

Capacity Building for the Emerging Oil and Gas Industry

For people in communities in and around the Jubilee Oilfields and the Oil City of Sekondi-Takoradi to benefit fully from the oil find, there would be the need to develop their capacity for them to find employment that will emerge from the new oil industry. This will supplement highly skilled manpower that will be trained by the country's universities, polytechnics and the Management Development and Productivity Institute (MDPI) of the Ministry of Employment and Social Welfare, which has started a short-term practical hands-on competency-based programme for capacity development for some Ghanaian youths especially for the oil industry (Daily Graphic, 2110).

The oil companies make provision of social amenities like clinics, schools, granting of scholarship and skills training for the youth of communities in that part of the Western Region part of their social responsibility. This will help the local people gain employment in the oilfields and enable them to cope with the adverse environmental impact of oil on livelihoods and the health of the local people in the oil producing communities (Nsiah-Gyabaah, 2008). This in turn will reduce or remove completely agitations by the local people against oil exploitation in the environment as has happened in other parts of West Africa with grave consequences.

Promoting the Use of Alternative Energy Resources

Because oil and gas are finite energy sources, i.e. they are depletable, the country must start to develop and use alternative energy sources that are less dangerous to use. These include the use of solar power, wind, waves as well as micro dams on the numerous rivers in the country and harnessing of the jatropha seeds (*jatropha curcas*) for the production of biodiesel oil. Although these plants compete for more agricultural lands, investment in its production would be worthwhile as it produces oil that competes favourably with gas oil from petroleum.

With regard to solar power, its advantage over crude oil is that it produces clean energy that is environmentally friendly, but needs a huge initial capital investment as the photovoltaic cells that it uses are very expensive. Nuclear power could have been a very important and efficient power source but experiences from the nuclear power disasters at the Chernobyl Nuclear Power Plant in Ukraine in the former USSR in 1986 and the Fukushima Nuclear plants in Japan after the Tsunami of 2011, have taught the world how dangerous nuclear power could be.

Implementing Environmental Impact Assessment and Management Plan

Before commencing oil exploration activities, Environmental Impact Assessment (EIA) is prepared and certified by the EPA. The EIA is a document that examines the likely environmental consequences, be they physical or socio-cultural, which will be associated with the activities of the production of oil, on the environment and the people. The EIA which also covers environmental mitigation measures must be monitored by the EPA to ensure its full implementation. The 'polluter pays' principle that was derived from mining and industrial establishments paying for the negative environmental consequences of their activities (Nsiah-Gyabaah, 2008) must also be applicable to oil production.

In addition, like all other industries, oil companies must be made to prepare Environmental Management Plans (EMPs), which they must follow to the letter. An EMP is a document that outlines identified negative impacts of a project, which is under operation. It should cover all negative consequences of the oil exploitation that were not envisaged when preparing the EIA as well as how these consequences are going to be mitigated. The EMP must be seen as a real working document, but not a mere paperwork. To ensure its compliance, there should be continuous monitoring of the oil exploitation activities by the EPA. This will make them certain that measures outlined in the document specifying how the negative impacts of their activities are going to be reduced or mitigated, are really carried out. This must also be done for the gas to be exploited.

Harnessing and Developing the Gas Industry In The Metropolis

Having realized the importance of gas in the development of the petrochemical industry and the negative consequences related with gas flaring, there was the need

for the government to have put the right structures for the harnessing of the gas that is associated with crude oil. As at April 2011, gas from the Jubilee Oilfields was being used either to meet the energy needs of the Floating Production Storage and Offloading vessel (FPSO) christened Kwame Nkrumah, which separates the crude oil and natural gas from the water that may be produced from the oil reservoirs.

The excess gas is re-injected back into the oil wells to increase pressure in the wells for easier pumping of more crude oil until the gas could be transported via subsea pipelines to be laid to the land to be used by the proposed gas processing plant to be built in the Western region. Initially, this will supplement gas from the West African Gas Pipeline Project to fuel industries such as the Aboadze Thermal Plant in Takoradi to produce relatively cheaper electricity. This will make power available even for the development of electrical railway system, the first in the country. This will enhance the development of tourism in the Oil City as transportation is vital for tourism development, because tourism involves the movement of people from their normal place of residence to a destination for sightseeing and relaxation.

Successful harnessing of the gas associated with the oil would also lead to the availability of cheap electricity for the development of other industries such as petrochemical, production of fertilizer, solvents and pesticides. Availability of cheap electricity would also mean an end to the frequent power cuts and their associated destruction of domestic electrical appliances as well as domestic fires occurring in Ghana.

Establishment of the Western Corridor Development Authority

Before the first oil rolled out of the Jubilee Oilfields in December 2010, a delegation of chiefs from the Western Regional Houses of Chiefs had sent a petition and a proposal to Parliament that they needed 10% of revenues from oil to be deposited in a fund for the development of the Region. This was not accepted by the Parliamentarians. However in the President's speech at the inauguration, he reiterated the establishment of a Western Corridor Development Authority (WCDA) similar to the Savanna Accelerated Development Authority (SADA) for the development of the three northern regions of Ghana, or the Central Regional Development Commission (CEDECOM), which was established to speed up the development of the Central Region of Ghana.

The establishment of the WCDA would be in the right direction as it would speed up the development of the Western Region, which is one of the least developed regions in the country. The establishment of the fund with part of the oil revenues deposited in it frequently and used for development of good roads, clinics and even a public University for the Oil City of Sekondi-Takoradi, would go a long way to speed up the development of the Sekondi-Takoradi in particular and the Western Region in general.

Environmental Management and Tourism Development in the Metropolis

The oil companies in the Sekondi-Takoradi Metropolis must be encouraged to build offices and beautiful high-rise estates with parks and children playground for their workers and people in the metropolis that could be tourist attractions. These parks and gardens will also help to beautify the environment. The development of these estates as well as the creation and turning of the inner city, for example around Market Circle into walkable pedestrian routes as has happened as part of the Inner City Commuter Links Upgrade Project of Johannesburg (<http://www.joburg.org.za/index.com>, 5/08/2011), will help to develop the Oil City for tourism. This will also enhance the development of a walking tour by tourists visiting the Oil City.

The Ghana Museums and Monuments Board in collaboration with the Regional Ghana Tourist Board, could also establish a Petroleum Museum, where both domestic and international tourists could visit and learn more about the history of oil prospecting and production in Ghana, how oil is produced, how much Ghana earns from the oil, downstream industries associated with oil and gas, how the oil revenues are being used and so on. This will enhance the information and education that people must obtain about Ghana's oil, thereby reducing people's misconceptions regarding oil in Ghana.

Conclusion

The reality that Ghana has become an oil producing country is now known globally. Whether the country would be able to manage the revenues from the black gold for the benefit of her people is yet to be seen. What is also yet to be seen, is whether oil would bring misery to communities in the Cape Three Points Area in the Western Region as has happened to communities in the Niger Delta in Nigeria that have been unfortunate to have this black gold located in their vicinity. Ghana has the advantage of learning from the mistakes of some oil producing countries in Africa such as Nigeria, Equatorial Guinea and Angola as well as the success stories of European countries such as Norway and the Netherlands, which have managed their oil revenues prudently.

This study has reiterated that crude oil production could have both positive and negative consequences on the environment. In conclusion, it has been established that oil revenues could be used for greening of the environment, development of infrastructure and the creation of a Petroleum Museum for tourism development in the oil producing communities in and around the Oil City of Sekondi-Takoradi in particular, and in the whole country in general.

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ENVIRONMENTAL RISK ASSESSMENT OF OIL WASTE IN THE NIGER DELTA-LESSONS FOR GHANA

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Abstract

For decades, the Niger Delta region has suffered from several oil wastes in the form of spills. The region has always suffered from the consequences of oil waste not only on the land but also offshore. The paper basically presents an assessment on oil waste in the Niger Delta taking into account the oil spill and law, consequences of oil spill through oil exploration and the accidents that periodically happen. These effects have been viewed in three main segments - environment, humans and the related assets. Ghana's oil find in recent time calls for lessons to be learnt from other African countries. To present a clearer picture of the different risks associated with oil spill, the paper quantifies the various risks and presents possible risk control measures. Finally, the paper raises questions concerning Ghana's preparedness to deal with the inevitable issues of oil waste. Have lessons been learnt? Are structures being put in place to help reduce the impact of oil waste? In considering all the control measures the paper concludes by recommending the three party model tool for ethical risk analysis to be used in preventing the most prevalent source of oil waste - Pipeline Vandalization – in Ghana.

Keywords: Oil waste, Oil spill, risk management,

Introduction

In 1956, the Shell British Petroleum (now referred to as the Royal Dutch Shell) had discovered oil at Oloibiri. Two years later commercial production of crude oil started and this has continued for 52 years and oil production in the Niger Delta has been quite visible as a result of its positive economic effect, however, most notable of this visibility is its negative social and environmental impact.

From the economic point of view, about 97% of Nigeria's foreign exchange revenue has been generated from the oil and gas sector representing 79.5 % of total government revenues. The main key players have been the government and multinational companies which includes Shell, Eni, Chevron, Total and ExxonMobil. The exploration and production of oil in the Niger Delta region has often been undertaken in 'joint ventures' involving the state owned Nigerian Nation Petroleum Corporation (NNPC) as a majority stakeholder, and one or more of the these multinational companies within the sharing contracts as the operator.

The area under review has been described as one of the 10 most important wetland and costal marine ecosystems in the world serving as a home to about 31 million people (Amnesty report, 2009). Despite the fact that the Niger Delta has generated over \$600 billion since 1960, its inhabitants live in poverty. The United Nation Development programme (UNDP) has described the region as suffering from ‘administrative neglect, crumbling social infrastructure and service, high unemployment, social deprivation, abject poverty, filth and squalor, and endemic conflict.’ The majority of the people of the Niger Delta do not have adequate access to clean water or health-care. Their poverty, and its contrast with the wealth generated by oil, has become one of the world’s starkest and most disturbing examples of the “resource curse”.

Niger Delta Oil waste

Oil Spill

For decades, the Niger Delta region has suffered from several oil wastes in the form of spills. These have occurred both on land and offshore. Oil spills have largely been caused by variety of factors such as blowouts, equipment failure, burst/rupture of flow lines/pipelines, corrosion of flow lines/pipelines, overpressure, overflow (tanks), valve failure, hose failure/single buoy moorings (SMB), operator or maintenance error, engineering error, sand cut (erosion), accident, sabotage etc (Awobajo, 1981).

In the late 1970s records of oil spill incidents in the Niger delta had risen due to oil spill caused by corrosion and ageing facilities than through sabotage. Awobayo (1981) in an analysis of oil spill incidents had indicated there were a total of 784 oil spill incidents between 1976 and 1980 which resulted in the loss of 1,33,875 barrels of oil.

Table I: Oil spill data in Nigeria between 1976 an 1998

s/n	Year	No. of spill incidents	Quantity spilled (barrels)
1.	1976	128	26,157.00
2.	1977	104	32,879.25
3.	1978	154	489,294.75
4.	1979	157	694,117.13
5.	1980	241	600,511.02
6.	1981	238	42,722.50
7.	1982	257	42,841.00
8.	1983	173	48,351.30
9.	1984	151	40,209.00
10.	1985	187	11,876.60
11.	1986	155	12,905.00
12.	1987	129	31,866.00

13.	1988	208	9,172.00
14.	1989	195	7,628.00
15.	1990	160	14,940.816
16.	1991	201	106,827.98
17.	1992	367	51,131.91
18.	1993	428	9,752.22
19.	1994	515	30,282.67
20.	1995	417	63,677.17
21.	1996	430339	46,353.12
22.	1997	390	59,273.30
23.	1998		98,345.00
	Total	5,724	2571,113.90

There have also been reports indicating that after 1980 most of the oil spill incidents have been from pipeline vandalization other done blowouts. The table below gives a report of pipeline vandalization and associated oil spill from 1970 to 2006.

Table 2: Pipe pipeline vandalization and associated oil spill from 1970 to 2006

Year/month	Incident	Primary cause	Quantity spilled	Spill site	Major impact/effect
1970	Oil blowout	Corrosion and operational failure	250b	Shell BP Bomu II	Air, soil and water pollution, loss of ecological and aquatic species and health problem
1972	Oil blowout	Corrosion and operational failure	250b	Elf Obaji 21	Air, soil and water pollution
1978	Oil blowout	Corrosion and operational failure	300,000b	Gocon's Escravos	Air, soil and water pollution
1978	Oil blowout	Corrosion and operational failure	580,000b	SPDC Forcados Terminal	Air, soil and water pollution
1980	Oil blowout	Corrosion and operational failure	400,000b	Texaco Escravo	321 villages displaced, 18 people killed,
1982	Pipeline rupture	Sabotage by locals	18,818b	abubu	Air, soil and water pollution, loss of ecological
1986	Pipeline rupture	Sabotage by locals	18,818b	Escravos	Villages displaced, eight creeks and villages
1998	Pipeline rupture	Sabotage by locals	18,181b	Jesse	1,000 lives lost, soil and water pollution, health problems and villages displaced
1998	Oil blowout	Corrosion and operation failure	40,000b	Idaho	Air and water pollution, loss of

					aquatic and ecological species
1999	Pipeline rupture	Sabotage by locals	-	Ishiagu	Water and soil pollution, loss of aquatic and ecological species
May 2000	Pipeline rupture	Sabotage by locals	-	Diebu	Water and soil pollution, seven people killed, loss of arable land
July 11 2000	Pipeline rupture	Sabotage by locals	-	Adeje	Air, soil and water pollution, loss of lives and property health
July 17 2000	Pipeline rupture	Sabotage by locals	-	Jesse	Air, soil and water pollution, loss of lives and property health
August	Pipeline rupture	Sabotage by locals	-	ishiagu	Water air and soil pollution, loss of ecological and aquatic species
Januray 3, 2002	NNPC Pipeline rupture	Sabotage by locals	-	Escravos	Air, soil and water pollution
October 15, 2002	NNPC Pipeline rupture	Sabotage by locals	40,000b	Akute ogun state	
March 16, 2003	NNPC Pipeline rupture	Sabotage by locals	40, 000b	forcados	Air, soil and water pollution, 20 people died
2003	NNPC Pipeline rupture	Sabotage by locals	40,000b	ishiugu	Loss of lives and property, air, soil and water pollution
April 29, 2003	NNPC Pipeline rupture	Sabotage by locals	40,000b	escravos	Water, soil and air pollution, loss of lives and property
May,3, 2003	Pipeline rupture/fire	Sabotage by locals	40,000b	Oso	Air soil and water pollution, loss of lives and property
June 22, 2003	Pipeline rupture/fire	Sabotage by locals	40,000b	Isiukwato	200 people burnt to death air, soil and water pollution, loss of ramble rums
Sep. 26,2003	Pipeline rupture/fire	Sabotage by locals	40,000b	Nembe	Five people killed, loss of revenue, water and soil pollution

Sec. 21, 2005	Pipeline rupture/fire	Sabotage by locals	40,000b	Ishiugu	Five people killed, loss of revenue, water and soil pollution
January , 2006	Pipeline rupture/fire	Sabotage by locals	40,000b	Diebu creek	Water and soil pollution, loss of ecological and aquatic species
March, 2006	Pipeline rupture/fire	Sabotage by locals	40,000b	Brass creek	Water and soil pollution, loss of ecological and aquatic species
May, 2006	Pipeline rupture/fire	Sabotage by locals	40,000b	Aggre ekeremot	Water and soil pollution, loss of ecological and aquatic species
		Sabotage by locals	40,000b	Snake island lagos	Air, and soil pollution, economic activity affect and , 200 killed, aquatic and ecological species

Source: K.N. Aroh et al, (2010)

Oil Waste and Laws

Since the beginning of oil exploration, the Nigerian government has put in place some regulation to ensure safety and negative oil impact on environment. However only a few of these legislation applies to pollution. Salu (1999) and Oshineye (2000) have identified the following in relation to oil waste in the Niger Delta. These include:

- Endangered species Act (1990)
- Federal Environmental Protection Agency – FEPA
- Harmful waste Act (1990)
- Mineral Oil (safety) Regulation (1963)
- International Convention on the establishment of an International fund for compensation for oil pollution damage (1971)
- African convention on the conservation of nature and Natural Resources (1968)
- Petroleum Regulation (1968)
- Oil in Navigation waters Acts (1968)
- Oil pipeline Act (1956) (Amended by oil pipeline Acts 1965)
- Environmental Impact Assessment EIA decree No. 86 (1992)

Before 1980 there had been some of these laws, however, attention was not paid to combat oil spillage. Again, these laws had suffered a supervisory defect in their implementation. In 1981, an effort was made to combat oil spill in Nigeria by

forming a consortium of 11 companies including NNPC known as Clean Nigeria Associates (CAN) which had overall responsibility to prevent and control spill and to combat pollutants in general.

Effects/Consequence

As you probably got from the previous parts, The Niger Delta has always suffered from the consequences of oil waste not only on the land but also offshore. The consequences of oil exploration and the accidents that periodically happen affect three main segments - environment, humans and the related assets.

Pollution of the Environment

For decades the activities of oil companies in that region have been endangered the environment and most of the ecosystems in that area. The most tangible consequences of those spillages can be categorized as below:

Reducing the Quality of Soil and its Productivity

The oil waste containing its chemical and physical components can influence the quality of the soil and affects the farming lands in the area. The effects of these pollutants are usually long lasting and it's difficult to recover the soil and in some cases it causes permanent damages on the land.

Destroying Crops:

Those pollutants are spilled in the area such as the waste of oil caused by blowouts can cause damages to the crops. This consequently affects the people lives we later come back to it. In Funiwa-5 during the time the blowout happened thousands of the swamp rice farms were destroyed.

Polluting the Water Sources

The effects of oil spill, especially when it occurs in high volume, are not limited to just the surrounding area, but it also includes the damages to the water sources. In the case of FUNIWA-5 in some villages such as Sangama, Kuluma-1, Kuluma-2 and Otuo Island the surface water were polluted and in these villages the water wells shown some signs of oil in the water. When these oil spills occurs in the rivers through pipelines it also affects the water quality and can cause serious problems for those who use these water sources. Even the digging process to establish the pipelines through the rivers or related activities will have serious effects on the water and sometimes changes the environment some creatures need to live in.

Damage to Marine Ecosystems

Usually in offshore spills the amount of oil are wasted influences the marine ecosystems including most of the creatures are directly or indirectly in touch with those water sources. For instance fish, birds, and other sea animals. These damages

may occur as a result of physical contamination which leads to suffocation of creatures or by chemical components which creates a toxic area for them. For instance, fish are directly in contact with these pollutants and may die due to it. But this is just the immediate effect of these pollutants. In fact it affects the eggs and their larva as well as the ability of fish to reproduce, and in long-term reduces the fish stocks.

The type of detergents is also another reason which endangers those ecosystems. Usually the detergents are used just removes the shine by breaking the structure of those pollutants and moving them to the sea bed. Therefore it makes the sea bed toxic and threatens the lives of many creatures in that area.

Negative Impacts of Flaring Gases:

Nigeria is known for flaring the most amounts of gases associated with oil exploitation in the whole world. It's claimed that from the 3.5 billion cubic feet of the gas being produced every year, around 2.5 billion is wasted via flaring. This amount of the waste can be used as a source of energy and can be separated from the crude oil, but due to the cost of such operation, it's mostly neglected in the Niger Delta. The most important effect of such flaring gases is the global warming since the result of these flaring processes is huge amount of methane releases in the atmosphere which is the main cause of global warming.

Impacts on Human Lives:

As it was mentioned, the nature of the pollutants and the place usually these accidents happens targets three main segment related to the local people's lives including fisheries, water sources, and farm lands. The influences of these damages can be categorized as below:

Effects on Welfare:

Since the income and initial needs of those people highly depends on their farming activities and their fisheries the damages were explained in environmental consequences affects the lives of the people by reducing the productivity of soil and damaging the crops, and etc. The reduction in the population of rural areas is one of the results of inability of people to produce their own food or make proper income due to the exploration activities which doesn't take their needs and requests into consideration.

Loss of Human Lives:

The effects of Oil waste on the water sources impacts the human lives negatively. The people in the Niger delta, especially in the rural areas, are highly dependent on the surface water sources or the water wells. They use these sources for bathing, cooking, drinking and other daily activities. The toxic water can cause several water-

borne diseases and in some cases will result in death of the people. Related to Funiwa-5, the released amount of oil polluted 1200 km² and 321 villages with a population of 320000 influenced by the consequences of the oil spill. Approximately, 180 people died and more than 300 showed different signs of illnesses caused by polluted water or contaminated food.(Odu and Offodum, 1986).

Respiratory Problems Due to Flaring Gases

The most important substances are released due to flaring gas are nitrogen dioxides, sulphur dioxide, volatile organic compounds like benzene, toluene, xylene and hydrogen sulfide, as well as carcinogens like benzopyrene and dioxin which all are dangerous for the human health. The impacts of these hazardous materials on humans are indicated to be different respiratory problems and disease such as asthma, chronic bronchitis leukemia and other blood-related diseases.

Loss of Material Assets

Fishing Equipment

The effects of oil spill especially in the offshore is not limited to only ecosystems. It also affects the fishing equipments are used in that area. Department of fisheries in Port Harcourt indicates that the damage to the equipments such as fishers' nets often means the end of their livelihood as a fisherman not only due to the cost of it but also because of the inability to access to some equipments.

Damage to the Exploitation or Exploration Equipments:

The oil spills in the form of raptures or obstruction usually is due to damages to the pipelines and other equipments are used for exploitation. On the other hand, in blow-out accidents, it is more likely that the rig will get damaged if the personnel don't have proper reaction. When a blow-out happens, due to the amount of rocks and other materials with sharp edges come out of the oil well or due to shallow gases may cause the blowout it will be possible that the oil start to fire which can make serious damages to the rig or other equipments or personnel. In the Funiwa-5 case, the fire that was started on January 30 caused the Sedeco 135c to get fired and destroyed.

Oil Waste Risk Management

Risk Quantification

Having identified the various sources of oil waste in Niger Delta, there is also the need to evaluate these risk items and their interaction and classify them in order to recommend a risk control measure to avoid if possible or reduce their impact in the future.

Oil Spill

There are a number of reasons why oil spills happen so frequently in the Niger Delta. Spills result from corrosion of oil pipes, poor maintenance of infrastructure, spills or leaks during processing at refineries, human error and as a consequence of deliberate vandalism or theft of oil.

Considering the trend of oil waste in the form of oil spill in the region, there have been several cases of pipeline vandalization (at least, 17 within 2000 and 2006) spilling several thousand barrels of oil. According to *ISEIS (2004)*, the pipeline explosion as a result of the vandalization has killed hundreds of looters and bystanders. The most recent of pipeline explosion in Ilado, Lagos Island on May 12, 2006 led to more than 200 people incinerated in the pipeline fire (*Ballogum et al. 2006*). Again, considering the consequence given in section 3.0 above, it is acceptable to quantify the risk of oil waste as tiger.

Table IV: Risk Item Quantification in the Niger Delta

Risk Item	Frequency	Consequence	Risk Quantification
Blowout	Low	Disaster	
Pipeline Vandalization	Very High	Major/Disaster	
Equipment failure	Medium	Major/Disaster	
Corrosion and operational failure	High	Major/Disaster	
Oil tanker accident	Low	Major/Disaster	

Tiger



Alligator



Puppy



Kitten



Based on the analysis above and the data in Table IV it was decided to combine the partial risks identified for the various items. Towards, this a risk-scoring scheme was introduced in this work. The following scheme was devised for the five risk items identified.

The risk items were coded as

$i = \{\text{Blowout -1, Pipeline vandalism -2, Equipment failure -3, Corrosion and operational failure -4 and Oil tanker accident -5}\}$

It was significant to examine the influence that severity had on oil spillage. The scoring system was based on the relative economic and social damage that the various risk items may cause. The risk items that could cause low economic and social damage (rated as kitten) were scored 1. The risk items that could cause medium economic and social damage (rated as puppy) were scored 2. The risk items that could cause high economic and social damage (rated as alligator) were scored 3. However, the risk items that could cause very high economic and social damage (rated as tiger) were scored 4.

Also, the frequency with which the risk items occur within a time frame was considered since it has a direct bearing on the total risk (the Risk Unit). The frequencies were scored. The risk items that had low occurrences were scored 1. The risk items that had medium occurrences were scored 2. The risk items that had high occurrences were scored 3. The risk items that had very high occurrences were scored 4.

The Risk Units were calculated for each risk item by the fact that risk unit is directly proportion to both the severity and the frequency of their causes. That is,
 $RU \propto \text{Severity} \times \text{Frequency}$. Neglecting the constant of proportionality,
 $RU_i = S \times F$. Where S and F are the severity and frequency respectively and i, the risk item {1-5}

Below are the calculations for the risk unit for the various risk items.

$$RU_1 = 1 \times 3 = 3$$

$$RU_2 = 4 \times 4 = 16$$

$$RU_3 = 2 \times 3 = 6$$

$$RU_4 = 3 \times 4 = 12$$

$$RU_5 = 1 \times 3 = 3$$

The RU values were categorized from low to very high. $RU_i \leq 4$ were categorized as Low, $4 < RU_i \leq 8$ were categorized as Medium, $8 < RU_i \leq 12$ were categorized as High and $RU_i > 12$ were categorized as Very High. A bar chart was used to illustrate these

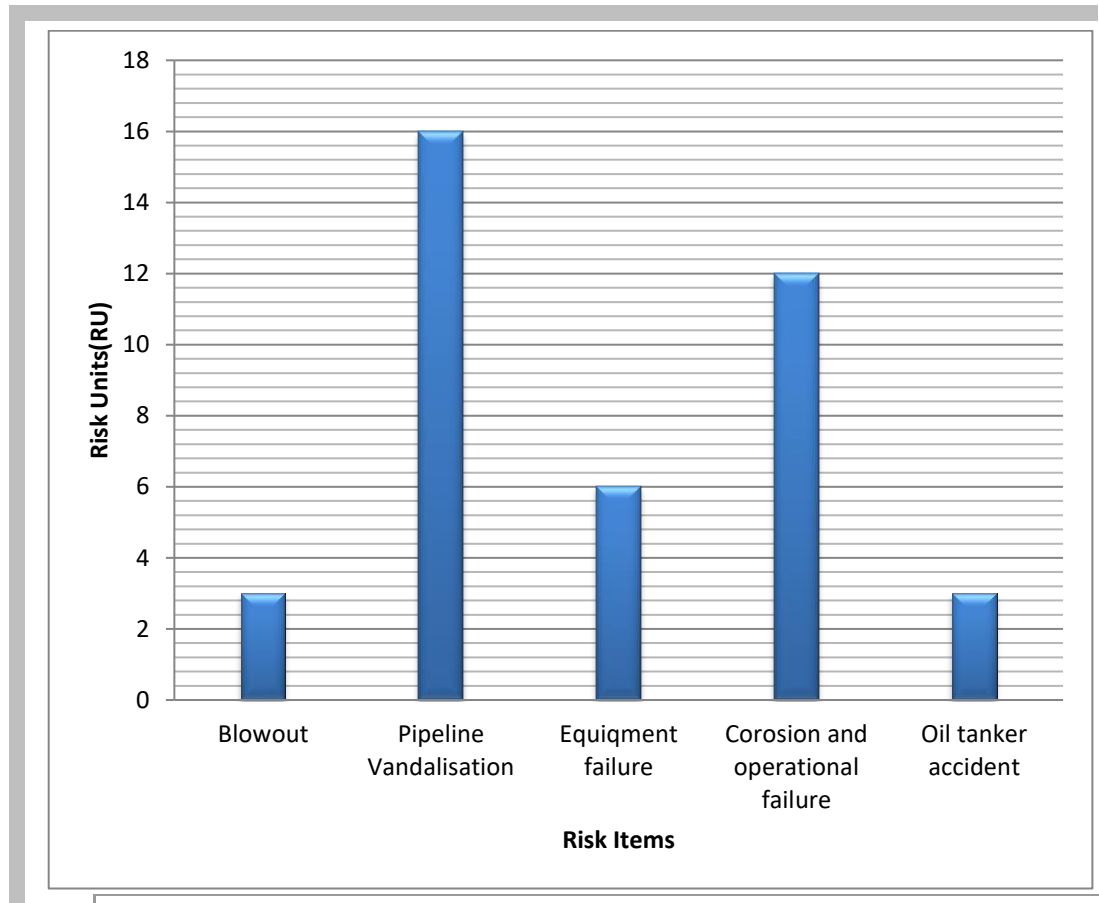


Figure 1: A bar chart comparing the various risk items by their risk units (RU)

From figure 1, it is clear that Pipeline vandalism poses the greatest threat with respect to oil spillage with an RU value of 16. This is steadily followed by Corrosion and operational failure, then equipment failure and lastly blowout and oil tanker accident.

For Ghana, this presupposes that there should be stern surveillance on our pipe lines. Authorities must make sure that our laws work. Offenders must be dealt with seriously to serve as a deterrent for others. Much emphasis and orientation should be given to our youth on the need to form pressure groups and watchdog committees to help track down offenders.

However, Corrosion and operational failure as a cause cannot be underestimated. Our pipes should be coated well enough to stand the test of the weather.

Risk Control Measures

The Niger Delta region is considered as high risk area based on the risk quantification done above. It is therefore important to suggest risk control measures to salvage the situation to prevent further deterioration and future oil waste incidents.

Dealing adequately with the Niger Delta as a High Consequence Area

It has been noted earlier that much of the oil infrastructure in the Niger Delta runs close to homes and water sources of the various communities. It is therefore important the inhabitants who live a rural lifestyle and have a significant dependence on their environment for food water and income, be given the needed attention and protection required. That is, the Niger delta requires from the oil companies, an additional risk reduction measure as defined by the US regulation integrated Management in High Consequence Areas.

Sanctions and Penalties

Under international laws governing the oil industry, the Nigerian government has an obligation to meet out appropriate sanctions and penalties to state and non state parties who abuse human rights. The absence such punishment has fuelled violations and abuses of human rights. It is therefore imperative on government to be firm and implement these sanctions to the latter because relatively lighter penalties would undermine both the environmental protection and human rights in the Niger Delta and this would compound the problem.

Governmental Contribution

It is clear that the Government of Nigeria needs to adopt measures that would provide a reasonable degree of protection of ecological and human environment from the activities of the oil industry. The measure so adopted must discourage indiscriminate release of damaging discharges into the environment through appropriate programmes. Such as contingency planning, adoption of best available pollution control technology and autonomous monitoring of the state of Nigerian environment.

Accessibility to Information

Access to information has been a basic problem in the Niger Delta. The communities have very little or no information about the impacts of the oil industrial on their lives. In the Funiwa 5 incident, the oil company had reported 200,000 barrels of oil while the department of Petroleum resources had indicated 400,000 barrel. Again, Texaco claimed that they only used government-approved dispersants and only in water that is deeper than 30m, yet was not willing to provide any information on their use of dispersants.

When the right information about investigation is made available to the public with corresponding impact and measures in a non-technical language, it will help reduce conflicts among all stakeholders in the industry.

Protection of Delta Communities

There have several incidents of human right violation in Niger Delta leading to sabotage. This is largely due to the fact that the people cannot feel the protection needed from the government as oil companies have so much control over the oil spill investigation and compensation systems. One option is for government to make the community feel their human rights are protected and another is to ensure access to effective remedy.

Lessons for Ghana

Oil spill is inevitable in oil exploration, however, when right structures are put in place their effect could be reduced to the barest minimum. Basic lessons for Ghana include enforcement of laws, involving local community and access to information. It is obvious that the Nigerian Government had necessary petroleum and environmental laws in place yet the issue of enforcement was lacking hence proper sanctions and penalties were not given. It is therefore important that the environmental laws and associate sanctions be implemented to the latter to ensure that the citizenry is fully protected.

Again, since oil conflicts has mostly generated from the neglect of the local community and lack of protection, it is of uttermost importance for the government of Ghana to ensure that the local communities in the Western region are involved in the processes as well as decision making. A constant effort should be made to regularly communicate the government readiness to support them which should be supported with actions. Information about disasters should not be concealed from them but made known together with combating measures.

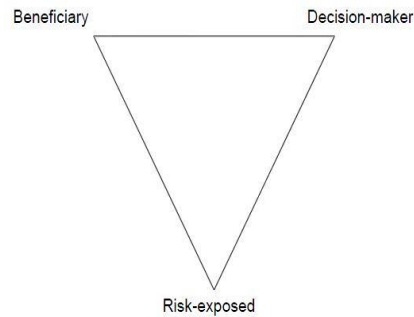
Conclusion and Reflection

The Niger Delta oil waste has taken different dimension over the past decade and had resulted in several conflicts among the major stakeholders. The main issues to be address had been government failure with legislation, lack of resources and capacity, corporate involvement in regulatory system, failure to deal with the human implication of oil waste, lack of information and consultation, inaccessible information and lack of effective sanctions and penalties.

In our opinion, while considering the above mentioned risk control measures, the three party model tool for ethical risk analysis could be used in finding a lasting solution to this problem. In this model the three major stakeholders, the oil

companies, the communities and the government should be made to play their individual roles while not taking undue advantage over the other.

Three Party Model Tool for Ethical Risk Analysis



This stakeholder approach would give an improved understanding of management responsibility on the part of both government and the oil companies and will transcend beyond shareholders interest to include social causes that benefits the community as a whole. This approach would to a large extent provide a means to understand the structure and extent of the oil companies' societal relationships to enable them establish the level of organized resources required for social obligations without compromising the interest of their shareholders whose interest they represent.

In this regard, issues like clean-ups of areas affected by oil spill, remediation of oil pollution impacted sites and payment of compensation for some damages should be critically looked at

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**AN APPRAISAL OF THE DEVELOPMENT AND APPLICATION OF
INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) IN AN
EMERGING OIL ECONOMY: A CASE STUDY ON GHANA**

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Abstract

Ghana is one of the developing countries that is endowed with abundant natural resources including oil deposits. Unfortunately, due to a number of socio-economic, administrative and political factors, these resources have not been managed in the most effective and efficient manner. Consequently, the country continues to wallow in abject poverty in the midst of plenty.

Over the years, agriculture has been the mainstay of the economy. About 65% of the population is engaged in agriculture. Unfortunately due to the poor agricultural practices by the farmers and non commitment of successive Governments towards the implementable agriculture policies, the citizenry have not been able to break the poverty cycle through the agricultural practices in the country.

The discovery of oil and gas has thus raised the expectation of the population to new levels. This is because there are a number of industries associated with the Oil and Gas Industry. Also associated with the oil and gas industry is the expansion of the education curricula to include academic, vocational and skills training associated with courses relevant with the oil and gas industry. Nevertheless, there are a number of challenges associated with such high expectations, especially in an emerging oil economy.

To manage these challenges, there will be the urgent need to develop the ICT industry and expand its applications in the country. The 21st Century dubbed, “The Information-Age,” is a knowledge-based society which is also closely associated with social mobility. Therefore, what is required to exploit the ICT potentials is to formulate the relevant policies that will enable the country develop the requisite human resource base for accelerated socio-economic development and growth. The Asian Tiger Nations have gone that path in the past and they experienced a meteoric rise in socio-economic development. Ghana can emulate their example. The National ICT Policy for Accelerated Development seeks to establish such policy framework. What is required is the political will to implement the policies. Unfortunately, this is lacking in the body politic in the country. Consequently, the

development and growth of democratic governance in the country seems to have been negatively impacted due to the absence of such a drive.

Introduction

Ghana is one of the developing countries that is endowed with abundant natural resources such as gold, diamond, manganese, bauxite, iron ore and of late oil and gas deposits. Unfortunately due to a number of political and socio-economic factors, these resources have not been managed in the most effective and efficient mannerⁱ.

Over the years, agriculture has been the mainstay of the economy. About 65% of the population is engaged in agriculture and that sector alone accounts for 35% of GDPⁱⁱ. Unfortunately due to the poor agricultural practices by the farmers and non-commitment towards implementation of agriculture policies by successive Governments, the citizenry have not been able to break the poverty cycle despite the numerous natural resources and vast fertile arable landsⁱⁱⁱ.

The expectations of the population have been raised to new levels due to the discovery of oil and gas in commercial quantity in 2007. This is due to the fact that, there are a number of industries associated with the oil and gas production. It is the expectation of the general populace that new jobs will be created. It is their hope that the challenges associated with the large unemployment in the country will be addressed. These expectations notwithstanding, there are a number of challenges associated with such high expectations, especially in an emerging oil economy in a developing country such as Ghana.

To effectively manage these challenges, there will be the urgent need to develop the ICT industry and expand its applications in the country. If well developed, ICT application in various sectors of the economy can help bridge the poverty gap. Ghana has since the beginning of the century developed such a policy^{iv}. However due to some socio-economic, administrative and political challenges, this policy is yet to be fully implemented.

Thus, this paper will seek to appraise the application of ICT in an emerging oil economy with specific reference to Ghana. Then the study will evaluate the state of ICT development and application in Ghana. Conclusion will then be drawn from the discussions followed by recommendations.

Methodology

Interviews were granted to a cross section of stakeholders in the oil and gas industry as well as the ICT industry. This was followed by review and qualitative analysis of published works and other secondary sources on the subject matter.

Results

During the study the following facts were established:

Most Ghanaians are of the view that, the production of Oil and Gas in commercial quantities will provide the panacea to the country's economic woes.

A section of economic and industrial experts caution against the high expectations from the oil and gas industry and the associated challenges which are likely to arise as a result of such high expectations.

Other categories of experts suggest that the Government should rather encourage farmers to improve on their farming practices so as to increase their yield and by extension their income. They are of the view that agriculture has been and will continue to be the mainstay of the economy. Oil and gas, they stated, is a finite resource, and as such, the development and growth of agriculture should not be sacrificed for oil and gas production. They suggest that, agriculture development and growth, can be achieved by formulating and implementing the right policies that will enable the farmers have access to concessional loans from the local financial institutions. This will enable the farmers upgrade their farming practices from subsistence to mechanized farming. In additional, there is the need for the Government to create the enabling environment for the farmers to acquire the requisite agriculture plant and machinery and technical advice from agriculture extension officers. Furthermore, it is proposed that investors should be encouraged to establish agro-processing industries and specialised marketing companies for agro-products.

The ICT industry is in its nascent stages in the country.

There is the need to create the enabling environment that will ensure the Nation develops the requisite human resource base which will drive the ICT industry.

If the policy on ICT for Accelerated Development is fully implemented, the ICT industry will certainly provide a catalyst for rapid socio-economic development in the country.

The ICT industry can be employed to improve the techniques for the production of oil and gas in the country.

Application of Information and Communication Technology in an Emerging Oil Economy

The petroleum industry includes the processes of exploration, extraction, processing, storage, refining, transporting (often by oil tankers and pipelines), and marketing of petroleum products. Petroleum is also the raw material for many chemical products including pharmaceuticals, solvents, fertilizers, pesticides, and plastics. The industry

is usually divided into three major components: upstream, midstream and downstream. Midstream operations are usually included in the downstream category. Information and Communications Technology (ICT) has come to play a vital role in the development and production of the oil and gas industry. ICT resources can be used by oil field operators, explorers, developers and upstream processors to find an innovative ways of undertaking their operations in a more effective and efficient manner. In the current knowledge-based information-age, ICT tools have always provided innovative solutions for many key areas in the oil and gas sector; including exploration, design, analysis, processing, production, storage and transportation.

Current State of Information and Communication Technology Development and Application in Ghana

The current National Information and Communication Technology Policy and Plan Development Committee under Prof Dzidonu was launched on Thursday 22 August 2002 by the then Minister for Communication Hon. Owusu Adjapong. He stated that as a result, the Government has identified five critically interrelated areas for strategic intervention, which include:

- Infrastructure – deploying a core ICT network infrastructure, achieving relative ubiquity of access, and investing in strategically focused capacity to support high development priorities.
- Human Capacity – building a critical mass of knowledge workers, increasing technical skills among users and strengthening local capabilities.
- Policy – supporting a transparent and inclusive policy process, promoting fair and open competition, and strengthening institutional capacity to implement and enforce policies.
- Enterprise – improving access to financial capital, facilitating access to global and local markets, enforcing appropriate tax and property rights regimes, enabling efficient business processes and stimulating domestic demands for ICT.
- Content and Applications – providing demand-driven information which is relevant to the needs and conditions experienced by local people.

He re-iterated that the information and knowledge economy is the economy of the future. Priority areas have been designated for the ICT4AD Policy and include: Human Resource Development, Education, Government and Governance, Private Sector Development, ICT Products and Services Industry Development, Agriculture and Agro-Business Industry Development, Value-Added Services Sector Development, ICT Community buy-in, National Health, ICT Physical Infrastructure Development, and Research and Development.

ICT infrastructural development in Ghana is progressing comparable to other low-income countries globally and above the 1.1% average for Sub-Saharan Africa.

Internet Service Providers. The Internet Service Providers are: KNet, Broadband4u, Africa online, Internet Ghana, Network Computer Systems, Zipnet, Busy Internet, Accelon, Ecoband Networks Ltd, Mobile Phone Operators, Vodafon (Onetouch), Scancom Ltd (MTN), Millicom Ghana Ltd (tigo), **Telephone Operators.** The fixed and mobile phone companies are, Vodafon (Mobile and Fix Lines), Tigo (Mobile and Fixed lines), MTN (Mobile), Airtel (Mobile), Kasapa (Mobile) and Glo (mobile. Yet to launch).

ICT Training Institutions. India Ghana Kofi Annan ICT Training Institute, Ghana Multimedia Incubation Centre, Ghana Telecom University, IPMC, NIIT, **Business Process Outsourcing.** The only business outsourcing company in Ghana is Exzeed Rising.

ICT Infrastructure. Currently the existing ICT infrastructure/services in Ghana include:

- International connectivity via SAT-3 Submarine Optical Fibre Cable
- 800 km National Fibre Optic Backbone which is being extended to 4000km
- connecting 23 sites nationwide.
- 4 International Gateways via satellite
- 35 operational Internet Service Providers
- 130 installed VSAT nationwide
- 128 FM Broadcasting stations
- 12 Television stations (6 are free on air)
- 2 fixed line telecoms operators
- 5 cellular telecoms operators.
- Main One submarine fibre cable linking Ghana to Europe.
- Submarine fibre cable for Glo

ICT Application for Agriculture and Natural Resources Management.

ICT systems can be used to improve upon current agricultural practices so as to increase yields per acre. Modern technology can be employed to agro-processing projects to substantially improve upon agricultural value-added products. This can facilitate the development of a dynamic and vibrant export-oriented agro-business industry in the country. This will be achieved through deploying and exploiting ICTs to support the various activities of the agriculture sector, including the commercialisation of key sub-sectors and the improvement of current agricultural practices; developing geographical information system (GIS) applications to monitor and support sustainable usage of natural resources; developing food insecurity and

vulnerability information to document who, where and why people are being affected by this issue; creating ICT awareness for all types of farmers at all levels nationwide, including empowering farm extension workers with relevant ICT skills; establishing an agriculture information system to provide support for the planning, production, storage and distribution of natural resources; encouraging market research through the use of ICTs to improve farmers' decision making abilities to align supply with market demands and to access new and foreign markets; linking farmers and farmers' groups and associations through ICTs to resources and services needed to improve agricultural livelihoods; establishing linkages between agricultural education, research and development, farming, agro-industry and marketing; improving research competency and promoting the application and transfer of new technologies, such as biotechnology, to develop a modernised and globally competitive agriculture sector; promoting the creation of agricultural export production villages; improving rural infrastructure development and encouraging irrigation farming; and supporting the private sector to add value to traditional crops while strengthening the production of non-traditional export commodities.

ICT Support for E-Economy. To facilitate e-economy projects, ICT resources can be used to facilitate private sector development, public private partnership, value-added services sector development, ICT products and services industry, software development industry, competition, sustainable development, poverty reduction, local and foreign direct investment, fiscal policies, financial markets, technological innovation, and research and development.

ICT support for Education. ICT will be utilised to transform the educational system to provide the requisite education and training services environment capable of producing the appropriate types of skills and human resources required for developing and driving Ghana's information and knowledge-based economy and society. This will be accomplished by improving and expanding access to educational, training and research resources and facilities through the use of ICTs; making the educational system more responsive to the needs and requirements of the information and knowledge-based economy and society; developing and restructuring ICT curricula for all levels of educational systems; transforming Ghana into an ICT-literate nation driven by information and knowledge; promoting ICT awareness and computer literacy within the public at large; encouraging the exchange of ICT education and training between local and international educational institutions; introducing computers for all levels of educational institutions; promoting e-learning and training systems to complement traditional campus based systems; Developing the ICT skills capacity for the management and staff of the Ministry of Education and educational institutions at all levels; developing educational management, information systems, and technical and vocational education programmes to enhance the quality of management at all levels for

educational systems; and ensuring that higher education is accessible to a large section of the population through the provision of high quality and efficient programmes and courses online.

ICT services can be used to facilitate universal basic education, higher education, research, infrastructure, illiteracy, financial and technical resources, learning materials, science and technology education, electronic distance education, information networks, local/international collaboration, technical and vocational education, accreditation and examination bodies, human resource development, educational management and information systems, and gender equality.

ICT Application for Health Delivery Systems. ICT can be utilised to support the activities and operations of the health delivery system throughout the country. In order to do this, all healthcare institutions will be networked to collate information, share data and communications online; the healthcare system will be restructured at primary, regional and tertiary levels by providing a national databank to support online national healthcare information, administration, and management; full internet connectivity and access for healthcare professionals at all levels will be established; ICT skills acquisition will be made mandatory for all healthcare professionals; Health Management Information Systems will be established for all levels of healthcare through the use of ICT; a proposed National Health Insurance driven health service will be enabled through the use of ICT; and ICT will be utilised to provide education and to combat major national health threats such as HIV/AIDS, malaria etc. The following can also be enhanced if ICT systems are employed; health administration, telemedicine, accessibility to medical facilities, electronic health networks, Health Management Information Systems, National Health Insurance, and human resource development.

ICT Infrastructure Development Policy. The National infrastructure Development policy deals with the following; ICT and physical infrastructure development, telecommunications and communications infrastructure, research and development, renewable energy sources, private sector, private investment, road network, international standards, legal and regulatory framework, cyber-laws, technological neutrality, universal service and access to information.

Challenges, Opportunities and Potentials for application of ICT in Ghana.

The major challenge facing the development of the full potential of ICT for education, research and development in the county is brain drain which has resulted in the lack of the critical mass of ICT-engineers and scientists relevant for undertaking ICT-related project professionally. Another major obstacle is the lack of an enabling environment and a sound ICT-roadmap and strategies by policy makers resulting in uncoordinated and unsustainable ICT-development activities. Other problems include:

- High running and subscription costs.
- Lack of good publicity and incentives to attract potential users.
- Identification of information sources that meet the needs of users.
- Poor Quality of Service of the internet and telecommunication services.
- Regulatory issues (exclusivity policies and ban on use of VOIP).
- Effective management of network traffic and infrastructure.

The solution strategy towards bridging the digital divide demands an aggressive human capacity building in ICT through training workshops, seminars and courses in collaboration with local and international institutions.

Table Showing Varieties of Application of ICT in Various Sectors of the Economy

<u>Application Services</u>	<u>Engineering Services</u>	<u>Business Process Services</u>
<u>Application development and maintenance</u> • Application development • Application development integration and testing • Application maintenance	<u>Manufacturing engineering</u> • Upstream product engineering – Concept design – Simulation – Design engineering • Downstream product engineering Computer-aided design, manufacture and engineering. • Embedded software – Localization • Plant and process engineering	<u>Horizontal processes</u> • Customer interaction and support (including call centers) • Human resource management • Finance and administration • Supply chain (procurement logistics management)
<u>System integration</u> • Analysis • Design • Development • Integration and testing • Package implementation		<u>Vertical processes</u> • Banking • Insurance • Travel • Manufacturing • Telecommunications • Pharmaceuticals • Other
<u>IT infrastructure services</u> • Help desks • Desktop support • Data center services • Mainframe support • Network operations	<u>Software product development</u> • Product development • System testing • Porting1/variants • Localization • Maintenance and support • Gaming	
<u>Consulting</u> • IT consulting • Network consulting		<u>Knowledge process outsourcing</u> • Business and financial research • Animation • Data analytics • Legal process and patent research • Other high-end processes

Conclusion

Ghana has a relatively diverse and rich natural resource base. Minerals, principally gold, diamonds, manganese ore, and bauxite; are produced and exported. The major discovery of oil and gas off the coast of Ghana in 2007 has led to significant expectation by the populace. According to industry experts, within 5 years, Ghana is likely to be the third-largest producer of oil in West Africa.

In the face of these realities, the development and growth of the manufacturing sector and ICT industry provides the best option for a developing country like Ghana to move away from the age old primary export-oriented economy. Ghana as a nation can formulate an industrial policy that seeks to shift its exports into high technology based manufacturing goods such as software and hardware development. Countries such as Brazil, India, Taiwan, Malaysia and Singapore employed Communications and Information Systems to achieve meteoric rise in their drive towards national socio-economic development and growth. Ghana can emulate their examples.

For accelerated development of the human resource base to support this project, it is proposed that the Government must offer scholarships for studies in these programmes as was experienced in the sixties and seventies. Also favourable environment should also be created for the financial institutions to support development and growth of the private sector to encourage them to invest in industrial development and growth in Ghana.

Industrial experts suggest that availability and cost of credit constitute the single largest constraint to private sector operations. Available evidence shows that financial institutions consider manufacturing and agricultural enterprises as very risky undertakings with high default traits.

The employment of ICT systems in Ghana would enable Ghanaians to significantly enrich their social, economic and cultural well-being through the rapid development and modernization of the economy and society. Information and Communication Technologies has been identified as the main engine for accelerated and sustainable economic and social development. This is in consonance with the main mission of the Ghana ICT4AD Vision is which is; “To transform Ghana into an information-rich, knowledge-based and technology-driven high-income economy and society. I am of the conviction that if ICT resources are extensively applied in the production at the new oil and gas well as pertains in other industrial countries, Ghana’s dream for accelerated industrial development and growth will become a reality.

Recommendations

In view of the foregoing the following recommendations are made:

- a. An all encompassing ICT Infrastructure development policy should be formulated in accordance with the ICT4AD policy framework.
- b. Efforts should be made by Government to create the enabling environment for investors to invest in the Community ICT Learning Centres.
- c. More training institutions in ICT subjects especially software development should be established in the country so as to address the should fall in the human resource base in this sector.
- d. Efforts should be made to include teaching of oil and gas related subjects in the curriculum of most of the tertiary institutions in the country.

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WOODEN MATERIALS IN BUILDING PROJECTS: FITNESS FOR ROOF CONSTRUCTION IN SOUTHWESTERN NIGERIA

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Abstract

A survey of building projects in south-western, Nigeria was conducted to assess wood usage in building roof projects in the zone and to determine the efficiency of wood utilization in building constructions prior to and during oil economy in south-western Nigeria. Based on various purposes of wood utilization in building projects, wood usage in building can be classified as structural, functional and decorative/aesthetics. Buildings in the rural area have the worst wood usage efficiency followed by roofs in the sub-urban area, while roofs in urban area are partially efficient. Based on roofing condition alone, approximately half of all the buildings surveyed ($n = 1720$) in the three zones are categorized as either substandard or deemed to have failed. Based on functional consideration, some of the urban and sub-urban housing roofs and only few of the rural areas attained the good-scoring grade.

This is attributed in part to many houses are owned by low income earners which means the houses are built to satisfy emotional needs while engineering factors such as strength of materials and structural purposes are ignored and to lack of strong government policy on housing standard in the country. More than half of the roofs surveyed have at least or more identified major defects. Recommendations include government directed policy on the minimum housing standard; possible built and lease programme for the low income earners; a vigorous programme of housing and health education; enhanced collaboration between stakeholders to develop enforceable standards for existing housing stock and future builds.

Key words: Housing roofs; wood usage; Nigeria; structural purpose; decorative/aesthetic purpose; functional purpose.

Introduction

Housing as one of the most important basic necessities of mankind is known to tremendously affect human health and well-being. Researchers have shown that housing can affect mental and physical health, both positively and negatively (Fanning, 1967; Macpherson, 1979; Riaz, 1987). Roof has been defined by various authors but Ezeji (2004) defined it as a framework on top of a building comprising of trusses on which a covering material is placed.

The World Health Organization (WHO) recognizes that the roof is one of the important requirements for a house to be considered well (WHO, 2005). This is

because while a house may be inhabited without some elements of buildings such as partition walls, beams or columns, a house without a roof is not conducive for human and even animal accommodation.

Most Nigerian cities, with the exception of the newly developed Federal capital city of Abuja, have experienced decay in housing especially in roof failures. Roof failures are manifested in forms (Mijinyawa et-al, 2007). Unlike developed nations, the mortgage industry is still in its infancy in Nigeria with the real estate sector contributing less than one percent to the nation's GDP (Punch Newspapers, 5th September 2007).

The quality of a residential area not only mirrors the city development, planning and allocation mechanisms between socio-economic groups, but also shows the quality of life of the urbanites. The realisation of a decent home in a suitable living environment requires the availability of clean air, potable water, adequate shelter and other basic services and facilities. The present study was aimed at investigating housing quality as well as the quality of the environment in which such houses are sited. This is pertinent in view of the increasing incidences of disease and epidemics in Ibadan confirmed by the studies of Sangodoyin and Coker (2005) and Aluko (2006).

The Study Area

This study was carried out in Southwestern Nigeria comprising Oyo, Ogun, Lagos, Ekiti, Ondo and Osun states. The region has a bi-modal wind pattern with peaks occurring in April and August associated with rainstorm causing damage to buildings with the roofs being mostly affected (Adenekan, 2000). The year and the annual range temperature between 3⁰C and 6⁰C with high rain intensity favour roof failures.



Study Methodology

The method of research was the structured questionnaire survey to evaluate the use and efficacy of building materials with particular reference to the roof structure before and after oil boom in Nigeria.

Based on ethical considerations, the traditional head of each place to be surveyed in

the three zones (rural, sub-urban and urban cities) were initially visited to seek their voluntary cooperation with the study team. The greatest co-operation was obtained in the sub-urban cities where many residents occupy the houses on a rented basis. The majority of the houses in the rural areas are owner occupied and some of those approached declined to participate. In this zone, houses are passed down from one generation to the next by inheritance and are largely owner-occupied. The least co-operation was given to the study in the urban centers. However, houses surveyed in the urban ($n = 360$), sub-urban ($n = 830$) and rural ($n = 530$) zones are considered to be representative of the general situation in the zones (Table 1.0).

Table 1.0 Location of houses

Location	No. of Buildings	Percentage of Availability
Rural area	530	30.81
Sub-urban Area	830	48.26
Urban centres	360	20.93
Total	1720	100.00

Similarly, the class of each surveyed house roof was determined using the environmental score as below: Good (0–19); Acceptable (20–39); Borderline (40–

59); Substandard (60–79); Unfit (80 or above) (APHA, 1950). Using a life span of building roof to be 40 years and roof rating to be acceptable from APHA, the suitability or otherwise of buildings both at pre and post oil boom were established using student's "t" method at 5% confidence level

Results and Discussion

Materials of Construction

During the survey, it was discovered that common roof truss materials in the zone are timber, concrete, steel and raffia palm. The choice of materials were influenced by the economy of the house owner, however, timber material is the leading material of construction both at the pre and post oil economy.

Table 6: Roof Truss Materials

Type	No. of Respondents	Percentage of Materials
Timber	1135	66
Concrete	189	10.98
Steel	69	4.01
Raffia Palm	327	19
Total	1720	100

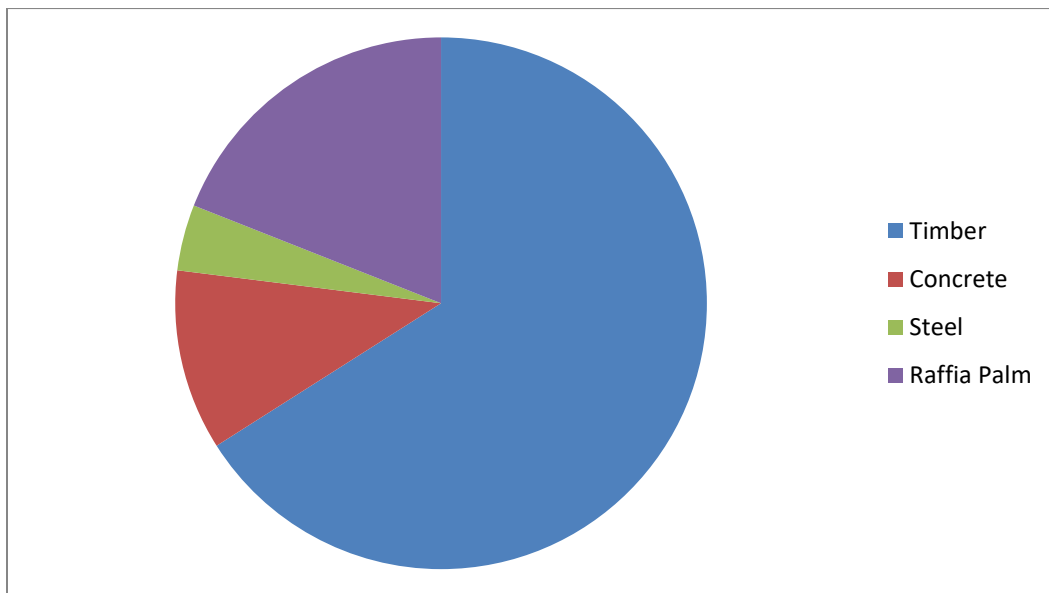


Fig. 2.0 Roof Truss Materials

Table 5: Purpose of Use of Various Wood Species in Building Projects

S/N	Local Name	Botanical Name	Purpose of Use		
			Decorative	Functional	Structural
1	Afara	<u>Terminalia ivorensis</u>	”	”	”
2	Apado	<u>Conluoa grandiflora</u>			”
3	Erun	<u>Erythroplum suaveolens</u>			”
4	Agbonyin	<u>Piptadeniastrum africanum</u>	”		”
5	Akokokoigbo	<u>Lovoa trichiloides</u>		”	”
6	Teak	<u>Tectona grandis</u>		”	”
7	Omo	<u>Cordial millenii</u>	”	”	”
8	Mahogany	<u>Khaya ivorensis</u>		”	”
9	Agba	<u>Gossweilero tendron balsamiferum</u>			”
10	Arere	<u>Triplochiton acleroxylon</u>			”
11	Apa	<u>Afzelia Africana</u>			”
12	Oro	<u>Nassogoidonia papaverifera</u>			”
13	Araba	<u>Ceiba pentandra</u>			”
14	Ayo	<u>Holoptalea grandis</u>			”
15	Ayin	<u>Anogeissus leicarpus</u>			”
16	Opepe	<u>Nauclea diderrichii</u>		”	”
17	Iroko	<u>Melicea excels</u>		”	”

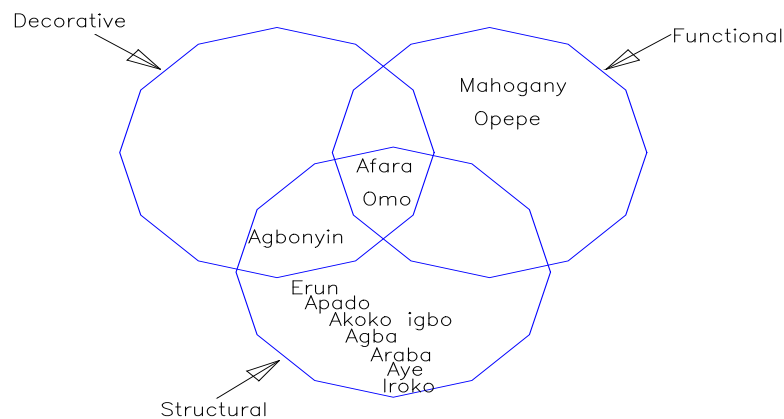


Figure 3: Purpose of use of Various Wood Species in Building Projects

Table 7: Frequency of use of various Wood Species in Building Projects

S/N	Local Name	Botanical Name	Frequency
1	Afara	<u>Terminalia ivorensis</u>	86
2	Apado	<u>Conluoa grandiflora</u>	25
3	Erun	<u>Erythroplum suaveolens</u>	25
4	Agbonyin	<u>Piptadeniastrum africanum</u>	30
5	Akokokoigbo	<u>Lovoa trichiloides</u>	30
6	Teak	<u>Tectona grandis</u>	50
7	Omo	<u>Cordial millenii</u>	90
8	Mahogany	<u>Khaya ivorensis</u>	25
9	Agba	<u>Gossweilero tendron</u> <u>balsamiferum</u>	20
10	Arere	<u>Triplochiton acleroxylon</u>	35
11	Apa	<u>Afzelia Africana</u>	38
12	Oro	<u>Nassogoidonia papaverifera</u>	35
13	Araba	<u>Ceiba pentandra</u>	16
14	Ayo	<u>Holoptalea grandis</u>	24
15	Ayin	<u>Anogeissus leicarpus</u>	40
16	Opepe	<u>Nauclea diderrichii</u>	15
17	Iroko	<u>Melicea excels</u>	15

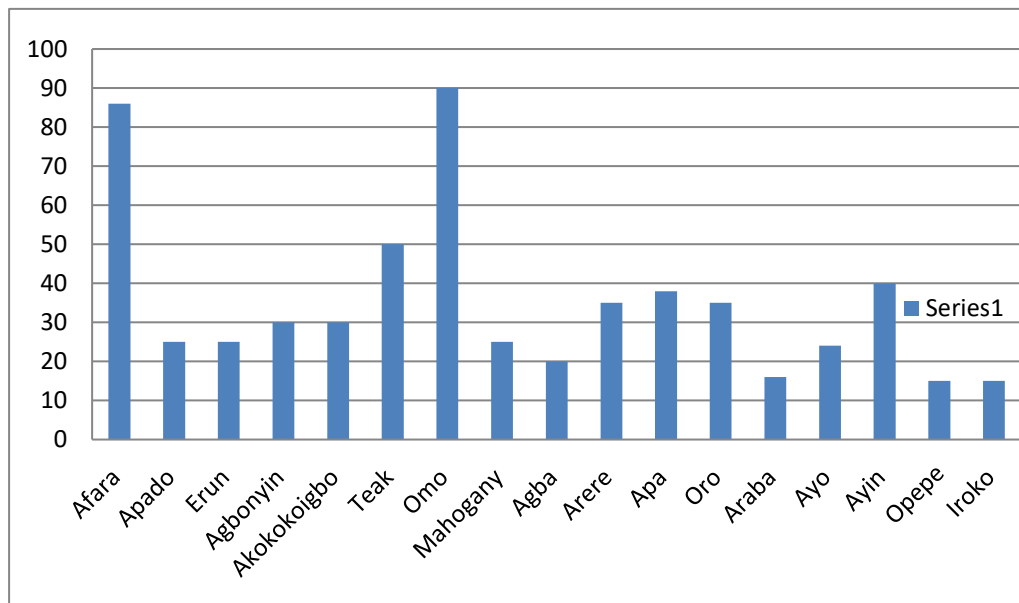


Fig. 3.0: Frequency of wood use in building projects

Discussions

Omo (*Cordia millenii*) and Afara (*Terminalia ivorensis*) appears to be the most favored wood species used in buildings projects . From table 6, about 90 of the building projects in the zone involved the utilization of Omo: while 86 uses Afara. Iroko (*Melicea exelsa*) Opepe (*Nauclea diderrichii*), Ayo (*Holoptalia grandis*) Agba (*Gossweilerodendron balsamiferum*) Erun (*Erythrophum suavecolens*), Apado (*Conluea gradiflora*) are the least used wood species.

Omo and Afara are mostly favoured in recent building projects because of their various uses as can be found in Table 5. They can be used for structural, functional and decorative purposes. Teak (*Tectona grandis*), Arere (*Triplochiton scleroxylon*), Apa (*Afzelia Africana*), Oro (*Nasogoidonia papaverifera*) are in fair demand because than can be used for both structural, functional and decorative purposes.

The demand of the following wood species:- Iroko, Opepe, Agba, Erun and Apado are in low demand as found in Table 5 because of their limited use. They are found only suitable for structural purposes. Therefore their use in building projects is restricted. This accounts for their low demand.

Another reason for the above results could be given as the availability of Omo and Afara in Southwestern Nigeria market. These species are in good quality in Ibadan but species such as Iroko, Ayo, Erun etc. are not available in good in quantities to meet their demands despite their good mechanical properties.

Omo and Afara are mostly used because of their mechanical properties. Afara is a very important species, yellowish-brown in color, rather coarsely textured with somewhat variable grain. Afara seasons well, stable when dry and have good strength properties. It works well (including turning) and stains and polishes excellently.

According to Brough (1964) Omo is fragrantly scented, durable and strong; it takes kindly to glue and stain but is rather soft and ope for polish. The colour varies from a pale yellow to a deep pinkish red, and under the tool, it gives a surface which in smoothness, has no equal. As an outdoor constructional timber, it would be most valuable on account of its durability and resilience properties.

On the other hand Iorko is a fine wood, loosely called “African teak” but of quite a different family. It is of excellent working qualities. It is strong moderately hard very durable timber of fairly open grain pale to dark brown in colour and of good appearance. Although somewhat cross-grained it planes well and will take a good polish when filled. Iroko is well adapted for work that requires a strong durable wood of good appearance for indoor and outdoor purposes. This good quality wood species is not in common use in recent building project in the university of Ibadan probably because of inadequacy to produce enough quantity to meet their demand. Most of these good quality wood species are not in use in recent building projects because they have been exhausted from the forest.

Opepe is uniformly yellow or yellowish-brown in colour normally interlocked grained, though a few straight grained planks are obtainable, with a rather attractive ribbon stripe figure when quarter sawn. Works well but has tendency to pick in paining and to split in nailing. It is not an easy timber to be treated with preservatives and may be slightly damaged by borer beetles. Opepe as a coarsed textured wood and has some tendency to split or check during seasoning.

Agba is a yellowish-pink to reddish-brown in colour, with a straight grain and a fine, even texture. Though it works easily, but it is sometimes rather gummy and may damage by borer beetles. It also seasons well.

Oro is lustrous red-brown with fine texture but slightly greasy feel, strong, durable and apart from a tendency to pick up when quarter-sawn, it works well: turns satisfactorily and polishes well. Its limitation is the tendency to warp slightly in seasoning but it is stable when dry.

Agbonyin sapwood light in colour and easily distinguished from the light golden-brown heartwood, which has some resemblance to Iroko. It is not an easy timber to work, tends to split in nailing. Though it stains and polished well, fairly resistant to

decay and may be attacked by borer beetles. It seasons slowly but stable when dry and moderately strong though rather brittle.

Arere is a timber light in weight and colour some what open pored. The wood is soft and its natural colour pale straw. Some of the logs are figured and rock, and are very difficult to manipulate with the plane owing to the overlapping and alternate grain. Teak is characterized by its open grain and little coarse texture and has a surface which is noticeably greasy to the touch. The rays are not visibly, but pores are easily distinguished. It is fairly hard to work. Shrinkage in slight and it does not warp or twist. It has, further, very high fore-resisting qualities and is immune from the attack of the white ant. Its resistance to crushing and transverse strain has rendered it practically indispensable for railway carriage construction. The timber stands up well to alternate wet and due conditions, hence its popularity for ships' decking. As a constructive timber its only rival is British oak. This wood species is in little use in recent building in the zone due to inadequate quantities to meet their demand.

Table 8: Ratings of Pre Oil Boom Building Roofs in Rural Areas

Ages (years)	Ratings of Buildings	Average Rating
0 – 9	28,20,23,25,24,26,22,23	23.88
10 – 19	41,42,40,39,40,41,39,39	40.13
20 – 29	42,45,43,43,42,44,44,42	43.13
30 – 39	46,48,47,47,46,45,45,46	46.25
40 +	51,53,55,52,51,52,52,52	52.25

Table 9: Ratings of Post Oil Boom Building Roofs in Rural Areas

Ages (years)	Ratings of Buildings	Average Rating
0 – 9	21,20,22,22,22,24,22,22	19.13
10 – 19	31,30,31,31,29,29,30,29	30.00
20 – 29	31,31,32,31,33,33,33,32	32.00
30 – 39	35,34,35,36,34,34,34,36	34.75
40 +	38,38,36,38,38,38,38,38	37.75

Table 10: Ratings of Post Oil Boom Building Roofs in Sub-Urban Areas

Ages (years)	Ratings of Buildings	Average Rating
0 – 9	19,17,17,17,18,18,19,19	18.00
10 – 19	25,26,28,29,25,22,28,29	26.50
20 – 29	28,27,28,27,26,28,27,29	27.50
30 – 39	28,29,28,29,29,30,28,31	29.00
40 +	31,34,32,31,35,33,34,33	32.88

Table 11: Ratings of Pre Oil Boom Building Roofs in Sub -Urban Areas

Ages (years)	Ratings of Buildings	Average Rating
0 – 9	21,19,20,21,20,18,20,21	20.00
10 – 19	28,30,30,31,28,30,29,28	29.25
20 – 29	34,34,34,34,32,35,33,34	33.75
30 – 39	38,37,37,39,38,38,35,37	37.38
40 +	40,39,40,38,38,39,38,38	38.75

Table 12: Ratings of pre oil boom building roofs in urban Areas

Ages (years)	Ratings of Buildings	Average Rating
0 – 9	33,33,35,34,33,33,36,35	34.00
10 – 19	31,34,34,33,33,36,36,34	33.88
20 – 29	40,38,39,43,43,38,40,39	40.00
30 – 39	44,40,42,44,44,43,46,48	43.88
40 +	47,47,46,46,47,43,45,46	46.25

Table 13: Ratings of post oil boom building roofs in urban Areas

Ages (years)	Ratings of Buildings	Average Rating
0 – 9	20,20,21,20,20,20,20,21	20.25
10 – 19	29,28,29,30,28,29,28,28	28.63
20 – 29	31,32,32,31,30,32,31,32	31.38
30 – 39	34,33,33,36,32,32,34,34	34.75
40 +	35,35,35,34,36,35,35,37	35.13

t values for tables 7, 8, 9,10, 11, 12 are 4.75, 1.38, -0.51, 9.39, 2.51, 0.051 respectively indicating that there are no significant difference in the use of wood and other truss materials in all the state economy.

Conclusions and Recommendations

Conclusions

Based on the survey carried, the following conclusions are made

1. Wood species are widely used for both structural, functional and decorative purposes in building

2. The species of wood in common use in building projects in Southwestern Nigeria are Omo and Afara probably due to their local availability in market and the mechanical properties of Omo.
3. There are still some numerous designated building components parts that wood could be used other than roof and frame construction.
4. Wood supply is dwindling down with a high cost of procurement. There is therefore the urgent need to utilize other timber species particularly lesser used one that are not yet in use for construction.
5. Although due to buoyant economy during the oil boom, taste and elegance dictate the use of other materials in roofing construction rather than functional or structural requirement,
However, it is concluded that there is no statistical difference between the use of wood at pre oil boom in roofing conditions and other building materials at post oil boom
6. Wood is efficient in use, reliable in service and good for all state economy.
7. To avert the problem of shortage of dwelling units and its attendant menace in urban cities, wood structures are canvassed for because of its low cost compared to other building materials.

Recommendation

1. It is opined that, further studies should be conducted into the modes of jointing of structural members and more research works could be employed into the connector of structural members.
2. The national housing requirement between 500,000 and 600,000 units considering the prevailing occupancy ratio of between three and four persons per room should be strictly adhered to.
3. Built and lease programme can be encouraged in view of the escalating cost of building construction.
4. There could also be research into the engineering properties of lesser used timbers.

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THE ISSUE OF COMPLIANCE TO THE PROVISIONS OF THE HEALTH AND SAFETY AT WORK ACT ACT (1974)

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Abstract

Predominantly in Ghana and Africa in general, statistical trends point to the fact that most employers, especially those in the manufacturing sector, only give much prominence to how much cost-effectively they can buy raw materials and other inputs for the manufacture of their finished products and how much profit would be derived after the finished products have finally been converted to cash. What ever condition the employee has to go through to ensure productivity as well as the state in which the final product itself goes through before they are eventually distributed to the final consumer, is not really much of a concern. The Health and Safety of the employee and even visitors, as well as the safety of stock provide the basis for the conduct of this all-important research.

In the researchers' bid to achieve the stated objectives, the use of tailor-made qualitative and quantitative methods in the analyses of issues, vis-a-vis popular data collection strategies were deployed. Notable among the findings unearthed by the research include the fact that most organisations have not put in place adequate systems to guarantee the safety of their employees, customers and other related safety issues.

Key Words: Emergency Response Plan, Means of Employee Involvement, Management Review of Safety Performance, Management Systems, Organisational Standing Emergency Committee, Quality Management System, Safety Assurance, Safety Management Systems, Safety Promotion, Safety Policy and Objectives, Safety Management System Components, Safety Management System Implementation Plan, Safety Planning Objectives and Goals, Safety Review Board , Safety Risk Management, Safety Roles and Responsibilities

Introduction

Since most industrial set-ups, factories and storehouses are prone to emergency situations, most especially fire outbreaks and employee injuries, care is always taken to either prevent such occurrences, or as much as possible, effective mechanisms are put in place to handle such emergencies professionally should they occur.

Moreover, due to the fact that no organization would want to experience an occurrence or possibly a recurrence of disaster such as fire outbreak and employee injuries, they may want to put in place preventive measures to forestall such eventualities. Nevertheless, certain unforeseen or undetectable circumstances could lead to so many organizational emergencies, notable among which include fire outbreaks, explosions, occupational injuries and chemical poisoning, all of which have the tendency to bring about fatalities and dire consequences.

Background of the Study

Normally during fire emergencies, the tendency for fire to spread quickly is through the aid of certain factors such as oxygen, temperature/heat, carbon dioxide and fuel. There is also the risk factor when equipment and other hazardous industrial chemicals are not properly applied or kept. These, if not kept at bay can potentially have catastrophic effects on human and general organisational safety. It was based on most or all of these considerations that the Health and Safety at Work Act (HSWA) was enacted in 1974.

The Health and Safety at Work Act of 1974, is basically a directive on: Health and Safety Management, Workplace Equipment, Personal Protective Equipment (PPE), Display Screen Equipment, Workplace Health, Safety and Welfare, as well as Manual Handling.

Under the provisions of the HSWA, any organization that employs five persons or more, is required to prepare and maintain a written statement explaining the health and safety policy of the organization, as well as make provision for its implementation. It is also the individual's responsibility, after all the necessary provisions have been made, including the provision of fire fighting equipment and training of personnel in the use of those equipment, to be aware that safety is everyone's responsibility and that one would be held personally liable for the result of failures in safety procedures.

The coming into being of the Control of Substances Hazardous to Health (COSHH) regulations, have also placed a lot of emphasis on the protection of employees from hazardous substances at work.

COSHH covers most workplaces, including; Manufacturers, Construction Sites, Farms and Laboratories, Utility and Service Industries. Under COSHH, it is the collective duty of both employer and employee to ensure that people, including visitors, are not unduly exposed to the harmful effects of such hazardous substances.

Research Objectives

The main ideals behind the enactment of the Health and Safety at Work Act (1974), was to ensure that everyone would be basically responsible for their own safety. In Europe and elsewhere, the enactment of the HSWA was received with enthusiasm by both employers and employees alike. After so many years of its enactment, this research sets out to look at the following objectives:

- To investigate the levels of compliance to the HSWA by public and privately owned institutions alike.
- To look into areas where additional education is required to improve upon compliance to the Health and Safety regulations, so as to conform to acceptable international standards.
- To ascertain whether the implementation of the HSWA has dawned on organisations to make provision for adequate professional manpower to manage vital health and safety situations in terms of their role in educating or synthesizing both employers and employees on their prime safety responsibilities, as well as managing the aftermath of critical emergency situations.
- To find out whether the HSWA is helping to achieve maximum productivity and/or improvements in the quality of an organisation's operational standards, through the enjoyment of health and safety security.
- To look into the causes of fire outbreaks and occupational injuries

Statement of the Problem

Many organisations, public and non-public institutions alike, downplay the detrimental effects of not following due process in health and safety practices. It is also common knowledge that publicity on organisational health and safety has been taken lightly and therefore has rather been low. This has somehow made it possible for some employers to take advantage of employees' ignorance to exploit the system to their advantage, in terms of the payment of compensations, etc, when accidents occur.

The issue here however might not be that of ignorance alone, but rather there is no motivation enough for people to understand the rippling effects of not following health and safety procedures. Moreover, the general thinking is that it is only the white man who ought to be safety-conscious because he invests heavily in those things.

Research Questions

- Have you ever thought of the fact that you could be taken unawares in your day-to-day routine activities at work due to ignorance or non-conformance to the adherence of basic safety regulations?

- After thirty-five years of the introduction of the Health and Safety at Work Act (HSWA-1974), can we say that there has been adequate public education and appreciation on the importance of the law?
- Has the introduction of the Health and Safety at Work Act removed the inconsistencies that characterized unapproved or unwarranted occupational health and safety practices previously, thereby improving the security of personnel and property?

Scope and Limitations of the Study

The scope of this research did cut across some safety prone publicly and privately owned institutions such as mining sites, manufacturing plants, construction sites, educational institutions and other service-rendering institutions in the Greater Accra, Eastern, Western, Central and Northern regions of Ghana.

Obviously, due to the sensitive nature of the subject, the researchers encountered the following problems:

- The scope of the research required a higher level of financial commitment and other logistical support. However, the sponsorship commitment was not fully met before the completion of the project.
- The researchers required lots of cooperation and ingenuity from respondents. Fortunately or unfortunately, even though there was a 100% success with respect to retrieval of questionnaires and interviews, assessing very vital information did not come easy.
- The possibility of questionnaires left unattended to, was inevitable and so frequent follow-ups had to be made to enable the team record the 100% questionnaire retrieval rate. This was worrisome because the team had to travel long distances to seek such information which was time-consuming and financially draining.

Nonetheless, because the subject matter has the tendency to negatively affect the success of an organisation and any of its personalities, irrespective of one's status in society, the researchers are of the fullest conviction that the much needed support and importance were attached to this exercise by the various respondents.

Literature Review

Introduction

In all approaches to working life, it must be taken into account that health and safety, as well as the quality of working life are not mutually exclusive. (Nigel Slack et al, 1998), argue that the design of any job should take into account its effects on job security, intrinsic interest, variety, opportunities for development, stress level and attitude of the person performing the job.

The main issue under consideration is that; are employers prepared to provide total job security for their employees and are the employees in their operations ready to take certain security responsibilities as a way of meeting their employers half-way? Depending on how this question is answered then the other elements such as intrinsic interest, variety, opportunities for development, stress level and attitude would be managed to enhance a balanced working life.

Meanwhile, it would be realised in due course that the extensive use of Aviation Safety literature in this chapter is significantly justifiable. This is largely due to the fact that the Aviation Industry has a comprehensive safety policy package that encompasses all safety areas in any safety-critical undertaking and which are constantly being reviewed to suit emerging international safety trends.

General Overview of Management Systems (Ms)

The management system of every organisation should uniquely comprise of the Quality Management System and the Safety Management System (**SMS**). The Quality Management System and the Safety Management System should correspond to the size, nature and complexity of the organisation, taking into account all the hazards and risks associated with its activities. In other words, Quality Management and Safety Management in every organisation should not be mutually exclusive, in that one must compliment the other in order to ensure total organisational management.

Quality and Safety Management Systems

The basic function of the Quality Management System is to monitor compliance with, and the adequacy of procedures required to ensure safe operational practices within an organisation.

The Safety Management System on the other hand is an organised approach to managing safety, including the necessary organisational structures, accountabilities, policies and procedures. However, the complexity of the Safety Management System should conform to organisational requirements for managing safety and this call for sound and workable policies to be drawn and implemented.

At the core of the Safety Management System is a formal Risk Management process that identifies hazards and assesses and mitigates risks. However, it is significant to recognise that Safety Management Systems are top-down driven systems, which means that the Accountable Manager, usually the Safety Manager of the organisation, is responsible for the implementation and continuing compliance of the Safety Management System. Inevitably, the failure or success of the Safety Management System will be dependent on the support levels that are offered to the Safety Manager.

It is quite remarkable to note that the Quality Management System and the Safety Management have complimentary but independent functions with the Quality Management System monitoring or playing supervisory role over the Safety Management System.

Safety Management System Implementation Plan (SMSIP)

In introducing a Safety Management System into an organisation, management should as a matter of urgency take the first step in developing an implementation plan. This will be a realistic strategy for the implementation of a Safety Management System that meets the needs of the organisation and defines the approach taken to manage safety.

Ideally, the contents of a Safety Management System implementation plan should include; Safety Policy (**SP**), Safety Planning Objectives and Goals (**SPOG**), System Description (**SD**), Gap Analysis (**GA**), Safety Management System Components (**SMSC**), Safety Roles and Responsibilities (**SRR**), Safety Reporting Policy (**SRP**), Means of Employee Involvement (**MEI**), Safety Communication (**SC**), Safety Performance Measurement (**SPM**), Management Review of Safety Performance (**MRSP**) and Safety Training (**ST**).

However, for smaller organisations, a simplified Safety Management System implementation plan may be developed to include;

- The organisation's approach to managing safety in a manner that meets its safety needs
- Coordination with the Safety Management System of other organisations with which it interfaces during the provision of services
- Endorsement by Senior Management and communication throughout the organisation.

The components of a Safety Management System should comprise of the following four;

Safety Policy and Objectives (**SPO**), Safety Risk Management (**SRM**), Safety Assurance (**SA**) and Safety Promotion (**SP**)

Safety Policy and Objectives

On the wider level, the safety policy outlines the methods and processes that an organisation will use to achieve desired safety outcomes. The creation of a positive safety culture begins with a clear, unequivocal direction from the Safety Manager.

In preparing a safety policy, Senior Management should consort with key staff members in charge of safety-critical areas. Constant consultation will ensure that the safety policy and stated objectives are of relevance to all staff and that there is a sense of shared responsibility for the safety culture in the organisation. A positive

safety culture is one where all staff must be responsible for, and consider the impact of, safety on everything they do.

According to the international standards of aviation practice, the safety policy and objectives of an industry could be segregated into the following five critical areas;

- Management Commitment and Responsibility; where it is expected that management would take corporate responsibility of health and safety issues through the exhibition of high level documented and visible or quantifiable commitment.
- Safety Accountabilities of Managers; where it is expected that there would be constant feedbacks or reports from such officials to give management a fair idea of how much its policy on safety is working.
- Appointment of Key Safety Personnel; where there should be an appointed authority or a team of safety authorities in place to execute safety policies on behalf of management. If possible, management could set up an Organisational Standing Safety Committee (OSSC) to review the activities of the Safety Department headed by the Safety Manager.
- The Emergency Response Plan; where contingency measures are put in place ahead of any unexpected or likely safety occurrences, in order to bring injuries and/fatalities to the barest minimum.
- Documentation; where there is the need to keep track or record of every health and safety related issue, since this would form the basis of researching into the service delivery levels of organisational health and safety.

Safety Risk Management

The basic function of Safety Risk Management is an organisation's ability to identify and minimise the hazard potential of every function within the organisation. Effective process safety and risk management therefore starts with the understanding of the hazards that are present in an organisation's functional areas.

Process Hazard Analysis (PHA) is therefore very significant in Safety Risk Management (SRM) to appreciate the hazard prone areas of each individual function within an organisation and this becomes a reality when the safety management unit has a deep understanding of the organisation's safety culture or the risks of their operations.

Safety Assurance

By seeking for employees to adhere to corporate policy as far as health and safety is concerned, it must also be appreciated that corporate safety obligations are derived in absolute terms from general health and safety regulations such as that of the Health and Safety at Work Act (1974).

Safety Assurance is therefore seen as an intervention to ensure that the various stages of health and safety rule implementation adheres to the general standards of international practice which should supersede that of the organisational safety culture which however may be used to benchmark that of the international best practice. When the two situations are not regarded as being mutually exclusive, then the Safety Assurance operation would enhance guaranteed minimum safety deficiencies.

Safety Promotion

Most employers and employees alike, subscribe to the fact that punitive measures are necessary in establishing a limited hazard situation in an organisation. Nonetheless, if managements of organisations acknowledge safety as a condition in which the risk of harm or damage is limited to an acceptable level and, that a hazardous situation or condition has the potential to cause adverse consequences, one of the prime corporate responsibilities of management is to direct funds and resources towards promoting employee health and safety, getting feedbacks and creating opportunity for its sustenance and subsequent improvement.

Methodology

The basic step in enhancing the attainment of quality of an operation is data collection. Data can help uncover operations requiring improvement and the extent of remedial action needed. The researchers applied modern research tools and methods in an attempt look through the problem and offer practical solutions to address the problems identified.

The population for the study did cut across some safety prone publicly and privately owned institutions such as mining sites, manufacturing plants, construction sites, educational institutions and other service-rendering institutions in the Greater Accra, Eastern, Western, Central and Northern regions of Ghana. A simple random of twenty (20) of these establishments were selected to constitute the sample for the study. In each region, four (4) of such institutions were sampled for the survey.

Questionnaires and structured interview guides were the main research instruments employed for data collection. The data collected were then analyzed using SPSS, with the assistance of two (2) data entry clerks. Appropriate statistical tests were performed to answer the various research questions.

Data Presentation and Analysis

Total number of dispatched questionnaire:	20
Total number of returned questionnaire:	20
Total number interviewed:	10

Type of Industry:

Organization	Frequency	Percentage
Construction	4	20
Education	4	20
Manufacturing	4	20
Mining	4	20
Service	4	20
Total	20	100

(Source: Field Survey – 2010)

Q1.1: Availability of Emergency Response Plans in the Organization:

Response	Frequency	Percentage
Yes	16	80
No	04	20
Total	20	100

(Source: Field Survey – 2010)

Q1.3: Specific Department In-Charge of Safety Issues in the Organization

Response	Frequency	Percentage
Yes	16	80
No	04	20
Total	20	100

(Source: Field Survey – 2010)

Q1.4: Officer Responsible for Safety in the Organization

Officer Responsible for Safety	Frequency	Percentage
Safety Manager / Supervisor / Safety coordinator	12	60
Others	04	20
None	04	20
Total	20	100

(Source: Field Survey – 2010)

Q1.7A: Availability of Environmental Safety Measures in the Organization

Response	Frequency	Percentage
Availability of environmental safety measures in the organization	14	70
Unavailable	06	30
Total	20	100

(Source: Field Survey – 2010)

Q1.9: Availability of Safety Policy in the Organization

Response	Frequency	Percentage
Yes	13	65
No	05	25
Not Sure	02	10
Total	20	100

(Source: Field Survey – 2010)

Q2.0A: Mode of Communication of Safety Policies to Workers

(Organizations use combination of options given, including):

Mode of Communication	Frequency	Percentage
Seminars / Workshop	05	25
Notice Board	08	40
Safety Manuals / Leaflets	03	15
Others	04	20
Total	20	100

(Source: Field Survey – 2010)

Q2.1A: Mode of Reporting / Announcing Emergency Situations in the Organization

(Organizations use combination of options given, including):

Mode of Reporting / Announcing Emergency Situations	Frequency	Percentage
Sounding of alarm bells / siren	08	40
Verbal / voice alarm by workers	02	10
Others	10	50
Total	20	100

(Source: Field Survey – 2010)

Q2.4A: Actions against Workers who do not adhere to Safety Regulation in the Organization:

(Respondents gave combination of options, including):

Possible Action for Breach of Safety Regulation	Frequency	Percentage
Caution	10	50
Suspension	03	15
Dismissal	03	15
Others	04	20
Total	20	100

(Source: Field Survey – 2010)

Q2.5: Awareness of Work-Place Temperatures in the Organization:

Response	Frequency	Percentage
Yes	14	70
No	04	20
Unaware	02	10
Total	20	100

(Source: Field Survey – 2010)

Q2.7A: Precautionary Measures for the Storage of Hazardous and Inflammable Materials:

(Respondents gave combination of options, including others)

Responses	Frequency	Percentage
Availability of Precautionary Measures	12	60
Not Applicable	08	40
Total	20	100

(Source: Field Survey)

Q2.9: Satisfaction Level Regarding Safety Management in the Organization:

Response	Frequency	Percentage
Yes	14	70
06		30
Not Sure	0	0
Total	20	100

(Source: Field Survey – 2010)

Summary of Findings, Conclusions & Recommendations

Summary of Findings

- There is the issue of incompetence on the part of safety personnel or the lack of institutionalised safety management roles in most of the various organisations. Indeed, it is quite worrisome to note whether the role of the Ghana National Fire Service does not include a mandate to effectively oversee to the establishment of structures that would help improve organisational safety, as well as assist in the training of personnel on the proper application of safety equipment should the inevitable happen.
- For most organisations, high levels of productivity are recorded within short-to-medium terms, however, this revelation is characterised by higher levels of employee turnover and absenteeism due to recurrent health problems.

- Ignorance, whether deliberate or inadvertent, is having adverse effect on a significantly large number of employees most of whom surprisingly are aware of the general implications of not adhering to sound health and safety practises. In other words, for fear of victimisation by employers and possibly loss of jobs, employees deliberately ignore their right to ensuring that their health and safety is guaranteed. For instance, a mine worker whose working temperature was determined to be well above 30 degrees centigrade humorously retorted that he would prefer to go impotent than to protest and loose his job because of high temperature and the in. His reasons were that much as he is the sole bread winner for his family, he enjoyed really enjoyed the job that he has been doing for close to a decade.

Conclusion

Empirical evidence points to the fact that even though people are generally aware of the implications of compromising their safety, the implementation of the compliance standards of practice as far as the Health and Safety at Work Act is concerned, leaves much to be desired.

It is therefore the belief of the research team that if the recommendations that have been suggested based on the findings are upheld and pursued with zeal, the country at large stands to benefit from building a more robust economy since a healthy nation promotes prosperity and stability.

Recommendations

- It is the strongest conviction of the research team that one of the curative measures of enhancing the strict adherence to health and safety regulations in our organisations and country as a whole is to mandate and equip the Ghana National Fire Service, through a legislative instrument, to embark on institutional checks and certification regarding safety management. By so doing, the compromise of safety would be effectively controlled while at the same time ensuring that the work scope of the Ghana National Fire Service is widened to enhance its efficiency.
- While instilling discipline in our health and safety system, it would afford the country an opportunity, beyond the mandate of the Ghana National Fire Service, to widen the revenue mobilisation base when defaulting individuals and organisations are prosecuted and made to pay various degrees of fines to an appropriate State Agency.
- Safety Management should be introduced as full time courses in our tertiary and professional institutions, much as the individual is sensitised on health and safety management, right from the Primary, Junior High, Senior High and Vocational School levels by inculcating safety management practices into their various curricula.

- Apart from having Safety Managers in place as full time positions to see to the total management of safety issues in various organisations, the research team is of the strongest conviction that periodic safety management workshops and seminars could be held for both employers and employees on how to respond during emergency situations.
- As a follow-up to the previous recommendation, it would be ideal for organisations to make provision for Fire Assembly Points where staff of an organisation would be evacuated to and accounted for in the event of fire outbreaks and other critical emergencies.
- To curb the high spate of electrical hazards, most of which have ended up destroying lives and properties, organisations that are safety critical should encourage rewiring of electrical cables as their buildings get older, much as they are also encouraged to get dilapidated buildings in shape.
- It would also be ideal for organisations to create a Safety Review Board (SRB) which would be a high level standing committee that would meet often to consider strategic safety functions and, this Board could be chaired by the Head of Entity with a significant number of members taken from the Board of Directors and Senior Management. The Board would also ensure that appropriate resources are allocated to achieve the established safety performance and give strategic direction to the safety policy implementers.
- Proactively, organisations should draw an Emergency Response Plan (ERP) where contingency measures would be put in place ahead of any unexpected or likely safety occurrences, in order to bring injuries and/fatalities to the barest minimum.
- Successive governments should be actively involved in safety awareness campaigns through the distribution of safety manuals, handbills, electronic communication messages, etc.
- According to (EASA's Notice of Proposed Amendment [NPA] section 18, pg 6, Dec 2010), accidents and serious accidents are important high-level safety indicators (1st tier indicators). It is therefore significant for an industry to have a safety data that will provide a comprehensive record of safety issues and how they are managed. Having put this in place, it would be important, as a first step, to look into this data as it can give an indication of the potential benefits or rule change. A rule change could improve the fatigue risk mitigation and thereby reduce the number of accidents and serious accidents in the future by minimising contributing factors such as degraded performance and human errors.
- Beyond all the available steps taken to ensure total organisational safety, there is also the urgent need to practice what this research team terms as; Defensive Safety Mechanism, in that much as safety management will inevitably continue to be a daily issue, individuals should make it their avowed responsibility of ensuring their own personal safety, their working environment, as well as the

safety of others. Comprehensive organisational safety would then be guaranteed when the other stakeholders play their individual significant roles.

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BIOGAS AS A POTENTIAL SOURCE OF ENERGY IN RURAL AREAS OF GHANA

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Abstract

Ghana has recently struck oil in commercial quantities. A significant amount of natural gas is also expected as by-product which could be used for domestic and industrial purposes. However, a lot of Ghanaians, especially the majority of rural farmers, are not well positioned to benefit from this gas. Biogas can then be developed to take the place of natural gas in rural areas. Ghana has the potential for biogas production, and the benefits include strengthening the energy security, boosting agriculture through high value fertiliser, creating new businesses in the rural areas, lowering domestic- and agro-waste and reducing environmental pollution. This paper evaluates some projects on biogas production. Constraints such as lack of technical expertise, and high initial cost of construction are identified. The paper recommends the involvement of government, public and private sector initiatives to support the production and utilisation of biogas by agricultural and rural communities. Biogas digesters could be introduced on pilot bases in some schools and rural communities, using household units as starting points. Collaboration could be sought with organisations that share the visions of biogas dissemination projects. It is hoped that Ghanaians will take this opportunity to produce this clean energy and enhance energy sufficiency at the rural level and help to promote equity in the use of gas between the rural and urban dwellers.

Keywords: Biogas utilisation, sustainable energy, agricultural and rural communities

Introduction

Background

Ghana has now started producing and exporting oil in commercial quantities. A great deal of natural gas is also expected as by-product. Natural gas is of late being widely used in the cities of Ghana and the demand for it keeps increasing. However, the use of this gas is not so popular in the rural areas of Ghana. Like many developing countries, Ghana has a large rural population mainly engaged in traditional agricultural production. The immediate concerns of the rural dwellers are energy for cooking at home and also for crop drying activities.

The main source of fuel for domestic cooking is firewood, and the people in most cases have to walk long distances to cut and cart the firewood. The use of firewood tends to pollute the environment and brings with it health hazards like breathing and lungs diseases from constant inhalation of smoke. The indoor air pollution has been linked to such illnesses as acute lower respiratory infection (currently the leading cause of death among children less than 5 years), chronic obstructive disease, lower birth weights, and others (Domanski et al., 2005). It is estimated that 1.6 million deaths a year worldwide and 1.4 billion illnesses can be attributed to the household burning of such solid fuels (WHO, 2004).

Some 2 billion people are without electricity. With the total population of developing countries expected to grow by more than 3 billion in less than four decades the problem of rural energy are likely to become more pressing than ever (World Bank Report, 2011). The use of appropriate, renewable energy technologies on a small scale to farmers should be given priority to reduce their over dependence on fuel wood.

Agriculture is a potential source of renewable energy supply, due to its capacity for production of biomass, which is the main source of energy in the rural areas. Effective use of biomass in the rural areas would help recognise agriculture as both the user and the source of this type of energy. The biomass is most effectively utilised through the extraction and use of the methane gas for energy supply. The most appropriate form in the rural areas is the biogas.

Biogas production through anaerobic digestion

The biogas digester system utilizes agricultural residues and human and animal wastes to provide an environmentally benign, high quality fuel in the form of gas to be used for household cooking and lighting. The biogas is created through an anaerobic bacteria decomposition of biomass. Biogas has a calorific value of 20 MJ/m³ and can be used for many domestic applications such as lighting, cooking, electricity generation, or fuel for modified internal combustion engines (Li et al, 1997). It has been shown that 1m³ of biogas could cook 3 meals for a family of 5 or 6, generate 1.25 kilowatt hours of electricity, or power a one horse power internal combustion motor for 2 hours (Rugby 2004). A biogas digester is essentially an underground and airtight pit that a user puts crops, animal manure, human faeces, and water into. Figure 1 shows a household biogas unit that uses cow dung mixed with water to produce the methane gas.



Figure 1 A household biogas unit that uses cow dung mixed with water and placed in a fermentation pit for the production of methane gas

Biogas digester technology is an appropriate resource for rural agricultural development, as the gas can be produced using indigenous technology and locally available resources. Biogas digester systems have been shown to considerably enhance energy efficiency and agricultural productivity, and thereby increase a rural household's income and living standards (White and College, 2005).

The residue of the raw material that is not converted is known as sludge (or slurry), which is a potent organic fertilizer that can significantly enhance a farm's productivity (compared to conventional application of animal and human wastes). This high-grade fertiliser has been shown to be both safer and more productive than the original manure (EWB 2004). One advantage of using biogas is the organic content of the waste is reduced, resulting in less pollution and health hazard. Also, the end products are inoffensive in odour, and rodents and flies are not attracted to the digested solids.

Among the limitations of using biogas are that the initial investment is for equipment is high, and daily feeding of the plant in the right concentration of organic matter is required. Regular supervision and maintenance are needed, and care must be taken to prevent escape of gas to the atmosphere and avoid explosion.

There is also a problem with final disposal of the digested material. There are also problems with storage and transport, and also with the removal of traces of hydrogen sulphide. Moreover there are some social prejudices against the use of biogas.

Municipal and agro waste, if treated properly, have a tremendous potential for energy generation (Ultanir, 1994). In addition to its energy potential, anaerobic digestion also is a unique treatment solution for animal agriculture as it can deliver positive benefits related to water pollution and air emissions (Zemin and Huisheng, 1994). Using manure resource for producing biogas will require the development of a variety of small digesters capable of using a wide range of feedstock.

Objective of Current Paper

The main objective of this paper is to show how anaerobic digestion, or biogas, can become one of the most appropriate energy sources to increase the living standards of the rural areas of Ghana. Considering that most of Ghana's residents live in rural agriculture oriented communities, understanding the conditions, policies, and implications of biogas adoption can help form insights into how these areas can successfully integrate biogas into their societies and economies.

Ghana, like most developing countries, is facing two crucial problems in the energy sector. The first is the widespread inefficient production and use of traditional energy sources, such as fuel wood and agricultural residues, which pose economic, environmental, and health threats. The second is the highly uneven distribution and use of modern energy sources, such as electricity, petroleum products, and liquefied or compressed natural gas, which pose important issues of economics, equity, and quality of life. To address these problems, this paper evaluates some successful programs and makes some useful recommendations for successful implementation of biogas projects in rural and agricultural communities.

Methodology

A number of biogas projects in different parts of the world were studied. The following aspects were studied:

- Motivation for the project (i.e. what prompted the project)
- The social and work culture of the people
- Project planning and execution
- Extension and dissemination activities
- The involvement of non-governmental organisations (NGOs), government agencies, policy makers, the communities, and research groups
- The running of the project
- The kind of successes attained

All these were considered in relation to how the biogas projects evolved and what contributed to their successes or otherwise.

Findings

The findings of the work are presented in the following case studies:

Case Study 1: Biogas Projects in Lijiang, China

The municipality of Lijiang, located in the southwest province of Yunnan, has been remarkably successful at minimizing barriers to biogas digester dissemination; and as a result, has a large population of rural farmers using the systems. Lijiang is a very diverse municipality with 22 ethnicities comprising roughly 690,000 people. Land use is predominantly rural, with roughly 235,000 rural households and 980,000 rural residents.

Though various biogas digester development and dissemination programmes have been in place in Lijiang since the 1980's; wide scale adoption in the municipality has only taken place since the late 90's. In order to address natural resource destruction and poverty in Lijiang, the Forest Bureau, The Nature Conservancy (TNC) and World Wildlife Fund (WWF) began a joint effort in 1999 to promote renewable energy adoption in the region with biogas at the heart of the programme. Households were selected within communities that had ideal conditions for quick dissemination of the biogas concept. These biogas digesters were often placed in villages that experience a lot of trade or are located in transportation routes, so that, the concept would spread quickly. These initial digesters were also heavily subsidized or provided free of cost.

In anticipation of a growing demand for biogas digesters, the organisations started a subsidization package to households wanting to integrate a biogas digester into their agricultural production. Further, labour was often free because members in the surrounding community often helped in the installation. In addition to financial incentives to promote biogas adoption, extension service that included training locals were also provided. The incentives resulted in biogas adoption targets being exceeded in all 6 of Lijiang's counties.

Sources: White and College, 2005.

Case study 2: Biogas Development in Ghana

The Appolonia biogas plant which was commissioned in 1987 was the first major biogas demonstration project in Ghana. The project was meant to solve both the energy and environmental problem of the mainly farming community and also demonstrate how renewable energy could be deployed to the benefit of the society. Consisting of 26 floating drum digesters, it was fed with a combination of cow dung from kraals nearby and also from a latrine constructed nearby which was supposed

to be used by the community. The gas from the digesters was channelled to a 12.5kW diesel generator installed on the site of the plant to produce electricity for use by the community. Part of the gas was also used for cooking in individual homes. The plant failed to perform as expected and at the moment has become a white elephant.

Multiplicities of factors have been attributed to the plants failure. According to some experts failure to involve the local people in the planning of the project led to the outright rejection of the project by the community. The absence of dung has also been cited as one of the problems which led to the dismal performance of the plant. Cattle farmers in the area do not practice zero grazing so the collection of the dung became a problem. The energy was virtually free for the community, and as a result, when the project was handed over to the community the people did not find it necessary to fund the project themselves. In effect, what was meant to be a trail blazer ended up killing interest in biogas because of improper planning. There was then no Government policy on domestic biogas plants.

Source: Brew-Hammond, *et al*, 2008

Case study 3: Biogas, The experience of Sri Lanka

Biogas has been pursued in Sri Lanka for about two decades, with the active participation of many governmental and non-governmental organisations at various periods of time. Many of the biogas projects were however implemented in isolation, with initiatives that proved unsustainable in the end. Practical Action South Asia, a non-governmental organisation (NGO) started its project on developing and popularising biogas technology in 1996 by carrying out a sample survey to find out the status of biogas technology in Sri Lanka and to learn lessons from the past experiences. A series of new activities then followed which were aimed at widespread popularisation of the technology. The organisation began investigations into how to reap the multiple benefits of the technology, which was until then seen by the rural population as a source of energy mainly for lighting. Main emphasis of the Practical Action South Asia biogas project was to develop and promote appropriate designs of biogas units to Diversify the energy supply systems, particularly to reduce the dependence on wood for cooking, Provide fertiliser for the agriculture-based economy, with 75% of the rural peasantry engaged in agriculture as their major occupation and

- Solve waste disposal problems

The project was set up to improve the existing low success rate of 28.5 to 33%, in spite of the nearly 5000 units in the country. The main features of the project are:

- Networking and institutional development and strengthening
- Promotion and extension
- Construction of demonstration projects

- Research and development
- Training
- Monitoring

These were geared towards inter-institutional collaboration of various institutions which were then working in isolation, sometimes with overlapping activities.

The project collaborated with NERD Central, a pioneer research organization who had received a silver medal in an international exhibition for environmentally friendly innovative processes (24E Salon International des inventions, Geneva 1996) for their innovations in the development of the Sri Lankan Dry Batch Biogas Unit. This dry batch unit was designed to handle the straw from a paddy cultivation whose cropping cycle coincided with the six-month digestion period of the unit, so that the fertilizer from the digested material could be used for the next crop. The project helped NERD Centre to commercialise this dry batch technology.

The project also worked together with the Department of Animal Production and Health which seeks to help their clientele (farmers) to obtain additional benefits by providing staff training to strengthen the technical capacity of the department to undertake the extension work on biogas technology within their existing service network. The training included project identification, implementation and trouble shooting.

Another area of collaboration was with the Universities in conducting biogas research and development, particularly focusing on the performance optimisation, cost reduction and assessing multiple end-uses. In addition, special training courses on renewable energy, including biogas, were conducted for the benefit of undergraduate students. Further, information dissemination and the implementation of pilot projects occurred in collaboration with the Non-Governmental Organisations (NGOs) operating at the grass-root level. The staff of these NGOs were trained on identifying opportunities for application of technology in their respective regions. Village level masons and end-use equipment manufacturers were given the necessary training on the construction of biogas plant, and plant owners were also trained on the operation and maintenance of biogas units.

Through the Practical Action South Asia biogas project, with its collaborative endeavours, over 60 new biogas schemes were introduced, and 75% of the energy requirement for cooking is currently supplied by various household biogas units. This has resulted in the reduction of time spent by women in the collection of firewood, cooking and cleaning utensils. Figure 2 shows a Sri Lankan woman happily using a biogas-powered stove to cook for herself and family. The women could save 2 to 2.5 hours per day when cooking with gas. Most of these women

(79%) are able to utilise these extra hours to earn up to 24% more of their monthly income.



Figure 2 A Sri Lanka woman using a stove powered by biogas to cook

The time for animal waste disposal has reduced, as the waste can now be diverted to nearby biogas units with minimum effort. The households who use biogas units have gained fairly social status in the villages. The health hazards have gone down as a result of a switch from kerosene lamps to biogas lamps. Practical Action is now working on setting standards for biogas systems in Sri Lanka. A study conducted by the project in collaboration with the Department of Agriculture Engineering, University of Ruhuna, to evaluate the bio fertilizer aspects of the biogas technology, has revealed that the by-products of the straw digesters have a very high bio fertilizer value. The study showed that, 10 tonnes of digested straw can replace the entire fertilizer demand of one hectare of paddy field. This has helped to reduce the fertilizer budget of the farmer significantly. Another observation is that the slurry, when diluted with water and sprayed on

green chillies can protect the plant from leaf disease. Moreover, leaves of plants grown on soil applied with the slurry show great resilience.

In addition to the energy and fertiliser benefits at household level, biogas is increasingly becoming recognized as a disposal technology by the local government authorities for whom garbage is a severe environmental problem. Three garbage based biogas plants have already been constructed and are serving as demonstration units.

Source: Practical Action

Case study 4: The case of Costa Rica

Two biogas projects dubbed 'Biodigestors in rural communities' were executed by two organisations in Costa Rica. The first project was implemented by Fundación para el Desarrollo de las Comunidades del Sur (FUDECOSUR), an international non-governmental organisation (NGO), in the Brunca Region in southern Costa Rica. The second project, which started some two years later, was done by Fundación Union y Desarrollo de las Comunidades Campesinas (FUNDECOCA), a local organisation, in the Huetar Region in the north. The main foci of the two projects were to provide clean energy for household cooking and to relieve the livestock-rearing communities of foul odours, flies and water contamination from animal waste. Local farmers were trained in the construction and use of the biogas digesters. The farmers were then given loans to build and operate the digesters themselves.

In FUDECOSUR's project, the loans were given to households that operated livestock farms and were willing to allow others to visit and learn how the biogas digesters work. The project involved Government representatives who provided technical assistance and support during the training sections. In the course of the project, 93 biogas digesters were installed, whilst 150 people were trained, about a third of whom were women. The biogas digesters are made of plastic, and they are situated above ground.

FUNDECOCA's project focused more on training the women, using a similar model of work in the northern part of Costa Rica. The project was performed in collaboration with FUDECOSUR, whose experience and expertise were used to provide technical assistance to FUNDECOCA. This showed up in the improvement of the biogas model, which led to the reduction of noxious fumes, elimination of the scum which would otherwise prevent the gas from exiting and a sieve over various openings so that rocks do not get in to break the plastic. Forty digesters have been built in this project.

A report on the assessment of environmental and livelihood benefits of the two projects showed that the environment has improved, as methane gas is no longer

emitted from any unused animal waste, and also the contamination of water from animal waste and the emission of smoke from firewood have reduced

- The general livelihood has improved due to the improvement in health, from reduction the reduction of smoke, foul odours and flies. , More money was saved from the reduced need to buy gas, electricity or wood for cooking.
- The 150 people who were trained by the FUDECOSUR project are now more aware of environmental protection, women's issues and health and also more knowledgeable about livestock management techniques, and economic management for sustainability. Some of the participants have become trainers themselves, and have even travelled to Nicaragua and Panama to help people build and use biogas digesters
- After the FUDECOSUR project during which 93 biogas digesters were installed, more than 200 additional digesters have been built after the project, some of which can be found in neighbouring Nicaragua and Panama
- The two projects have strengthened the collaborative links between the international organisation FUDECOSUR and the local organisation FUNDECOCA in Costa Rica
- Thirty-one communities are now managing their biogas digesters with the help of loans from FUDECOSUR; FUNDECOCA was active in 14 communities, and 11 farmers from these communities are making use of local revolving loan funds to manage their own digesters.

Source: Latin America & Caribbean: Costa Rica-1

Case study 5: The case of Ecuador

A pilot project was started at the coast of Ecuador in November 2000 by the NGO Fundación Ecuatoriana Santa Maria del Fiat for producing biogas and bio-fertiliser from sewage and residual waters. The principal objectives were to provide energy and fertiliser to a nearby school while managing their sewage and residual water systems to reduce the foul odour and the possible ground-water contamination.

The community was highly involved in the planning and execution of the project, with representatives of various zonal committees helping to make decisions about the design of the system. During the execution stages, workshops were organised for students at the school to learn about biogas and alternative energy, and the students were trained to enable them to make presentations about the use of biogas to the surrounding communities. Two biogas digester units were built for demonstration purposes.

The system uses human waste during the school period. During the summer, manure from surrounding farms and vegetable matter are used to operate the

system. The school's stoves were redesigned to make use of the methane gas produced in these periods for cooking. The water reclamation system was designed to clean soapy water from the school to be reused.

The system is now able to process 12m³ of waste while 20m³ of water is recycled per day. The energy needs of 1200 people are now taken care of by this project. The school has reduced its use of butane gas for cooking by 60% through the use of biogas, thereby reducing greenhouse gas emissions. Biological and water waste are no longer being dumped over the cliff into the ocean, and thus marine biodiversity is protected. The risk of water contamination has also gone down, and the risk of disease is now lowered.

The use of fertiliser from the digester reduces protects the plants from insects and thereby reduces the use of pesticides.

The students are now more experienced with regard to the use of biogas. With the model digesters, 11th and 12th grade students are able to make presentations to the local community about the operations of the digesters, energy use, and waste management in relation to the environment in general. The students are now involved in making and distributing thousands of posters and creating video for distribution nationally and abroad. The school now sells fertiliser called 'BIOL' and 45% of the sale revenues return to the school. Job has now been created for people who are now paid to operate and maintain the biogas system.

The awareness of the surrounding communities about biogas is now great. The simultaneous installation of a waste water reclamation system helps to highlight the benefits of using a water recycling system together with the biogas production, which requires significant amounts of water. The school is located next to a religious sanctuary which attracts a number of visitors and tourist, and this gives the whole system good exposure. Effort are now being made to scale it up to the other parts of the country with the help of UNICEF.

Source: Latin America & Caribbean: Ecuador.

Discussions

The above case studies highlight important factors that are crucial for the success or otherwise of biogas for rural development. All the projects had similar motivations: addressing the issues about sanitation, health, environment and the provision of clean energy and fertiliser for rural communities.

One of the factors that ensured success of Lijiang project of China is the fact that the government had seen deforestation as a 'huge' problem and wanted to avoid it by tackling the root cause: providing alternative energy sources to its citizens.

The citizens were also involved in the planning, and financing of the scheme. There was also collaboration with three organisations, Forest Bureau, TNC and WWF, who shared some of the visions of the project implementers, and these helped to push the agenda forward as each of the organisations tried to pursue their core objectives. The initial selection of those with the right conditions for dissemination must also have helped in making the project popular in the communities. Feedstock was not a problem, as the programme was also integrated into agricultural production. Pilot projects were constructed in marketing centres and along transportation routes that will ensure that many farmers saw such successful programmes and went for them. All these enhanced the dissemination and adoption of biogas in this Chinese community of Lijiang, where up to the 1990s people did not know much about biogas. As indicated by Aklaku (2007) the Chinese have actually been working on biogas since the 1940s and they have been trying to improve on the technology. More than five million small biogas digesters have been constructed in China, and over 20 million persons use biogas as fuel.

The biogas plants in Appolonia in Ghana proved to be unsuccessful in the long run because the beneficiaries were largely uncommitted. The work culture of the people also made it difficult to obtain the needed cow dung and other materials for the running of the system. There was no definite programme from Government or any organisation to raise the awareness and motivation of the people. Biogas digesters are still not popular in Ghana, let alone household digesters. Biogas digesters are however now in place for some hospitals at Akwatia and Battor and there is also a digester for a slaughter waste treatment and energy generation at Ejura, all in Ghana (Aklaku, 2007).

The initial biogas projects of Sri Lanka were not sustainable, as each project was implemented in isolation. Lessons from these failed projects were then taken on board during subsequent projects. The key was the development and popularisation of the technology. All stake holders were involved at various stages of the project. For the commercialisation of the project, the implementers collaborated with an organisation that had already won an international award on biogas. Government agencies helped in providing extension services and training. The universities were used for further research, training and development on the technology. NGOs were used for technology dissemination at grass-root level. Village level masons and end-use equipment manufacturers were also given the necessary training. All these were geared toward popularising the technology, and they have been paying off after about two decades of Sri Lanka's endeavours in biogas.

Costa Rica had two projects in different periods by two implementing organisations where, through collaboration, the experience of the first project was

made available for improving the digester designs of the second project. The government provided technical assistance and supported the training sections given to local farmers who were also given some loans. The second project concentrated more on the women, who normally had to walk long distances to look for firewood. This made the people more knowledgeable about women and energy issues, and the digesters were widely adopted, with some spill over into neighbouring countries.

In Ecuador, zonal committees were represented in the discussions about the designs of the digester. The system was sited at tourist attraction centre which provided good exposure of the project. Training workshops were organised for students and some digesters were purposefully built for demonstration at those workshops. The unit was planned to use human waste during school period and to use manure and vegetable matter in summer. The whole system was operated in tandem with a waste water reclamation system. Thus water problem was addressed in addition to the energy and fertiliser problem. All these facilitated the success of the projects with the students becoming experienced in the use and dissemination of the biogas technology, whilst the school also received revenue from the sale of fertiliser.

In all the projects studied, extra effort was consistently made to popularise the use of biogas systems at grass root level, with the exception of that of Ghana. In China, Sri Lanka and Costa Rica, the foci were household unit, whilst that of Ecuador serviced a school. The activities at grass root level promoted a sense of ownership among the people. This enhanced the dissemination and adoption of the digesters, which were very important for the sustainability of the biogas project. The project in Ghana was somehow too ambitious from the beginning, focusing on electricity generation to the whole community from a central location. A project like this normally encounters more difficulties in getting the local people involved.

From the above discussions, it could be said that the long-term success of biogas projects for a community depends on a number of factors which must all be considered together in the planning and execution of the projects. Key among these factors are:

- Adherence to the features of the project that the users would prefer, based on their work and socio-cultural practices
- Collaboration with organisations that share similar goals
- Identifying programmes which can be integrated into the biogas project
- Addressing the difficulties in technology dissemination
- Addressing issues about the availability of feed stock
- Identifying the household problems in relation to energy use

- Existence of the right government policies on renewable energy (e.g. loans, public-private partnerships etc)
- Deciding on the focus and the target groups
- Setting up parallel training programmes for builders and users at grass-root level during the running of the biogas projects
- Keeping in mind that the success of the project may not be immediate; initial failures should not discourage project implementers.

Some guidelines which take most of the above factors into consideration are in place (ENERGIA, 2010). The main focus of these guidelines is gender mainstreaming and this was prompted by the need to solve household problem where women have to walk long distances to fetch fuel wood. Biogas programmes are already in place in Kenya and Nepal, making use of these guidelines (ENERGIA, 2010).

The principal barriers to the adoption of biogas technology include: lack of financing, low level of education about the systems amongst potential users, and shortage of skilled technicians to service the systems (Byrne et al, 2004). Other barriers include the lack of technology transfer due to the fact that many farmers have either not heard of the biogas digester system or do not know how to access the materials and/or technical know-how to effectively use the system. This has resulted in many farmers being unable to invest in and benefit from the biogas digester. The Ghanaian rural farmer is no exception, in spite of the economic, environmental, and health benefits in adopting a biogas digester system.

A feasibility study conducted by KITE concluded that it is technically feasible to provide 80,000 households in the Ashanti region and three northern regions with at least a 6m³ fixed dome digester to meet their cooking fuel needs. The report proposed a Public Private Partnership financing mechanism as the way forward in promoting domestic biogas dissemination in Ghana (Brew-Hammond, *et al*, 2008).

As indicated by Ahiataku-Togobo (2007) there are some definite procedures that need to be followed regarding the installation, operation, maintenance and safety requirements in the use of the digesters. This means the training given to the installers and users should be taken seriously like any other activity of the project. Students of first and second-cycle institutions could be introduced to the digesters so that they become used to the technology as they grow. This will help in improving the social perception of the digesters and also enhance the dissemination and adoption of the technology. This could reduce the psychological gradient in the use of gas between the urban centres and the rural areas. Human waste could be used as feed stock especially in areas where animal

waste is not enough. There would be no problem with foul odour, as this would be reduced through anaerobic digestion.

Conclusion

Many homes in the urban centres now use natural gas for cooking and the number is likely to go up now that more gas is expected as by-product of the oil that has now been discovered in commercial quantities in Ghana. There is lot of potential for the use of biogas as renewable, alternative source of energy in Ghanaian rural communities, who are not so well-placed to be using this natural gas. Anaerobic digestion is a unique treatment solution for animal agriculture as it can deliver positive benefits related to multiple issues, including renewable energy, water pollution, and air emissions. Anaerobic digestion of animal manure is gaining popularity as a means to protect the environment and to recycle materials efficiently into the farming systems. Human waste could also be used where there is not enough manure. However, in order to maintain sustainability, biogas projects should not be implemented in isolation. Various stake holders must always be identified and be involved at all stages of the biogas development. The dissemination of the project is as equally important as its functionality.

Recommendations

Biogas digesters could be introduced on pilot bases in some schools and rural communities. Household units could be used as starting points. Digesters could be constructed in schools for teaching and demonstration purposes.

Collaboration could be sought with organisations that share the visions of biogas dissemination projects. Biogas projects could be sited at marketing centres and along transportation routes to give them exposure to rural dwellers.

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THE ROLE OF PAINTING IN THE OIL INDUSTRY IN GHANA (A CASE STUDY IN SEKONDI-TAKORADI METROPOLIS)

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Abstract

Creative Art Industries in Ghana have an important role to play in enhancing Ghana's economy through oil extraction. Creative art can be described as all types of art (Painting, Graphic Design, Ceramics, Textiles, Music and Dance) that are made through human creative and artistic sensibilities. Creative arts can form a key component in a new knowledge economy capable of delivering urban and rural regeneration. The study recognizes the crucial role painting plays in the maintenance and protection of offshore structures and equipment used in oil extraction. This study seeks to assess the role of painting and its employment opportunity in the oil industry. Again, it advocates the need to run HND/B – Tech. programmes in Marine Paint. As of now, there is no tertiary institution in Ghana that trains Marine Painters. Descriptive research method based on qualitative research approach was adopted and this was used to describe research methodology, through results discussion and findings. The results of the study indicate that painting helps in the prevention of decay, corrosion and rusting. Therefore, it will be very useful in the maintenance of oil extraction structures and equipment. The study concluded that including marine painting in the Polytechnic curriculum will go a long way to enhance Ghana's economy through employment and oil production.

Key word s: Painting, Marine Painting, Offshore-Structures, Oil - Industry

Introduction

With the discovery of oil in commercial quantities, Ghana has become one of the oil producing countries in the sub-region. Since the oil and gas industry world over requires a high level of capital intensive and attracts high caliber of man power resource in the sector, Ghana stands little or no benefit from the industry if its universities and polytechnics do not train students to meet man – power requirements in every compartment of the oil and gas industry. One cannot denial the fact that, painting plays a crucial role in the maintenance and protection of structures and equipment of the oil industry. According to Tubb (1967) if materials use for building are left unprotected from the sea or weather they deteriorate and decay.

From www.maritimematters.com/2011/03/vroom-father-of-maritimepaintaing, painting of boats, commercial vessels, ships and rigging of sailing ships dated back

to colonial times when it was common for wealthy ship owners, marines and merchants to commission paintings of the boats and activities by which painters made their living.

But in the modern world, painting has become a big business since it is linked with oil and gas industry whose huge equipment and installations are at the mercy of sea conditions and therefore require the painting or coating of weather exposed surfaces. Spreading paint on a suitable surface such as wall, fabric, paper, metal or wood by an artist according to Appiah (1997) is termed painting. He explains further that, the aesthetic enhancement of the painting is affected by factors such as surface on which painting is done, the kind of painting used, and the liquid used in mixing the paint. Amenuke et al (1991) throw more light on the fact that, painting is done with colours (pigments) oil colours, gouache, poster colours, emulsion and enamel paints. Amenuke et al further state that, decorating walls of buildings and surfaces of things such as furniture, and vehicles are some painting benefits. They describe painting as the art of creating pictures or covering a surface by applying colour (paint).

Hurst (1963) is of the view that consistency, opacity, and spreading capacity are important characteristic of paint. He further explains that a paint consistency is a term used to describe the condition or fluidity of paint. Opacity of paint implies the covering or hiding power of paint.

The area covered by a given quantity of paint is the termed spreading capacity. According to Hayes (1978), all paints are composed of three constituents. The coloured pigment particles, the medium that carries those particles and the diluents. Liquids such as turpentine, kerosene, petrol and water allow painters to control the consistency of the paint to achieve a desire effect. The finished appearance and feel of a painted surface is influenced by the intrinsic properties of each component. Goodier et al (1963) and Fulcher et al (1989) enumerate the following source of paint for special purpose:

- | | |
|--------------------------------|----------------------------|
| 1) Anti-condensation paint | 7) Fluorescent paint |
| 2) Anti-fungus paint | 8) Polyurethane paint |
| 3) Bituminous paint | 9) Texture paint |
| 4) Cement paint | 10) Anti – fouling paint |
| 5) Chlorinated rubber paint | 11) Fungilical paint |
| 6) Damp – proofing compound | 12) Marine paint |
| 13) Flame – retardant paint | 15) Acid – resisting paint |
| 14) Micaceous iron oxide paint | 16) Anti – corrosion paint |

Morgans (1962) emphasizes that, paints for use under marine conditions are conveniently divided into those used for ships, dock and harbor installations.

Statement of the Problem

Painting as an area under the creative art industry has been of great help to Ghana. This is through education, employment, decoration and foreign exchange. Painting of buildings and murals are made to add aesthetic enhancement to spaces. As Ghana extract oil in commercial quantities, painters will be needed to paint onshore and offshore structures and equipment that are used in the oil extraction. This would help prevent corrosion and rasting of oil extraction equipment.

As of now there is no HND/B-Tech. Programme designed to train polytechnic students in marine painting. Are there brighter employment avenues for painters in the oil industry? Can painting play a role in the oil industry? It is for the foregone reasons and questions asked that, the researchers' deemed it necessary to research into the topics.

Objectives

The objectives of the study are:

- 1) To assess the role of painting in the oil industry.
- 2) To create job awareness in the area of painting for the oil industry.
- 3) To advocate the need to run HND/B – Tech. programme in marine painting.

Methodology

Population Studied

The population studied for this research constitutes canoe painters, painting students and experts in the field of painting in Sekondi – Takoradi Metropolis. Expert in the field of painting comprised of naval officers with indepth knowledge in shiphusbandry (marine painting) and lecturers in painting.

Sampling

An opportunity for the researchers to study only a portion of the population rather than the entire population was through sampling. The researchers used Simple Random Sampling to trim the entire population to a workable size. Below is a table 1. Showing population selected and sample size.

NO.	POPULATION SELECTED	SAMPLE SIZE
1	canoe painters	8
2	painting students	30
3	naval officers	10
4	lecturers in painting field	9
Total	4	57

Data collecting instruments.

The researchers used Interview and Observation.

Interview

Personal interviews were conducted with selected members of the entire population. Views regarding the role that marine painting plays in the oil industry, appropriate paints for marine painting, job opportunities for painters, and the need to run HND/B – Tech Programmes in marine painting were obtained.

Observation

The researchers visited Sekondi – Naval Base to observe vessels and problems associated with them in terms of paint and effect of rust in them. Canoe painting along the coast of Sekondi – Takoradi was observed.

Results

Results of the study have been described under the following: Canoe Painters, Painting Students, Painting Lecturers and Naval Officers.

Canoe Painters

Concerning type of paint used for canoe painting, painters indicated that, they use oil (enamel) and emulsion paints. They normally use emulsion paint for priming. This is then followed by oil (enamel). Talking about the number of times one needs to paint a canoe in a year. Five (5) painters were of the view that, it depends on the weather conditions. Three (3) were of the opinion that, once the canoe is always on the sea they would recommend every four months. As regards to why they paint canoes, four (4) painters said for protection and long life span of canoes. Two (2) said for protection and beautification, and two (2) said for identification.

Painting Students

Concerning the relevance of painting in the oil industry, twenty-eight (28) students were of the opinion that painting plays an important role in the oil industry. According to them, the paint helps in covering and protection of huge machines used in oil extraction. Two (2) students were of the assertion that, painting is a two-dimensional art and that it has no significance in oil extraction. With regard to employment opportunities in the oil industry for painters, all the thirty (30) painting students interviewees agreed that painters can gain employment in the oil industry. They showed interest in furthering their studies in marine painting since Ghana has started oil extraction in commercial quantities.

Lecturers in the Area of Painting

Considering the role painting plays in the oil industry, all the nine (9) lecturers interviewed at the Painting Department, Takoradi Polytechnic strongly believe

painting has a significant role to play in the oil industry. They explained that, surface preparation, treatment and spray painting practices are very essential to the protection of most oil extraction ships, equipment and machines. Four (4) Lecturers were of the view that, painting of oil extraction ships and other offshore structures are not only for aesthetic purposes but for ensuring long-life span of structures and equipment. On the issue of job creation in the oil industry, all painting lecturers recommended that there is the need to design a curriculum for HND/B – Tech. in Marine Painting. They explained that, this would help train and produce more marine painters who would get employment in the oil industry.

Naval Officers

Looking at painting and its place in the oil industry, five (5) naval officers were of the view that surfaces of machines, vessels and other offshore structures for oil extraction need protection against corrosion, salt-spray, salt water and extreme variations in temperature conditions. They agreed that, painting plays a crucial role in oil industry worldwide. With regard to appropriate paint used for offshore painting, two (2) Naval Officers were of the opinion that, fungicidal, anti – fouling and marine paint are very good for offshore structures. They further explained that fungicidal paint contains compound of tin and other substance design to prevent the formation of mould growths. Another officer pointed out that, anti – fouling paint is suitable for protecting bottoms of ships from marine growths such as sea weeds and barnacles. He threw more lights on the fact anti fouling paint contains toxic substance such as metallic – copper, copper compound and tin compounds. Two (2) senior officers revealed that, men under training are trained in marine painting. Marine painting is a specialized programme under ship husbandry. And that, there is no polytechnic running the programme in the country. According to them, the Naval Base has a well structured syllabus and that trainees are taken through the following: maintenance of paint, painting systems, surface preparation, painting methods, care of tools and equipment and defects in paint work. An ex-Naval officer C. P.O. “1” said, painting is very important to every oil extraction business worldwide. He was of the opinion that, Polytechnics should run a designed programme such as marine painting and marine engineering. To him, such programmers’ would go a long way to help the oil production business. He talked about places such as dry dock where painters and welders are highly needed. According to him, oil tank ships and other ships are periodically (every 9 months) sent to the dry dock. At the dry doc, the sea water is pumped out from the bottom of the ship. It is at the dry dock that sea weeds are carefully removed from the ship base. He revealed that, if weeds are not removed, they reduce the normal ship movement or speed. The ship base is then clean and repainted. He threw light on the fact that, oil extraction structures and equipment need to be painted by marine painters to prevent rusting, corrosion and deteriorating. He explained further that, corrosion happens within the sea water and rusting occurs out of the sea water.

Discussion

It can be inferred from the result that, marine painting is very essential in the protection of oil extraction equipment and structures and a greater proportion of students interviewed knew paint as a material containing certain properties that help prevent corrosion and rusting. Therefore, painting has an important role to play in the oil industry.

Painters are therefore needed in the maintenance of the oil extraction ships and other oil extraction structures. The two students, who talked about painting not being important to the oil industry, contradicted themselves by alluding to the fact that painters can gain employment in the oil industry.

Canoe owners and fishermen seem to know sea effects on their canoes. They rely on the services of canoe painters to paint their canoes. Canoes are painted for beautification, identification and protection against diverse weather conditions. Periodic painting helps to ensure long-life span of canoes.

Painters who ought to work in ensuring long-life span of oil extraction ships and equipment need special skills and training. And this calls for a design curriculum in HND/B-Tech. Marine Painting in the country's Polytechnics. This will go along way to help some polytechnic graduate gain employment in the oil industry.

All Naval Officers interviewed agreed that, painting plays an important role in the oil industry. Paint such as fungicidal and anti – fouling are very good paint for offshore painting. Marine Painting forms an aspect of ship husbandry programme at the Naval Base. Trainees are taken through a structured syllabus for marine painting.

Findings of the Study.

The following are findings of the study:

- Paint as a material helps in the protection and beautification of oil industry machines and other offshore structures.
- Painting students expressed a great interest in furthering their education in B-Tech. Marine Painting.
- Like ships, canoes are painted periodically for beautification, identification and against decay.
- There is an indication that, currently there is no tertiary institution in Ghana that trains students in Marine Painting.
- Marine Painting is a specialized area of ship husbandry at the Sekondi Naval Base. The Naval Base has a well structured syllabus for painting. Trainees are taken through Paint maintenance and systems (priming, under and top coats) Surface Preparation (galvanized, and zinc, ungalvanized steel, copper and brass), Painting Methods (brush roller and spray painting), care of

Tools and Equipment, Defects in Paint Work (bittiness, blistering, cracking, cissing, discolouration, brush marks, peeling grinning, sagging and shriving)

- There are a lot of job opportunities for painters in the oil industry.

Conclusion

Ghana's oil extraction will go a long way to enhance its economy through job creation, education, health care, transportation and agriculture. All these cannot materialize if painting does not play a role.

Interior and exterior spaces of officers, accommodation, buildings for oil extraction companies need to be painted. Surfaces of vessels, heavy machines and equipment that are use in oil extraction need to be protected. For ensuring long life span of oil extraction vessels and structures on the sea, above the water-line, intermittently immersed, permanently immersed is through good maintenance practices that rust and corrosive action of the sea water, salt spray etc. would be prevented.

With the booming oil and gas industry in the country, and the creation of job opportunities coupled with the fact that the country's polytechnics are established to provide skilled middle man power to the industries, students who graduate from the country's polytechnics with HND/B-Tech. (marine painting) are in a better position to get jobs in the oil industry.

It is recommended that, tertiary institutions such as polytechnics should design and run a curriculum in painting, thus HND/B –Tech. (marine painting). This would help train more marine painters for the oil industry. Oil companies such as Tullow Oil should sponsor Polytechnics in Ghana to train students to fit into the oil sector. This will enhance the future of job opportunities in their oil business.

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JOB ROTATION AS A COMPONENT OF STAFF DEVELOPMENT IN POLYTECHNICS IN GHANA

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Abstract

Job rotation (JR) is a systematic movement of employees from one job to the other within an organization or department as a means of learning about how other functions operates. JR as closely linked to succession planning has become a critical area of concern in organizations. This is because if a replacement is found easily for a vacant position, there is continuity and corporate vision is easily achieved. There has been a realization that management has ignored this process of human resource development only to formal workshops and classroom knowledge and skill acquisition. As such, most members of staff have little information or no knowledge of JR and its relevance. Relatively little research has been undertaken but with no concrete laid down model. This research was therefore designed to assess JR in Polytechnics to bring to light some of the benefits of the practice such as reduced stress and the like. The methodology included a population of all Polytechnics in Ghana, with a sample of six (6) out of the ten (10) Polytechnics. Both close and open-ended questionnaire and unstructured interviews were used to collate data. It was observed that though staff of Polytechnics have knowledge on JR and the awareness is high, they are not enthused about the process because it is not implemented formally in the Polytechnic. This paper has also presented Polytechnics with a comprehensive model on the process of JR to ease management's burden in their quest to make it a component of human resource development.

Keywords: job rotation; job design; management commitment; staff development;

Introduction

Job rotation (JR) as a management development (MD) tool is not new in the development of human resources (HR) of an organization but has not received much recognition from both management and staff irrespective of its immense benefits.

It is the process whereby an employee is assigned not to a single and specific task but a set of tasks among which he or she rotates as with some frequency (Cosgel and Miceli, 1998). The goal of staff development according to Paul (online paper) is to train staff to meet the organisation's minimum standards. This training must be ongoing and should ensure that employees know the size and scope of their authority and responsibility, who they report to for guidance and support, and also have the tools to effectively do their jobs.

Job Design (JD)

The development of staff is closely linked to the JD of the institution which is the personnel or reengineering activity of specifying the contents of the job, tools and techniques to be used, surroundings of the work and the relationship of one job to the other.

It also refers to the way a set of tasks, or an entire job, is organized and this helps to determine what, how, and order in which they are executed (en.wikipedia.org/wiki/Job_design [Source](#)) and also it takes into account the factors which affect the work, and organises the content to make it less risky to the employee. A well designed job encourages a variety of good body positions, reasonable strength requirements, mental activity, and foster feelings of achievement and self-esteem. This addresses issues like work overload or under-load, repetitiveness, limited control over work, isolation, shift, delays in filling vacant positions, excessive working hours, and limited understanding of the whole job process.

Approaches to Job Design

Various methods exist in the design of jobs which are job enlargement (JEL), job enrichment (JER) and job evaluation which are periodic in addition JR to determine the strategic worth and weight of jobs for the achievement of corporate objectives.

JEL includes more or different tasks and boost interest but may or may not give employees more responsibility to motivate them. JER allows employees to assume more responsibility, accountability, and independence when learning new tasks, thus, allows for greater participation and new opportunities.

JR moves employees from one task to another, thus, distributes group tasks among a number of employees as a sequential activity like assessment of current work practices through discussion of process with the employees and supervisors involved for clarity, changes to identify training required.

An effective JD involves task analysis, as recommended by Robertson and Smith (1985). The analysis cuts across policies, incentives, and feedback that inevitably affect the efficiency and motivation of the employees responsible for the job. The methods of execution and coordination of tasks are also essential as they must be implemented on a small scale at the first instance to allow for adjustments and a continual revaluation is imperative.

One approach in question to help in the development of competency level of staff is JR which is a crucial process in an employee quest to improve upon himself and his. For example, an electrical engineer may move from fabrication to assembling plants and to circuit design section at designated times. Through this process, he is exposed to other aspects of the job and his skills are improved, thus making him more efficient and versatile.

In industry today, job rotation is viewed as just another transfer rather than as an important tool for implementing HR strategy. It has become a ritual at best, without any focus on the outcomes achievable through a little planning and implementation effort. It is also used as a means of punishing poor performers and settling scores resulting from organizational politics, etc.

It is observed that JR is the best way of keeping the HR from complacency and boredom of routine since it is very difficult to sustain interest in a given job for any substantial length of time. This is because human beings by nature have the tendency to outgrow their jobs through the learning and experience gained over a period of time (<http://www.alagse.com>). Therefore, stimulating human mind through diversity of challenges is a means to developing creativity and improving institutional performance.

Consequently, a well planned job rotation programme has immense positive impacts on the job satisfaction and retention of cherished HR. While there is relatively little research undertaken in this area a prospective emancipatory action research study has been on-going in North West London health services for several years by Patrick Coyne, Dr. Ricky Lucock, Prof. Buchan and Jane Ball, with the local health communities (www.nurserotation.com).

It is identified to have contributed greatly to the successes of firms in Japan. An influential study by Ouchi (1981) identifies non-specialised career paths as one of the fundamental properties from which others can learn as affirmed by Appelbaum and Batt, (1994), Osterman (1994), the evidence of the innovative transformations at the workplace through the practice of effective JR as a result of management's commitment.

It was further argued that innovations in the firms emerged consequently from JR by allowing workers to apply their knowledge of one task to the improvement of the other (Meltin M. Cosgel, Thomas J. Miceli 1994). A well known Communal Society, the Israeli Kibbutz, practiced job rotation for years (Helman [1988], Leibenstein [1989]) since the positive derivations outweighed the cost of its implementation.

According to Andrews (1963), a variety in schedules is viewed as "a source of pleasure" and the frequency precludes monotony which results in low productivity. This could be done without necessarily sending the individual to another department as in some cases; but rather, to a supplier to observe how the business operates from the suppliers view point to broaden employees outlook or to a foreign organization to gain a global perspective. This allows the employee to perform diverse roles to gain a better understand of the different issues.

Similarly, Campion, Chershin and Stevens (1994) say, JR has benefits like job satisfaction and stimulation, improves ability to deal with difficulties like sabotage,

backbiting and other forms of resistance that come along with the implementation of change.

In an era where tertiary education has become paramount and competitive, there is the need to have a well resourced staff in terms of job proficiency to be able to satisfy the customer base and enhance corporate image. This has made employees of Polytechnics aware of the need for development. As a result, are undergoing various forms of training whether sponsored by or not and ignoring the critical practical experience and versatility of the workforce that is needed.

However, there has been the realization that JR is not given the necessary attention and seriousness and is either done as a form of punishment or as stop gap during periods of shortages. It is therefore the objective of this research to access the process and develop a model for its implementation in organizations. This is critical in the career development process of every staff since it contributes greatly to their productivity.

This will create the necessary awareness, boost staff interest and desire to bring about a higher level of creativity and innovation and has also designed a model make it a very effective employee development practice. As such, this research, sought to ascertain whether JR is employed in Polytechnics, its basis, level of management and staff enthusiasm and the constraints. The limitation was mainly the availability of funds and cooperation staff of sampled Polytechnics.

Methodology

The target population included all Polytechnics in Ghana with a sample size of six; namely Takoradi, Accra, Kumasi, Sunyani, Cape Coast and Koforidua and made up of two strata; heads of department and senior staff or members in the various departments.

Questionnaires, interview guides, telephone interviews and participatory observations were used to collate the data which allowed a sizable amount of information to be gathered. This was preceded with pre-testing of the questionnaire for the design, structure, and content to reduce ambiguity and ensure clarity. Statistical Package for Social Sciences SPSS was used in the processing and analysis of data and was presented by the use of frequency distribution tables and graphs.

Results

The respondents answered similar questions but related to rank and position in the Polytechnic.

Research question one: How long have you been in this institution? Respondents were asked to indicate their length of stay in their respective Polytechnics as shown in Table 1 below.

Table 1 Length of Stay in Polytechnic

Length	HOD		STAFF	
	Frequency	Percent	Frequency	Percent
0 – 1 yr	4	5.6	24	10.3
2yrs			27	11.6
3yrs	12	16.7	43	18.5
4yrs	24	33.3	28	12.0
5yrs and above	32	44.4	111	47.6
Total	72	100.0	233	100.0

From the table 1, it is observed that 32 (44.4%) of the HODs had stayed for 5 years and above, 24 (33.3%), 4 years and 12 (16.7%), 3 years. The least stay was 1 year and below represented by 4(5.6%). For the supervised staff, 111 (47.6%), over 5 years, 28 (12.0%) and 43 (18.5%), 3 and 4 years respectively.

Research question two: How long have you been at this position?

Table 2 shows how long the staff had remained at their current positions over the period in the Polytechnics.

Table 2 Length of Time at Position

YEARS	HOD		STAFF	
	Frequency	Percent	Frequency	Percent
0 – 1 yr	24	33.3	50	22.2
2yrs	4	5.6	56	24.4
3yrs	8	11.1	47	20.9
4yrs	24	33.3	28	12.4
5 yrs & above	12	16.7	45	20.0
Total	72	100.0	224	100.0

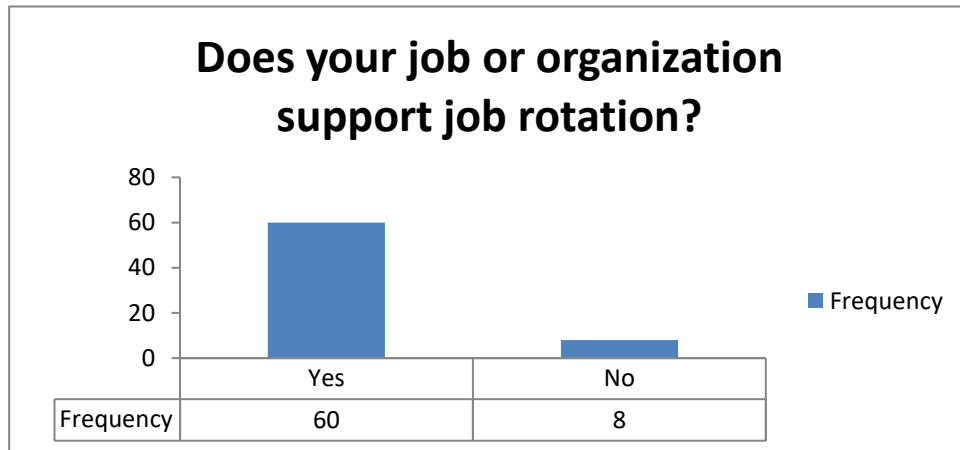
It is observed that for HODs, 12 (16.75%) and 24 (33.3%) had been at their current positions for over 5 and 4 years respectively. 24 (33.3%), a year and below, 8(11.1%) three (3) years. On the part of the supervised, 50 (22.2%) and 56 (24.4), a year and below and 2 years respectively. 47 (20.9%) and 45 (20%) 3 and 5 or more years and above respectively.

Research question three: Does your institution use the tool of job rotation as an essential part of job placement? None of the respondents answered this question.

Research question four: Does management support job rotation?

The respondents were asked to indicate whether management supported the process.

Figure 1 Management Support



It can be inferred from figure 1 above that as many as 60 (88.2%) responded in the affirmative and 8 (11.8%) responded in the negative.

Research question five: Do you consider it as a form of staff development?

The respondents were asked whether they considered job rotation as a form of development of staff capabilities.

Table 3 Form of Staff Development

RESPONSE	HOD		STAFF	
	Frequency	Percent	Frequency	Percent
Yes	52	72.2	191	82
No	8	11.1	15	6.4
Not at all	12	16.7	16	6.9
Total	72	100.0	222	100

The table 3 above indicates that 52 (72.2%) of the HODs believe that job rotation is a form of staff development. 8 (11.1%) and 12 (16.7%) said no and not at all respectively. For the staff, 191(82%) responded in the affirmative. 15 (6.4%) and 16 (6.9%) of them said no and not at all respectively.

Research question six: Have you been able to develop your subordinates through job rotation

Table 4 Ability to Develop Staff

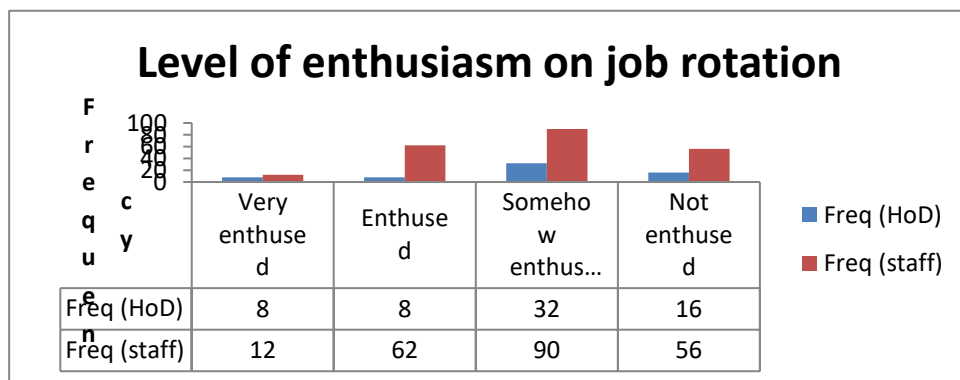
Response	Frequency	Percent
Yes	40	55.6
No	32	44.4
Total	72	100.0

Table 4 above shows that 40 (55.6%) of the HODs said “yes” and 32(44.4%) said “no”

Research question seven: What is the level of staff enthusiasm?

Respondents were asked to indicate their level of enthusiasm about the process if it carried out in their respective Polytechnics.

Fig 2 Level of Staff Enthusiasm



From figure 2 above, 8 (12.5%) HODs said they were very enthused and enthused about the job rotation process. 32 (50%) and 16 (25%) respectively were somehow enthused and not enthused by the whole process. On the part of the other staff, 12 (5.5%) and 62 (28.2%) were very enthused and enthused respectively. 90 (40.9%) and 56 (25.5%) were somehow enthused and not enthused about the process at all.

Research question eight: Is the process competency-based?

This question sought to find out whether the process is competency-based.

Figure 3 Competency base

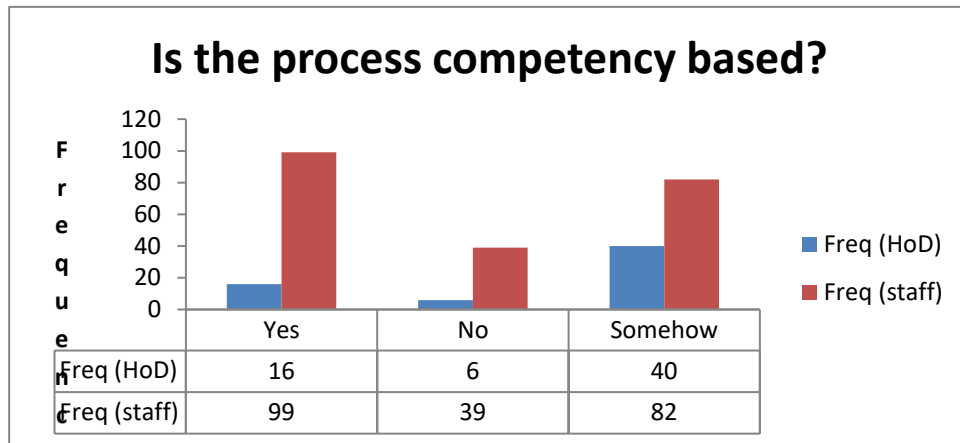


Figure 3 indicates that for the HODs 16 (26.7%) responded “yes”, 6 (6.7) responded “no” and 40(66.6%) said “somehow”. The figure also reports that for the other staff, 99(45%) said “yes”, 39 (17.7%), “no” and 82 (37.3%), “somehow”.

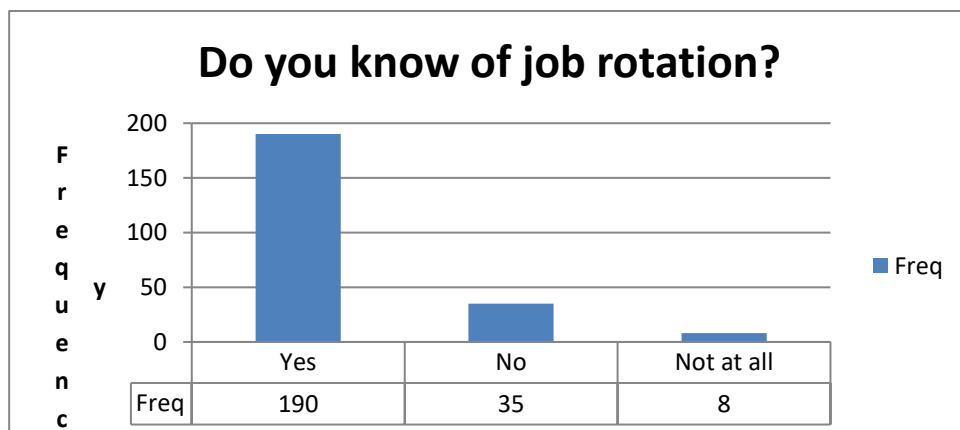
Research question nine: Do you wish it to be part of your human resource strategy?

No response was received for this question.

Research question ten: are you aware of job rotation?

It was expected of respondents to indicate their awareness or otherwise of job rotation.

Figure 4 Self - Awareness



The figure 4 above shows that as many as 190 (81.5%) said they were aware of job rotation. 35 (15.0%) and 8(3.5) of them respectively said no and not at all.

Research question eleven: Are other members of staff aware

Respondents were asked to assess their colleague's awareness of the process

Figure 5 Other Staff Awareness

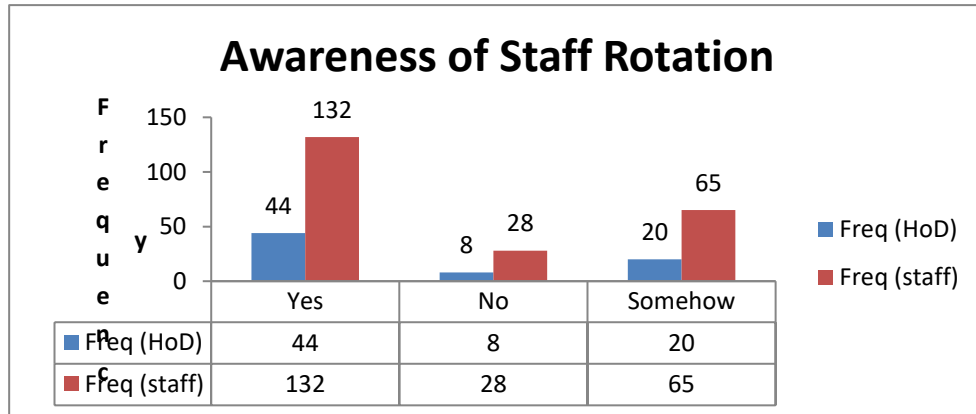


Figure 5 above indicates that 44 (61.1%) of the HODs said their subordinates were aware. 8 (11.1%) and 20 (27.8%) of them said no and not at all. 132 (58.7%) of the other staffs said yes, 28 (12.4%), no and 65 (28.9%), not at all.

Research question twelve: which tools does your institution use in selecting people for job rotation?

The respondents were asked to select from a list of tools that were used for the selection of individuals for job rotation.

Table 5 Selection Tools

TOOLS	HOD		STAFF	
	Freq(HOD)	Percent	Freq(staff)	Percent
Observation	24	40	89	45.6
Coaching	4	6.7	32	16.4
Interview	12	20	16	8.2
Assessment test	4	6.7	28	14.4
Others	16	26.7	30	15.4
Total	60	100	195	100

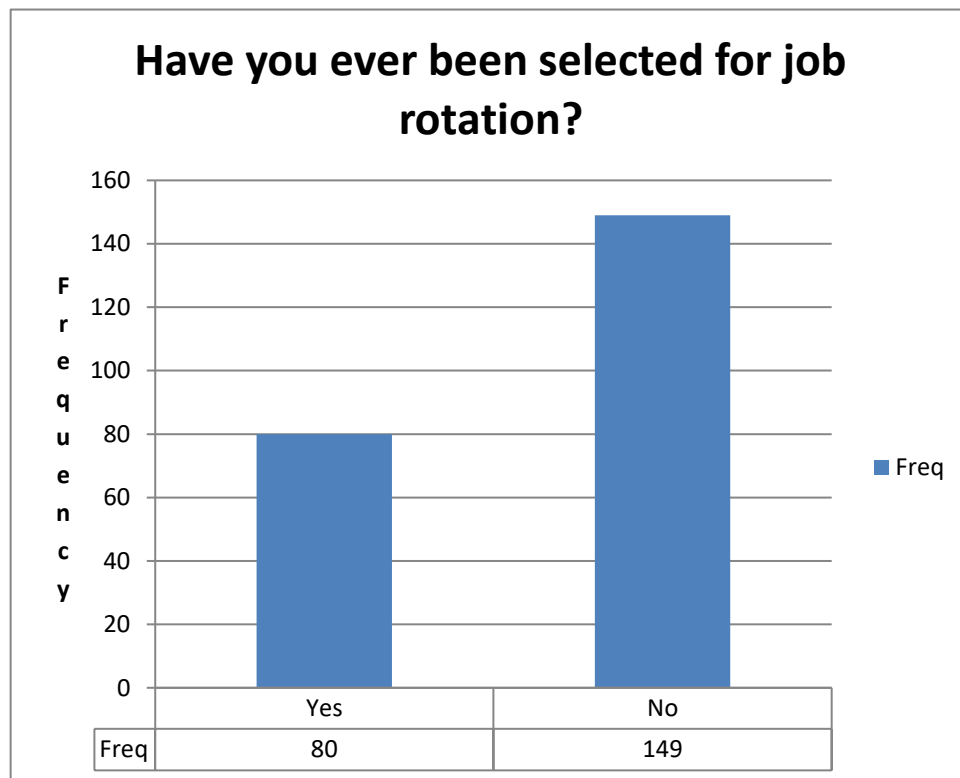
It is inferred from table 5 above that the response for observation is 24 (40.0%), interview 12 (20.0%) with coaching and assessment test representing 4 (6.7%) respectively. 16 (26.0%) also mentioned other tools like experience, qualification among others. For the other staff the highest mode of selection is observation 89(45.6%), 32 (16.4%) and 28 (14.4%) indicated coaching and assessment test

respectively. The least method used in the view of the respondents is through interview. 30(15.4%) of them also mentioned experience and qualification as some of the other tools for selection.

Research question twelve: have you ever been selected?

This question sought to find out from the respondents if any of them had been selected to undertake job rotation in the Polytechnic or an analogous institution.

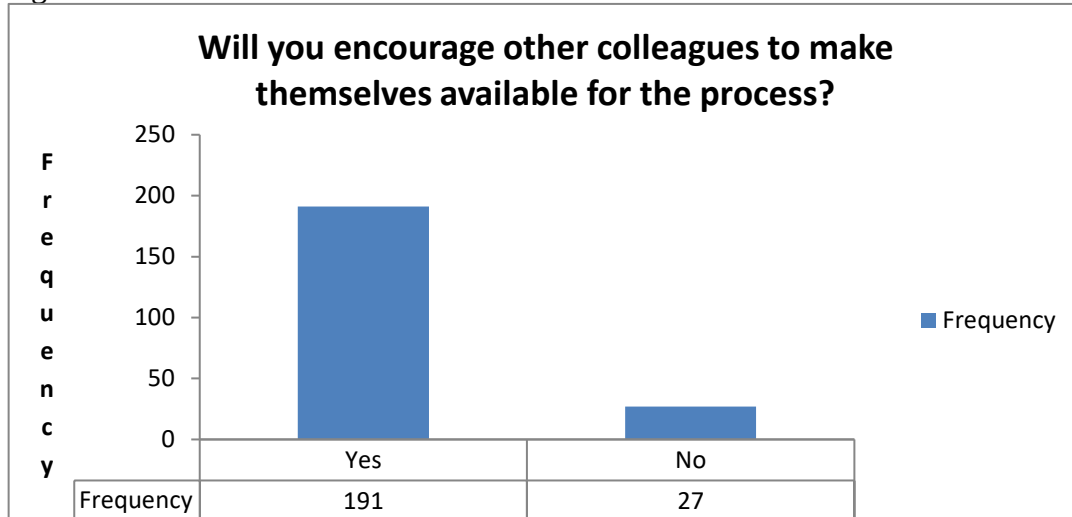
Figure 6 Personal Involvement



The figure above shows that out of the 229 respondents, 80 (34.9%) of them said they have once been selected for job rotation. The remaining 149 (65.1%) responded in the negative.

Research question thirteen: will you encourage your colleagues to make themselves available for the process?

Figure 6 Recommendation to Others



The figure 6 above shows that 19(87.6%) of the respondents indicated ‘yes’ and 27(2.4%), “no”.

Research question fourteen: State some benefits derived from job rotation.

Few of the respondents mentioned multi-skill, reduction in boredom, among others as some benefits of job rotation.

Research question fifteen: What are some of the problems which have evolved from this process?

No response was received for this question.

**Discussion
Process**

From the afore presented results, majority of the staff had stayed in the Polytechnics for at least five years and had remained at their current positions for up to a year or four.

This means that they may have gained much experience and therefore had more control over what they do, but with little diversification and so are limited in scope.

This process was however not used as condition for job placement in the Polytechnics. However, though Management support was present but it was not

committed to it. As a result, it was not used effectively and for the right purposes. Respondents indicated that they considered it form of staff development but were not enthused about effective because management is perceived to be unfair in job placement and appointment to positions. There was a perception that it is competency based but could not indicate whether they wanted to be part of the HR strategy. This Appalburn and Batt (1994) asserted that it is management's involvement that makes the process effective.

According to Janni (eHow member), job rotation programmes sometimes offer customized assignment to promising employees in an effort to give them a view of the entire organization. These assignments could rum for a year or more and sometimes vary in size and formality. Paul Nicolazzo also explains that competency based recruitment and promotional standards together with an effective staff development system helps to ensure consistency in quality and safety.

Awareness

Staff responses indicated that they were aware by virtue of knowledge from school but could not explain individually that it was practiced in their respective Polytechnics. This lack of participation is confounding given that rotation programs are a respected means for learning how other functions operate, and that such knowledge is essential to becoming a better business partner ([Adrienne Fox](#) ; [HR Magazine](#), [March, 2003](#)).

Selection

Considering the responses, observation was perceived as the tool used for the job rotation process. Though none had been selected for the process but they were willing to make themselves available as well as encourage their colleague because they were aware of the immerse benefit.

Benefits

According to respondents, some of the benefits gained for participating in job rotation include, multi-skilled employee thus, the ability to handle different tasks. There is also high sense of integrity, reduction in boredom, resulting self empowerment and job enhancement. All these will increase competency level of staff and eventually result is efficiency and higher productivity.

This is affirmed by Andrews (1963) that a variety in work schedules at the workplace is viewed tends to provide some pleasure and the frequency precludes monotony which usually results in low productivity.

Campion, Cheresin and Stevens (1994) also asserts that job rotation has numerous benefits like job satisfaction and stimulation, the organization's ability to deal with

difficulties like sabotage, backbiting and other forms of resistance that come along with the implementation of change.

Problems

Much could not be identified in terms of the problems as a result of the fact that it is not carried out as a formal exercise and the few that are undertaken, staff are not well informed about them.

The general perception is job transfer from one department to another, not job rotation.

Management commitment to the implementation of job rotation is low especially when employees have to move to another organisation for further training.

Janni (eHow member) asserts that irrespective of the fact that job rotation has immense benefits, lack of time, resources, etc do not allow organizations to embark on this activity.

Conclusion

It is observed from the analysis that though most staff in the various categories have knowledge on JR, they do not see the importance because few have been selected specifically to be part of this process but there were not set objectives to be measured.

Also the non-existence of an HR strategy has not allowed JR to be part of as a result of management unawareness of the immense benefits like reduction in boredom and stress associated with particular jobs, creativity and innovation among staff.

It was realized that the lack of management commitment was also due to lack of time and inadequate resources among others.

Recommendation

It is commended that management and heads of department or sections remain fair and firm to be able to achieve the mission of the Polytechnics, with respect to adherence to set procedure to gain employee confidence. The recommendation further includes a job rotation plan outlined below:

Model for job rotation

For any job rotation process to be effective, there must be a laid down procedure to make it less cumbersome and results oriented.

Precautions:

- Heads of departments and sections must also be sensitized encourage staff to give off their best and also be able to identify potential staff.

- The staff who are selected must also be sensitized since it a psychological exercise.
- There must be a plan

Job Rotation Plan

The plan involves simplified steps to yield the desired results. These include:

1. Identify positions in the organisation
2. Select potential staff
3. Determine specific tasks to be performed
4. Determine the timeframe for the execution of the tasks.
5. Set objectives to be achieved
6. Measure performance after period
7. Give feedback to staff

NB:

The staff could be sent to other organizations for further training or go on exchange programmes.

Suggested area for further research:

- Assessment of the job rotation plan three years after its implementation.

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HEALTH AND SAFETY PRACTICES IN THE GHANAIAN CONSTRUCTION INDUSTRY: NEW JUABEN MUNICIPALITY AS A CASE STUDY

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Abstract

Ghana's construction industry is seen by many around the West African Sub-Region as one of the hazardous industrial sectors with its workers more prone to injuries, accidents and many other fatalities. In developed countries such as United Kingdom, United States of America and Japan, there is strict legal enforcement of safety in the construction industry and also in the implementation of safety management systems which are designed to minimize or eliminate accidents at work places. However, occupational safety in construction industry is very poor in developing countries such as Ghana. This study investigates the prevalent Health and safety management practices and perceptions in the construction industry in the New Juaben Municipality of Ghana. The study was conducted among construction contractors and government officials within Koforidua Municipality through questionnaires, structured survey interviews, observations and discussion. The results of the study revealed that there are many occupational safety problems in the construction industry in Ghana. These problems include lack of adherence to safety regulations and standards, low priority of safety, lack of data on safety at construction sites, lack of competent manpower, lack of safety training and promotion and lack of documented and organized safety management systems. Finally, the study proposes some recommendations for safe construction in Ghana.

Key words: *construction, safety, training, risks, injuries, accidents*

Introduction

The construction industry remains a major contributor to the Gross Domestic Product (GDP) of all economies around the globe. It is the main provider of structures, facilities and infrastructure upon which other sectors of economies depend (National Statistics UK, 2008). Notwithstanding this, the industry is widely regarded as an accident prone industry (as explained in a study of 100 individual construction accidents by Haslam et al., 2005 and a textbook on occupational health and safety in construction project management by Lingard and Rowlinson, 2005).

The reasons construction is risky and prone to health and safety risks are because of the physical environment of the work, nature of the construction work operations, construction methods, construction materials, heavy equipment used, and physical

properties of the construction project itself (see a study on perceptions of 30 Latino American workers on construction risks by Menzel and Gutierrez, 2010).

In the United States, the rate of accidents in the construction industry is reported to be twice that of the industrial average (NSC USA, 1987). In Ghana is the second most hazardous industry after manufacturing (Government of Ghana (GOG) 1987).

In 2000, the Labour Department (2000: 22) reported that the construction industry in Ghana accounted for the highest rate of occupational deaths in comparison to other industrial sectors. According to the Labour Department (2000) report, 56 out of a total of 902 occupational accidents that occurred in construction in the year 2000 were fatal.

Due to all these challenges the construction industry in Ghana contributes about 4.7% of the GDP and also had a rate of return on their assets to be about 8% while other sectors had 3.4%. In the midst of this high economic performance of the construction industry, the industry is still hazardous. (Ghana Statistical Services 2009).

The government of Ghana in its development strategy (Government of Ghana (GOG) 2005) aims to move the country into a middle income country by the year 2015. This requires commitment by the government to improving productivity of all economic sectors of the country. For this to be achieved working conditions need to be improved, particularly for construction. Anaman and Osei- Amponsah (2007) have shown that Ghana's construction industry has potential as a driver of economic growth, although government's commitment to improving productivity of the sector is low. Improving the health and safety performance of the sector is one means of enhancing the productivity of the construction sector in Ghana.

Aims and Objectives of the Study

This paper intends to examine health and safety management practices in construction industry in Ghana with specific reference to New Juaben. In order to carry out this study, the researcher carried out the following specific objectives:

- 1) To analyse the health and safety management practices at construction sites in the New Juaben Municipality.
- 2) To examine the role of supervisory agencies on implementation of health and safety management practices on the construction site in the Municipality.
- 3) To find out whether managements of Construction Company are making any conscious effort to improve safety practices on site.
- 4) To find out the effect of health and safety on the construction site and job satisfaction.

Health and Safety Management in Developing Countries

Health and safety management practises in many developing countries evolved from institutional and legal frameworks developed by colonial administration to manage the safety, health and welfare aspects of industrial settings at the time. In Ghana, a labour department, established in 1938, was responsible for implementing the Factories Ordinance passed in 1952 to provide a code of protection for factory workers (Visano and Bastine 2003).

Past studies on health and safety management practises in construction in developing countries provide ample evidence of lapses in the management of safety and health at construction sites. These studies have identified key problems associated with safety and health at construction sites and are summarised in Table 1. Their findings reveal weaknesses in occupational health and safety administration, economic conditions, climatic conditions and the characteristics of the construction industry of developing countries influence safety and health at construction sites. Also, the effective implementation of safety and health programs is absent in most construction businesses in developing countries. The construction industry of Ghana shares in many of these features of safety and health management in the construction industry of developing countries.

Table 1: Health and safety in developing Countries

Author(s) and Year	Summary of research	Key constraints to effective safety and health management
Suazo and Jaselskis (1993)	Compared the occupational safety and health administration system of a developing country (Honduras) and that of a developed country (US).	The study found that the occupational safety and health administration of the developing country Honduras was incomprehensive and limited in coverage.
Koehn et al., (1995)	The study examined problems in health and safety management of construction projects in a developing country India.	The study identified ignorance on the part of workers, bureaucracy and time pressures as factors militating against effective safety and health management in the construction sector.
Koehn and Reddy (1999)	The study explored safety problems and labour	The findings of the study indicated certain

	requirements in the construction industry of India.	characteristics of construction in developing countries contributed to poor safety and health performance of the industry: ▪ availability of cheap labour means workers are compelled to take unacceptable risks because of fear of being dismissed; ▪ workers cannot afford the cost of proper nutrition because of low wages leading to fatigue and slow rate of work; and ▪ Poor health and safety attitudes.
Haupt and Smallwood (1999)	Study examined health and safety practices on community projects in South African Construction industry.	The findings of the study indicate that health and safety practices are rarely adopted on community projects: typically, no inductions are conducted; workers are not consulted on health and safety issues; PPE is seldom provided; and policies, rules and health and safety programs are not implemented.
Peckitt et al., (2002)	Compared health and safety risk management between a developed country (UK) and a developing countries (Caribbean countries).	The study found that: ▪ positive influences on the safety culture of the British construction industry include; relatively high levels of regulation, resources and formal health and safety management systems; ▪ Positive influences on the

		safety culture of the construction industry of the Caribbean include: strong personal locus of control for safety, high risk perception and slow pace of work.
Smallwood (2002)	Study examined the link between religious believe systems and safety and health.	The study's findings showed that religion puts emphasis on the need for conservation of life and the environment.
Peckitt et al., (2004)	Examined the role of societal culture in influencing safety culture of the construction industries of UK and the Caribbean.	The findings of the study demonstrate that societal cultural biases have an impact on safety culture. Societal orientations to power relationships, time, human relations, materialism and risk taking were found to be important factors influencing safety culture of the Caribbean both countries.
Mwombeki (2005)	Study investigated the implementation of health and safety on construction sites in Tanzania	The study found that a majority of Tanzanian contractors, small or large, appear to understand the importance of health and safety programs but did not implement such programs to improve the poor health and safety performance of the construction industry.
Gibb and Bust (2006)	The study investigated the implications on safety and health of carrying out engineering and construction projects in developing countries.	The study identified a number of factors having a negative impact on health and safety management in developing countries: • Poor infrastructure; • Problems in communication;

		• Unregulated practices; • Adherence to traditional methods of working; • Non availability of Construction equipment; • Extreme weather conditions and corruption.
Kheni (2008)	Health and safety in the construction SMEs in developing countries a case of Ghana	Lack of skilled human resources, inadequate government support for regulatory institutions and inefficiency in institutional frameworks responsible for health and safety standards are some of the challenges affecting the health and safety in the construction industry in Ghana.

In Ghana, Addo-Abedi (1999) reported that virtually all domestic construction businesses operate as small scale contractors managed by owner/managers and their spouses and in some cases, their children. These SMEs are constrained by limited access to financial and information resources as well as regulations and procedures which make it difficult to effectively manage the safety and health aspects of their operations. The quality of working conditions within SMEs is therefore relatively unsatisfactory when compared with working conditions in large construction businesses within the country. Considering that a sizeable proportion of the labour force in construction is employed within construction SMEs, this raises the level of concern for safety, health and welfare within the SME sector in construction as many workers are exposed to hazards on site. However, there are laws that seek to address the health and safety management issues in the construction industry. The table 2 outlines some of these laws.

Table 2: Implementation of safety and health legislation

Government Department/Agency	Health and safety law mandated to implement	Summary of applicability to construction sites
Factory Inspectorate Department	Factories, Offices and Shops Act 1970	Sections 57, 6-8, 10-12, 19, 20, 25-31, 33- 40, 43-54 and 60-87 are applicable to building and civil engineering works
Labour Department	Labour Act 2003 Workmen's Compensation Law 1987	Part XV of the Labour Act concerns health and safety and applies to workplaces including construction businesses Workmen's Compensation Law 1987 is applicable to construction businesses
Environmental Protection Agency Environmental	Protection Agency Act (Act 490) Pesticides Control and Management Act (Act 528)	Both Acts are applicable to building and civil engineering works and therefore of relevance to construction businesses
Mines Department	Mining Regulations 1970	Building and civil engineering works carried out under the ambit of mining companies are affected by the regulations
Town and Country Planning Department	Planning and Building Regulations	Applicable to all physical developments.
National Road Safety Commission	National Safety Commission Act (Act 567)	Applicable to road construction works

Study Area and Research Method

Study Area

Koforidua serves as the administrative capital of both the Eastern Region of Ghana and the New Juaben Municipality. According to the Ghana Statistical Services report (Census 2000), the population of the New Juaben Municipality is about 87315. The Municipality shares boundaries with East-Akim Municipal on the North-East, Akwapim North District on the East and South and Suhum Kraboa Coaltar

District on the west. Obour Tabiri remains a major feature of the New Juaben Municipality.

The main occupation of the economically active population in the Eastern Region is Agriculture and its related activities. Sales, production, transportation etc are also the account for the employment of the active population. Within the New Juaben Municipality, Professional and Technical Services, Sales, Production, Construction etc form the dominant occupation of the economically active part of the population. The Association of Building and Civil Engineering Contractors of Ghana (ABCECG), Koforidua Branch has forty (40) members who undertake works in the related fields. These contractors employ staff to undertake construction works for their clients. Some of the works include the Koforidua Water Project, construction of residential and commercial facilities, roads, bridges, etc.

Research Method

Literature Review

Works done by other researchers in the area of health and safety in the construction industry and other relevant documents were reviewed. This guided the research team in selecting the best methods for the research from which salient conclusions and recommendations were drawn.

Site Visits

The team visited thirty (30) construction sites to observe condition prevailing there. The team made two visits per site.

Data Collection

Qualitative research method was chosen for this paper, semi-structured interviews were conducted with key persons within institutions with related responsibilities for health and safety on construction sites. These were persons within the participating institutions who had attained the status of supervisors, managers or Directors. The interviews were conducted at Labour Department Koforidua, Associations of Building Civil Engineers and Road Contractors Koforidua Branch and Site Supervisors. A total of 10 interviews were conducted (Table 3). The interview questions sought information on the following:

- Health and safety management practices at construction site in the New Juaben Municipality.
- The role of the supervisory agency on implementation of health and safety practices at the construction site in the Municipality.
- Efforts made by Construction Company to improve safety practices on site.
- The effect of health and safety management practice on employee job satisfaction.

Data from document sources were also analysed.

Table 3: Schedule of interviews conducted

Organisation/institution	Number of persons Interviewed	Schedules of persons interviewed
Labour Department Koforidua	1	Staff
Association of Road Construction Ghana (ASROC) – Koforidua	1	Eastern Regional Executive
Building Contractors and Civil Engineering Association of Ghana (BCCAG) – Koforidua	1	Eastern Regional Executive
Construction Firms	4 3	Site Engineers Workers

Results and Findings

This section summarises the main results of the interviews. The empirical data are presented as narratives and quotations.

Health and safety management practices at construction sites in the New Juaben Municipality.

Much attention of the research was focused on the Personal Protective Equipment (PPE) used on construction sites. Some of the parameters assessed are provision of safety boots or footwear, helmet, high visibility vests, safety signs and markings, safety glasses, first aid and scaffolds on site.

Field research findings revealed that very few workers on site wore a full protective gear. Most of the site Engineers interviewed said that most of the safety parameters listed above are provided since they are considered as essential to the work itself. For instance, the provisions of scaffolds are essential for height on site, without it, storey buildings cannot be constructed.

Very few employees on the other hand said they are not provided with this safety gear. Sites visited showed that a greater number of employees were not in safety gears as seen in figures 1 - 4 below:



Fig. 1: workers in safety Boots



Fig. 2: showing worker in full safety gear



Fig. 3: worker in High-Vis Jacket & Boots



Fig.4: workers on scaffolds

Source: field work 2010/2011

The involvement of the various contractors associations i.e. ASROC and BCCEA in health and safety management within construction industry in the new Juaben Municipality is limited to instances of strained industrial relations between employers and their employees where the issue(s) of contention relates to safety and health conditions at the workplace. Many construction firms are not registered with these associations and this limits the extent to which the association can get involve. The position of the Associations regarding health and safety within the construction industry in the municipality is summarised by one interviewee as follows:

“The health and safety standard at construction sites have not been very encouraging especially the sites of non-members and that is why there is an increase in accidents on construction sites. We have consistently explained to these firms to join us i.e. ASROC or BCCEA so that they can take advantage

of our numerous training programmes on safety laws and health and safety standards at workplace. Apart from that, the only way we can reach these firms is for them to come to the health and safety forums that we organise”
(Regional Executive Member of ASROC).

The role of the supervisory agency on implementation of health and safety practices on construction sites in the Municipality.

The influence of government institutions with responsibility for implementing health and safety standards in New Juaben Municipality is minimal. The Factory Inspectorate division which is under the Labour Department is responsible for enforcing health and safety legislation in most of the economic sectors including construction rarely carry out inspections of construction sites in the Municipality. Although it is a requirement for contractors to register their sites with the department, it is mainly large international construction businesses operating in the Eastern Region that comply with the requirement. The response of one interviewee of the department indicates construction firms’ compliance with the Factories, Offices and Shops Act is less than desirable:

“I must say that the most serious abuse of the Factories, Offices and Shops Act occur in the informal sector which includes small domestic contractors in the region. Many of the owner/managers of small construction businesses are ignorant of their responsibilities under the health and safety law affecting the construction sector. The Department has embarked on educational campaigns to help raise the level of health and safety awareness within the construction sector”

(View expressed by personnel of Factory Inspectorate Division of Eastern Regional Labour Department during an interview).

Views of other departments with responsibility for implementing safety and health standards within construction industry in the municipality portray the sector as one which pays little regard for the safety and health of its employees. Hazards associated with construction activities are often overlooked, resulting in serious accidents.

Respondent from the Eastern Regional Labour Department said:

“Small-scale contractors want to make the maximum profits and would not provide the necessary personal protective equipment for their workers. They do not evaluate the risk involved in carrying out construction work and as such do not take steps to minimise or eliminate hazards. Some of their workers are employed without completing their apprenticeship training; while some may not be trained. They may not be sensitised for their safety. Most of their workers are from the informal sector where they may not go under any regulation or union. They would not want to spend their time, money and

other resources to train their workers up to a certain standard of safety and health”

Efforts made by Construction Companies to improve safety practices on site
Some Directors of construction firms interviewed indicated that they are making conscious efforts to improve on safety. They also complained that profits on projects are eaten away by payment of compensations and settling bills resulting from accidents on site. Again, firms were losing out on the payment of safety gears catered for at the general items section in the Bill of Quantities (BOQ). The position of Site Engineers regarding the provisions of health and safety parameters at construction site was summarised by one interviewee as follows:

“We provide these basic safety gears on site because we consider them as part of the contract execution. This is because most of them are paid for by the client as part of the contract; therefore, we have no problem at all providing them to our artisans and employees on site. However, most of the employees rather don’t wear them because they claim to be uncomfortable. Therefore, we rather have problems enforcing the wearing of safety gear because it is one thing providing and another using them. Mind you, payment is made by submitting receipt for purchase and picture displaying usage”
(Site Manager of KOOK Engineers)

Again, most firms seem to be dealing with the age-long problem of labourer learning skilled work on-site. To them, majority of the accidents occur as a result of untrained labourers learning the trade of artisanship on-site.

The effect of health and safety management practice on employee job satisfaction
Most employees are contracted to work on a specific project and are laid-off after completion of the project. Hence, the safety of these workers are overlooked, these have resulted to high employee turnover and low staff morale. Therefore, many of the initiatives that are introduced occasionally by management on site are met with apathy, cynicism or obstruction.

As explained by one concrete mixer operator:

“Even though, the company provided me with a safety gear three years ago, it is at best not used because everything is spoiled. I asked for replacement but as you can see, the project is near completion and I have not received any. I presume management intends to lay-off some of us that why they are hesitant”

(A concrete mixer operator working on the site of Damoah Yao Ent.)

Some employees interviewed also said they always expressed their unhappiness, when their comrades get injured as a result of a preventable accident on site. However, employees who were provided with the full protective gear on site said

they were very happy and could do things without the fear of a possible injury as summarized by one worker on site:

“To Be Coming To Work Every Day And Thinking That In Spite Of The Dangers Associated With Construction Work, I Can Go Back Home In Peace And See My Family Again, Is Enough Motivation For Me. The Protective Gear the Company Has Provided Gives Me Enough Assurance That The Company Thinks About Me, Therefore, I Give Off My Best At Site”

Conclusion and Recommendations

Conclusions

Field research findings revealed that health and safety at most construction sites in the New Juaben Municipality is unacceptable. Even though contractors in the Municipality are made to purchase for use safety gears as part of the contract execution, very few workers on site wear these protective. In addition, the involvement of the various contractors associations i.e. ASROC and BCCEA in health and safety issues at construction site in the Municipality is very limited.

The research also revealed that, the Factory Inspectorate division of Labour Department and other regulators mandated by law to enforce health and safety legislation in construction sites at the Municipality, rarely carry out inspections because of financial constraints and the inability of contractors to register their sites with the division as stipulated in the law.

Finally, the paper established that health and safety management practice in the Municipality has effect on employees' satisfaction. A good health and safety practice on site improves the satisfaction of employees. The parties responsible for ensuring internationally acceptable standards of health and safety on construction sites in Ghana are Government, clients, consultants, contractors, workers and civil society.

Recommendations

The following are recommendations which would help in improving the health and safety of construction activities:

1. Employees are to take reasonable care for the health and safety of themselves and others affected by their acts or omissions.
2. The construction workers should be trained on construction safety and related issues.
3. Regulatory agencies should be resourced to conduct their activities very well.
4. Site supervisors and contractors should ensure strict usage of PPE on site through awards and motivation.

5. The Government and its Allied Agencies must ensure that Government construction projects adhere to health and safety issues outlined in the conditions of contract.
6. The Legislative Arm of the Ghana government must enact a law that would protect the health and safety of construction worker, considering the contributions of the construction sector to the GDP of the country.
7. Further research into the cost indices of safety gears and contract delivery.

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PROSPECTS OF THE LOCAL TEXTILE INDUSTRIES AND THE EMERGING OIL AND GAS IN GHANA

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Abstract

This survey investigated the opportunities and prospects of the Local Textile industries in exploration and processing of Ghana's emerging oil and Gas. Data was collected from subjects made up of personnel from Ghana Tex Styles Company and six exploration and oil related companies, Tullow, Ocean Rig, Modec and Mernergy located in Takoradi. The researcher used questionnaires and interviews; they developed a fourteen item questionnaire and ten item interview guide which was used in collecting data for the study. Purposive sampling procedure was used in selecting participants. The findings included the use of varied textile products in daily activities from simple to complex based on the production processes of the textile material. Some includes absorbent pads, cotton rugs, woollen blankets, fibre web sling, nose masks, filters, hand gloves and vice versa residue fuel for boilers in Textile industries , for producing wax, dyes and synthetic polymers for fibres and finishes.

Introduction

The textile industry in Ghana established over the years has gone through several phases of developments and has dealt with activities that has not gone beyond the converting of cotton fibres into yarns and fabrics and depends on cotton, linen, rayon, and silk from other countries to produce most fabrics like printed wax, mummy cloths, fancy, java, diva, batik, tie-dye, screen printed fabrics and kente woven with hand or machine with distinctive colours and design.

The textile industry is large with diverse areas of operations and considering the industry purely in relation only to clothing considerably underrates its importance since clothing takes only about half of the output of the industry, the other half is divided evenly between household and industrial applications. The development of man-made fibres is an important aspect of textiles that needs to be adapted in the textile industry in Ghana so that they can also manufacture textile products that can be used for industrial applications aside the production of mummy cloths, fancy etc. The growth of the textile industry is dependent on an industry like the petroleum industry since most of the source of raw materials used in producing textiles is from petroleum, like the residue fuel oil obtained from petroleum used as a means to generate steam energy for the boilers used for processing in the textile industries in Ghana and many more benefits which will be dealt later in this research study.

The discovery of the crude oil in the Western, Central, Eastern, and the Volta Region of Ghana serves as a catalyst of opportunities to expand the horizon of the textile industry and to change its focus of operations from only the manufacture of household textiles to industrial textile applications.

Overview of textile and the petroleum industry

According to Ajavon .I (2007), *“Textiles involve woven fabrics made from natural or synthetic yarns”*. Sackey .J (1995) is also of the view that *“textiles as the designing, production and decoration of fibres, yarns and fabrics”*. It could also be the processing of fibres, yarns and fabrics. It could also be the processing of fibres into fabrics. The word is pronounced as “tekstailz” which refers to all fabrics either in the piece or garment form.

Kadolph, S.J. (2007) and Taylor, M.A. (2007) share the same opinion that *“the word “textile” originally meant a fabric produced by weaving, but its application has greatly broadened”*. Now, the term is used for wide range of products made from fibres or filaments, including not only woven, knitted and felted fabrics but also lace, nets, yarn, cord and many other materials. The varieties of these products and their uses have applications in almost all our activities.

According to the Microsoft Encarta (2009) textiles is *“a generic term from Latin “texere” which means to weave, originally applied to woven fabrics, but now also applied to natural and synthetic filaments, yarns and threads as well as to the woven, knitted, felted, tufted, braided, knotted and embroidered fabrics made from them; and to non woven fabrics produced by mechanically or chemically bonding fibres.”*

From the various findings on textiles, the researcher is also of the opinion that, textile is formed when pliable fibres and yarns which goes through conversional spinning and weaving processes to form fabric and it's decorated for the purpose of serving the essential needs of man. Textiles is a powerful medium, rich with symbolic meaning and aesthetic significance that inculcate beauty and the presence of purpose to the user. That is why Corbman .B (1983) states that, textiles have an important bearing on our daily lives, that everyone needs to know something about them. From earliest times, people have used textiles of various types for covering, warmth, adornment and even to display wealth and for communication.

Corbman .B (1983) gives an overview of the textile industry as complex, large and diverse in area. The textile industry with its range and markets begin in Agriculture with fibre production of cotton, flax and other fibrous plants; In Husbandry of sheep, silkworms and other animals; In mining of metals and minerals; In Forestry for wood; In chemical research and the production of synthetics. These fibres are then processed into yarns and fabrics, for industrial and consumer uses by various means

such as knitting, weaving etc. The fabrics are converted into cloths which provide particular appearances and performances. Every one of these aspects of the textile industry is a field in itself.

According to Elsasser .V.H (2005), the *“textile industry encompasses every aspect from raw fibre production to final consumption of product which is a fascinating blend of science and technology, art and design and business”*. She explained that, the textile industry is international and offers extensive career opportunities because the industry is in parts that are complex. They can be divided in five general areas; Science and Technology, Art and Design, Manufacturing and Production, Sales and Marketing, Product Development.

According to Wikipaedia Encyclopaedia, Textile Industry is *“a term used for industries primary concerned with the design or manufacture of clothing as well as the distribution and use of textiles”*.

The New Encyclopaedia Britannica defines the modern textile industry to be still closely related to the apparel industry, but the production of fabrics for industrial use has gained importance. In the most technically advanced communities, the textiles industry employs a high range of workers like technicians, engineers, and artists which gives the industry a high degree of consumer orientation that leads to emphasis on marketing operations.

From the review, it can be analyzed that, the textile industry is broad and quiet complex with many parts that offers job opportunities. The textile industry can therefore be defined as an industry that manufactures raw materials like fibres into yarns and fabrics for end products. Aside production, the industry is a whole structure on its own with a lot of components. Therefore the textile industry has a major relevance to the economic growth of a nation. Today modern textile industry has now improved textile characteristics and quality control.

According to Business Dictionary Online, the *“petroleum industry includes the global processes of exploration, extraction and refining petroleum as a specific raw material into a desired state of products”*.

The New Encyclopaedia notes that *“petroleum industry is an industry of refining petroleum and natural gas into different products and chemicals”*.

According to New Encyclopaedia Britannica, petrochemicals are simply chemicals that happen to be derived from starting material obtained from petroleum. They are also used for a variety of commercial purposes.

The Microsoft Oxford Dictionary (2009) also defines “petrochemicals as chemical properties and processing of petroleum and natural gas; relating to the chemistry of rocks”. A chemical obtained from petroleum and natural gas.

These definitions of petrochemicals and what they are also gives an idea about the petroleum industry and its activities.

From the researchers' point of view, there is clear understanding of the characteristics and functions of the petroleum industry as being an oil refinery with other complex parts that produces chemicals used for manufacturing products. The Encyclopaedia also gives complexity between the petroleum industry and the petrochemical industry but both industries can be related to as oil refineries. Therefore, the importance of the petroleum industry to the textile industry is something which is inevitable.

Purpose of the Study

Throughout the years, the activities and production of the textile industry in Ghana has been limited to only the manufacture of cotton fibres converted into yarns and fabric, finished into household products like consumer textiles which are mostly used for clothing than for industrial applications.

The petroleum discovery in Ghana has brought about many oil companies that will use textiles in their field of work and will require support that deals with technical textiles.

Therefore this project seeks to unearth the opportunities in the petroleum industry for the textile industry and the various textile materials used in the petroleum industry and to examine how these opportunities can promote the growth of the textile industry in Ghana.

Research Objectives

The objectives of the research seek:

- To identify and examine the opportunities of the petroleum industry on the textile industry in Ghana.
- To identify the various textile materials used in the petroleum industry and its relevance.

Research Methods

The researcher employed the qualitative approach for which data collected were assembled described, analyze, and interpret findings obtained.

Population

The population of the study includes Modec, Tullow, Mernergy, Ghana Tex Styles Company, and Ocean Rig Company. They included leading staff of the selected population.

Data Collection Instruments

The research tool used in collecting data was mainly questionnaires and interviews. For the questionnaires, both close ended and open ended questions were used. The interviews used, helped the researcher to probe further into areas that were not clear and controversial.

Justification of Instruments

The close ended and open ended questionnaires were used to allow the respondents enough chance to answer the questions in their own words and enable them to provide information freely. The interviews enabled the researcher to solicit information from staff who generally found questionnaires to be a bother and also equipped the researcher the chance for further probing.

Findings and Discussions

Introduction

This contains the presentation, analysis, and interpretation of the data collected. A total number of forty (40) questionnaires were distributed and only twenty five (25) people responded.

The data gathered from the field study shall be discussed under the following sub-headings:

- Prospects of the Petroleum industry for the Textile industry
- The various textile materials used in the petroleum industry

- **Prospects of the Petroleum industry on the textile industry**

A total number of twenty five (25) respondents from the oil companies were analyzed. According to the information gathered, there are a lot of opportunities hidden and in stock for the textile industry and textile personnel.

During the field study, the researcher noted that twenty five (25) respondents out of twenty five (25) from the oil companies representing 100%, did not have any idea about the direct importance of textiles to oil exploration but through explanation and questioning by the researchers, they were able to understand the concept of textiles and acknowledged its relevance in the petroleum industry.

According to Mr. Martin Quainoo (personal communication on 15th /04/ 2010) of Ocean Rig in Takoradi, brought to bear the stand of the textile industry and textile personnel. He explained that, even though textiles was a need in the oil field, textile personnel cannot be employed as workers in the oil field but can work as suppliers to the oil companies or the petroleum industry because, they were only end product users than manufacturers. He further stated that, there were small scale business

enterprises which supplied them with textile materials, laundry and cleaning services but were not textile oriented people.

Mr. Quainoo noted that, the government has a policy which insisted that the oil companies stop the importation of textile materials and use made in Ghana products. This serves as an opportunity for the drive of product development projects to be initiated by the textile industry.

Out of the field study, it was also realized that fifteen (15) respondents out of twenty five (25) from the oil industries representing 60% stressed that the residue fuel oil which is also called atmospheric residue is given to the textile industry to generate power for their boilers. While the 10 respondents making the 40% were ignorant about the actual use of the products. It was also noted that the fuel oil was also used for vehicles used in the textile industry and also for greasing their machines.

The use of by-products of petroleum is of great value to the textile industry. Three (3) respondents out of twenty five (25) representing 12% were of the opinion that the fuel oil are given to the textile industry for the production of wax. Five (5) respondents representing 20% were of the view that most modern pigments and dyes used on textiles were synthetic based colorant obtained mostly from petroleum products although textile dyes were originally of natural extraction being derived from a number of vegetable and animal sources. It was also noted from the respondents that nine (9) representing 36% rather talked about other chemicals used in the as intermediaries. The intermediaries are petroleum products which are further processed into chemical finishes. Other chemicals like finishes, sodium hydroxide, printing pastes are all petroleum based products which are resources for a major industry like the textile industry. The remaining eight (8) respondents making 32% did not have any technical knowledge in the field of study.

Five (5) respondents out of twenty five (25) representing 20% were of the fact that petroleum products can be used for polymer formation and processed into synthetic fibres because majorly all synthetic fibres were produced from petroleum. These polymers obtained from hydrocarbons can be used by the textile industry includes, polyesters, polyamides (nylon), polyvinyl chloride, polystyrene, acrylics, polypropylene, and elastomers. These are strong synthetic polymers used to form fibres for clothing and other materials for other applications in the industrial field.

Out of the research conducted, eleven (11) people out of twenty five (25) representing 44% noted that, the textile industry should manufacture coveralls that can be used in the petroleum industry in fabric compositions that are strong, less absorbent finishes and can protect them like khaki. Fifteen (15) respondents out of twenty five (25) representing 60% were also of the view that the textile industry should manufacture and produce the oil companies with cotton rags in large

quantities. The remaining 10 respondent (40%) were adamant on the importance of the textile industry to the petroleum exploration.

Sixteen (16) respondents out of the twenty five (25) which represents 64% from the oil industries were of the fact that textile personnel can take up the responsibility of establishing laundry and cleaning services which can be much appreciated than the existing and newly established laundry enterprises due to the skill, experience and knowledge acquired in the way to handle and maintain textiles. Three (3) making 12% were more interested in the exploration process than the service provider while the remaining six (6) respondents representing 24% shared the view that, normal textile uniforms for administrative purposes should be supplied by the local textile industry.

Fourteen (14) respondents out of twenty five (25) representing 56% from the oil companies noted that, all areas of the industry needed textiles while eight (8) respondents representing 32% were rather of the view that the administration, safety and production departments needed textiles. Three (3) respondent representing 12% was of the opinion that, textile like curtains was needed only for the administration and human resource department but was not needed in the safety and production department and on the rig because, supervisors from far and near had their attention on the workers especially in cases of accident and for the supervision of right tools used for the appropriate job.

The various textile materials used in the Petroleum industry

Twenty two (22) respondents out of twenty five (25) representing 88% of the oil companies were of the view that, khaki coveralls are suits made in one piece that is worn to protect workers due to its strength and impervious handle from danger when worn. Three (3) did not know the quality and characteristics of the garment they wear. Among other apparels used, twenty one (21) respondents out of twenty five (25) representing 84% were of the opinion of using hand gloves which are textile materials that cover the hand and wrist with separate parts for each finger and provide warmth and protection, an example was a knitted dotted hand glove. The four (4) representing 16% did mention respiratory masks (to cover the nose and mouth of workers as a means of protection from inhaling bad odours and chemicals during the drilling processes and they are mostly disposed after usage), socks, ear plugs, safety blankets, and fireproof uniforms.

Out of twenty five (25), twenty (20) people which represents 80% stated emphasis on cotton rags and four (4) representing 16% stated calico used as rags in the oil companies for general cleaning like dusting tools and were used by the workers to clean sweat (personal hygiene). One (1) representing 4% commented on the use of absorbent pad which is a nonwoven textile. It was used in the occurrence of water

mixed with oil. It was known to be an oil/water filter and it's an important textile material needed during oil spillage to prevent the damage of the soil and water bodies. The oil is mostly recovered if it is good oil.

Three (3) people out of twenty five (25) representing 12% were of the opinion that woollen blankets were used for protecting toxic areas on the rig and for insulation purposes. Only three (3) respondent 12% was of the opinion that fibre web sling is a device that uses a strap or a piece of cloth or rope to support and lift heavy objects like metal or rubber pipes and some machines in the oil field. Nineteen (19) respondents representing 76% could not identify whether the materials mention were textile products.

On oil spillage, four (4) respondents out of twenty five (25) representing 16% from the oil companies noted that, textiles was used to protect the skin while seven (7) people representing 28% noted that textiles was used for cleaning and wiping oil spills. Fourteen (14) respondents representing 56% were of the opinion that woollen blankets were used in smothering flames in case of fire out break during oil spillage and was also used to prevent workers from slipping while.

It was therefore noted by the respondent that textiles was very important in the oil field to protect the environment. These were the various opinions and views of respondents from the oil field.

Summary, Conclusion, Recommendations

Summary

Out of the research, it was realized that, the petroleum industry will need textile products for its day to day activities. Some of these textile products are absorbent pads and cotton rags which are mostly used in cases of oil spillage, woollen blankets are also used for smothering flames during oil spillage. Other textile products used are fibre web slings, nose mask, filters, insulating blanket hand gloves, and many more.

The importance of these textile products to the petroleum industry cannot be understated; this must alert the textile industry in Ghana to diversify its activities from the production of household textiles to technical textiles.

The research also unearthed the use of the residue fuel oil from petroleum as a great source of energy for the boilers used for processing and producing wax, dyes, synthetic polymers for fibre, finishes and many more in the textile industry.

It was also discovered that, the creation of services like laundering of textile materials for the oil companies will be a means of creating jobs for textile personnel. Textiles are expected to remain clean and retain its physical integrity. Some textiles

have a high soil propensity than others, due to this, there have been various modifications of fibre and chemical finishes which are used during laundering, for cleaning, drying and ironing to keep textiles smooth and soft. These are the experience and knowledge which gives competitive advantage to textile personnel over existing and newly established laundering enterprises that are being managed by people who are not textile oriented.

Conclusion

The data collected during this research unearthed the benefits and importance of the petroleum industry to the textile industry; textile materials used in the petroleum industry. It was discovered that the textile industry and personnel has the opportunity of being the sole suppliers of textile materials and also rendering laundering services to the petroleum industry. The research also brings to light the benefits and importance of petroleum products which are the main source of raw materials in manufacturing textile products like dyes, finishes, wax, synthetic fibre polymers, and powering the engines of textile machines etc.

This research has therefore revealed the great benefits of the textile industry to the oil find and the importance of the petroleum industry to the textile industry.

Recommendations

- i. This study should be used to encourage textile personnel to have the desire for other vocations in textiles like textile chemist, textile engineering, textile consultancy, laundering and cleaning services so that personnel can come out with innovative textile products and services that can be used in other fields of work like the petroleum industry.
- ii. Seminars on petroleum products and its benefits to textiles should be organized to broaden the knowledge of personnel and equip them with the expertise to design and process textile products that can be used by the industry.
- iii. The researcher also recommends that, the textile industry should delve into the production of industrial textile applications like filters, cotton rags, absorbent pads etc. aside the production of household textiles like mummy cloths, so that the petroleum industry will be able to patronize from the textile industry since the government has given the oil companies the policy of using made in Ghana textile products.

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**AN EVALUATION OF THE QUALITY OF CUSTOMER SERVICE, CARE
AND SATISFACTION LEVELS AMONG CUSTOMERS OF KOFORIDUA
POLYTECHNIC RESTAURANT**

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Abstract

Today, quality customer service and customer care have become key elements in differentiating one restaurant from another. If managed superlatively, they serve as strategies for ensuring customer loyalty and creating competitive advantage. Koforidua Polytechnic “Hospitality Restaurant” was established in 2006 by Mrs. Agnes Amissah, the Head of Department of Hospitality, purposely to make facilities available for practicals and experiments for Hospitality students and bring hygienic lunch close to staff, students, guests and the general public. Observing the perception among customers that the Restaurant’s customer service quality and satisfaction levels leave much to be desired, the study was undertaken to assess the reliability and responsiveness, assurance, and empathy of staff in serving customers, assess the level of customer satisfaction, and develop intervention strategies for improving customer service quality & satisfaction. Literature on customer service quality was reviewed and primary data was gathered through observations, interviews and questionnaire administration. Frequencies, percentages, tabulations, and cross-tabulations were used to analyse the data collected, while pie and bar charts were used to present information. The study revealed, among others, that regular customers who patronize the restaurant on daily basis are about 120 out of which 78% are males and 22% are females. The study indicated negative gaps between the levels of reliability and responsiveness customers expect and what the Restaurant actually delivers to them. On responsiveness, assurance, and empathy, respondents rated the Restaurant average. Based on the findings and the conclusions drawn, recommendations were made to help improve upon the Restaurant’s performance and customer satisfaction levels.

Introduction

Koforidua Polytechnic “Hospitality Restaurant” was established in 2006 by Mrs. Agnes Amissah, the Head of Department of Hospitality. Until it was established both teaching and non-teaching staff had difficulty meeting their lunch needs and wants. Similarly, a section of the students from affluent backgrounds also had difficulties in getting good lunch. Visitors and guests of the Polytechnic had to go far away from the Polytechnic premises for lunch.

All food vendors on the Polytechnic premises concentrated under the popular mango and pear trees near the Engineering block so members of the Polytechnic community fondly call the place “Bush Canteen”.

Hospitality students of strokes 1 and 2 needed a hotel or restaurant facility for practicals in preparation for their external examinations. To meet these needs and requirements, Mrs. Agnes Amissah sought and was given approval for the commencement of restaurant services targeted at academic, non-academic staff, students and guests from far and near. As mentioned earlier, the restaurant was commercialized and started operations in 2006. Common foods served include various types of rice (jollof, vemiciline, and stew) and Ghanaian dishes like fufu with light, groundnut, or palm nut soups, ampesi with palaver sauce, and “rice balls) with the afore mentioned soups on request.

In addition to its normal day-to-day operations, the restaurant undertakes contract jobs from outsiders and the Polytechnic community in general for special occasions such as committee meetings, end-of-year get-together, seminars and conferences. As at now i.e. 2011, soft drinks such as Coca-Cola, Fanta, and fruit juices such as guava, pineapple, orange, are served, chilled or otherwise.

However, a lot of questions are raised in respect of the restaurants’ customer service quality. Specifically, the perception and belief among academic staff, non-academic staff, and students who patronise the Koforidua Polytechnic Restaurant is that customer service quality and satisfaction levels leave much to be desired. This research work therefore sought to investigate the quality of customer service and discuss key customer service gaps and other challenging issues that must be addressed to enable the restaurant build capacity and ability needed to give clients good value for money.

Research Objectives

The study was undertaken specifically:

- a. To assess the reliability and responsiveness of staff in serving customers.
- b. To assess the assurance and empathy of staff in serving customers.
- c. To assess the quality of tangibles (physical evidence) of the Restaurant.
- d. To assess the level of customers’ satisfaction

Research Questions

The study sought to address the following research questions:

- a. What is the quality of customer service at the Restaurant?
- b. What factors determine customer satisfaction levels?
- c. What is the level of customer satisfaction at the Restaurant?
- d. Is there the need for improvement in customer service delivery?
- e. What improvements and interventions are required?

Literature Review

Service quality is influenced by expectations, process quality and output quality. In other words, the standard of service is defined by customers who have experienced that service and used their experience and feelings to form judgement (Chen *et al.*, 2001). Customer service quality and customer satisfaction are so closely related that one can hardly talk about one without the other. A development of service quality by Gronroos (1984a) distinguishes between ‘technical’ and ‘functional’ quality:

- i. Technical quality refers to the relatively quantifiable aspect of a service that consumers receive in their interaction with a service firm. It forms important bases for judging service quality because it can easily be measured by both customer and service provider. Examples of technical quality include the waiting time at a restaurant and the reliability of its services. This, however, is not the only element that makes up perceived service quality.
- ii. Functional quality: Because services involve direct consumer-producer interaction, consumers are also influenced by *how* the technical quality is delivered to them. This is what Gronroos describes as *functional* quality and cannot be measured as objectively as the elements of technical quality. In the case of the queue at a restaurant, functional quality is influenced by such factors as the environment in which queuing takes place and customers’ perceptions of the manner in which queues are handled by the restaurant staff.

Gronroos also sees an important role for a service firm’s corporate image in defining customers’ perceptions of quality, with corporate image being based on both technical and functional quality. See figure 1.

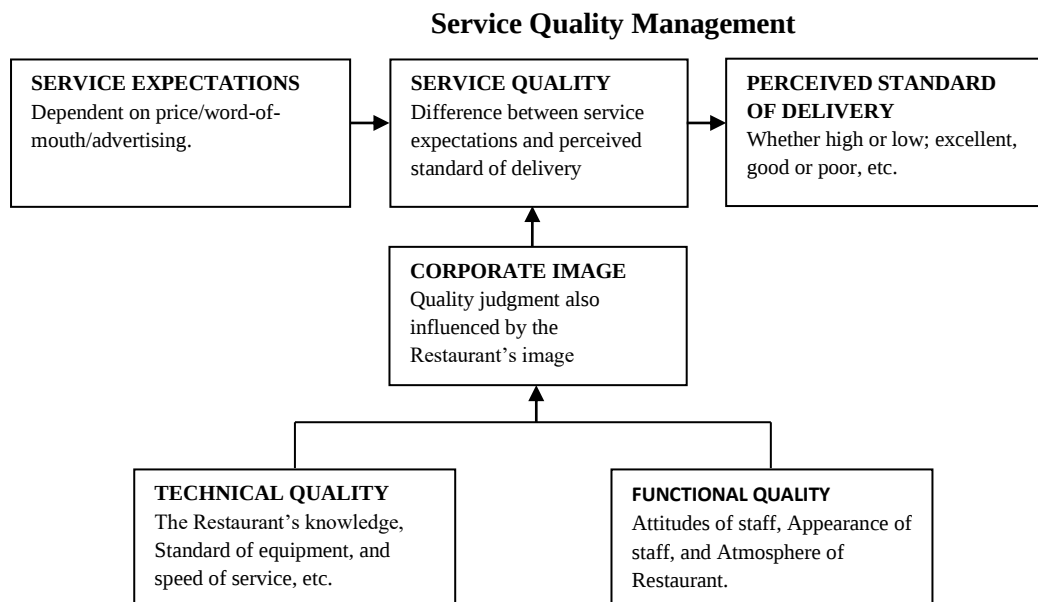


Figure 1: Consumers’ perception of technical and functional quality applied to the Restaurant’s practice (based on Gronroos, 1984b).

According to Palmer (2008) 'quality is determined by the difference between what a customer expects and the perceived level of actual performance'. These findings have evolved from a set of qualitative marketing research procedures, culminating in quantitative technique for measuring service quality that is known as SERVQUAL (Parasuraman *et al.*, 1985). The SERVQUAL model has been widely applied in the service industry.

The SERVQUAL model can be used by companies to better understand the expectations and perceptions of their customers. It is applicable across a broad range of services industries and can be easily modified to take account of the specific requirements of a company. In a nutshell, the model provides a framework or guideline for an investigatory instrument, which can be adapted or added to as needed.

SERVQUAL is originally based on a generic 22-item questionnaire, which is designed to cover five broad dimensions of service quality that the research team consolidated from their original qualitative investigations. The five dimensions covered, with some description of each of them are as follows:

Dimensions for Evaluating Service Quality

Based on this service-quality model, researchers have identified the following five determinants of service quality in order of importance (Berry and Parasuraman, 1991):

- i. **Reliability:** Ability to perform the promised service dependably with consistency and accuracy. Reliability means performing the service right the first time.
- ii. **Responsiveness:** The willingness to help customers and to provide prompt service.
- iii. **Assurance:** The knowledge and courtesy of employees and their ability to convey trust and confidence.
- iv. **Empathy:** The provision of caring, individual attention to customers' genuine problems.
- v. **Tangibles:** The appearance of physical facilities, such as cutlery and furniture sets, TV and radio sets, the building, equipment, personnel, communication materials, etc.

Inability of any firm to meet these criteria causes unsuccessful quality customer service delivery. The model, shown in figure 2, identifies five (5) gaps that cause unsuccessful quality customer service delivery.

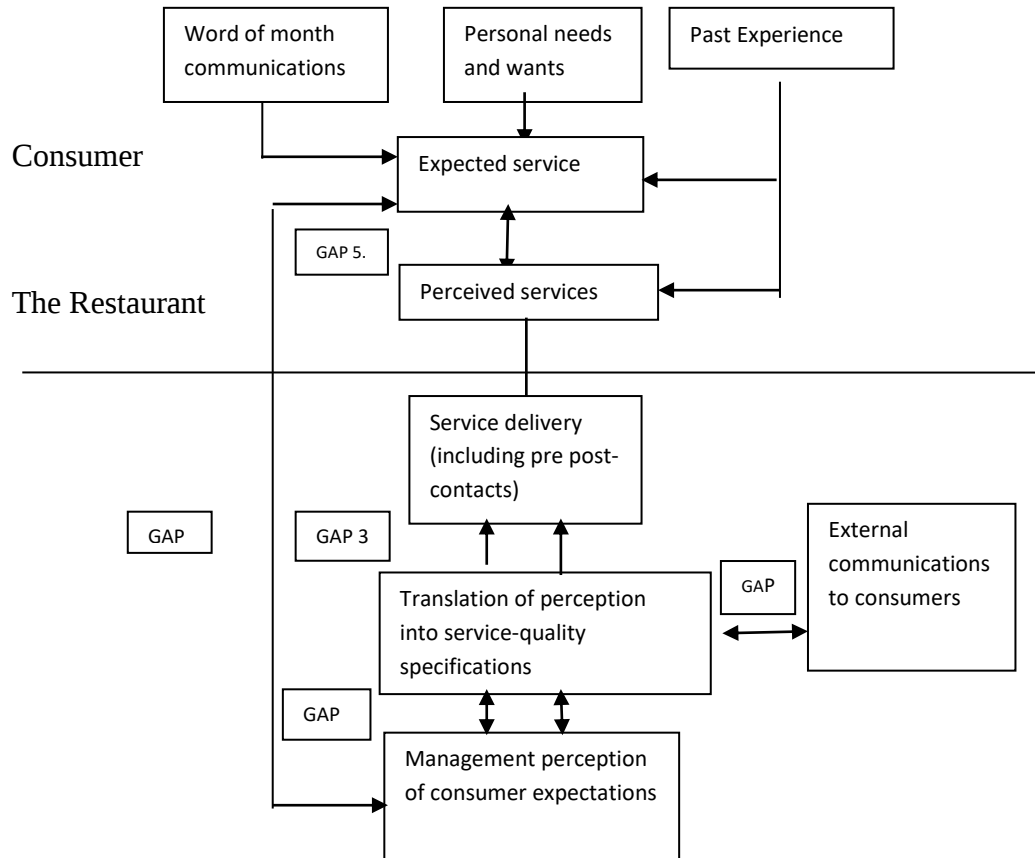
Gaps that cause unsuccessful Quality Service Delivery

Parasuraman, Zeithaml, and Berry (1985) identified five gaps that cause unsuccessful quality service delivery:

- i. Gap between customer expectation and management perception: Management does not always correctly perceive what consumers want. For example, management of the restaurant may think that customers always want continental dishes, but customers may want local dishes with more personal services.
- ii. Gap between management perception and service-quality specification: Management might correctly perceive customers' wants, but not set specific performance standard. For example, the restaurant manager may tell attendants to give fast service without specifying it in minutes.
- iii. Gap between service-quality specifications and service delivery: Personnel might be poorly trained, incapable, poorly motivated, unwilling to meet the standard; or they may be held to conflicting standards, such as taking time to listen to customers and serving them fast.
- iv. Gap between service delivery and external communications: Customer expectations are affected by statements made by company representatives and advertisements. For example, if the restaurant's adverts and brochure shows a beautiful building, but customers arrive and find the interior decor to be cheap and tacky looking, external communications have distorted the customers' expectations.
- v. Gap between perceived service and expected service: This gap occurs when the customer misperceives the service quality. For example, a top-official of the restaurant may keep visiting key customers to show care, but some of them may interpret this as an indication that something is really wrong with their business which the restaurant management perhaps wants to find out.

According to McDaniel, Lamb, and Hair (2006) "when any one or more of these gaps are large, customers perceive service quality to be low. As the gaps shrink, customers perceive improvement in service quality." This implies that managers of service organizations such as Koforidua Polytechnic Restaurant should always endeavor to close these gaps as soon as they are detected.

Figure 2: SERVQUAL MODEL



Source: A. Parasuraman, Valarie A. Zeithaml, and Leonard L. Berry, "A Conceptual model of Service Quality and its implication for Future Research," *Journal of Marketing*, 49 (1985): 41-50.

The same framework was used to guide this study in measuring customer service quality and satisfaction levels among customers of Koforidua Polytechnic Restaurant. Literature on the topic indicates that, while the majority of research suggests that service quality is a vital antecedent to customer satisfaction (Parasuraman *et al.*, 1985; Cronin and Taylor, 1992), there is also evidence to suggest that satisfaction may be a vital antecedent of service quality (Bitner, 1990). Irrespective of which view is taken, the fact remains that the relationship between satisfaction and service quality is strong when examined from either direction.

Thus, satisfaction affects assessment of service quality and assessment of service quality affects satisfaction (McAlexander *et al.*, 1994). This indicates that both are vital in helping buyers develop their future purchase intentions. In an empirical

study of the relationship between satisfaction and quality, Iacobucci, Ostrom, and Grayson (1995) concluded that the key difference between the two constructs is that quality relates to managerial delivery of the service while satisfaction reflects customers' experience with that of service. They also advanced a very important argument that quality improvements that are not based on customer needs will not lead to improved customer satisfaction.

Essentially, the Five Determinants of Service Quality model namely: reliability, responsiveness, assurance, empathy, tangibles, by Berry and Parasuraman (1991) and Gap model of Service Quality namely: gap between customer expectation and management perception; gap between management perception and service-quality specification; gap between service-quality specifications and service delivery; gap between service delivery and external communications; and gap between perceived service and expected service, by Parasuraman, Zeithaml, and Berry (1985) formed the framework for the study.

Scope and Methodology of the Study

The study focused on Koforidua Polytechnic Restaurant, students, lecturers and non-academic staff. Preliminary investigations were conducted, questionnaires tested, then a sample size of 116 selected from a population of about 140 customers over two weeks. Research Assistants administered questionnaires to respondents in their homes, offices, staff common rooms, etc. and even at the Restaurant on the instructions of researchers for about two months. Administered questionnaires were retrieved over a period of 4 weeks. Also, some of the customers were interviewed in their offices or homes to ensure confidentiality and expression of sincere opinion on the state of the restaurant's service quality and satisfaction levels among customers. Observations too were made in the Restaurant to watch how frontline staff attended to customers.

The survey research method was used to purposively administer questionnaires of 24 questions comprising open-ended, close-ended, and a Likert 5-scale items to 102 loyal customers. Personal interviews, which lasted between 1 and 15 minutes per individual were conducted involving 10 customers and 2 management members of the Restaurant and observations were made to observe the interface between attendants and customers for more information to supplement data gathered through questionnaires.

Frequencies, percentages, tabulations, and cross-tabulations were used to analyse data, while pie and bar charts were used to present information.

Discussion of Results

A distribution of Gender

78% of the 102 respondents were males while only 22% were females. What probably explains this situation is the fact that Ghanaian ladies generally prefer eating at home to eating in public places.

Questionnaire Administration

102 (88%) of the 116 questionnaires administered were retrieved. All questionnaires administered to teaching staff were retrieved. However, 9 and 5 of them could not be retrieved from students and non-teaching staff respectively, representing 14 (22%) of the total questionnaire administered. This shows that response and retrieval rates were high, especially among the teaching staff.

Reliability and Responsiveness of the staff

15% of the respondents indicated that it takes an attendant between 1 to 5 minutes to be served. 85% of them indicated that it takes an attendant between 5 to 15 minutes to be served. This suggests that it takes an attendant between 5 to 15 minutes to serve customers.

From the responses, 51% of the respondents would want to be served in less than 5 minutes; 34% would want to be served in 5 minutes; and 14% would want to be served between 5 and 10 minutes. Only 1% would want to be served between 10 and 15; while none of them would want to wait for more than 15 minutes. This implies that most (85%) of the customers would want to be served within 5 minutes.

Assurance and Empathy

Student-respondents rated attendants' performance on the six (6) customer service quality determinants as follows: of the 219 answers analyzed, 14% rate customer service quality as Very poor, 23% rate it as Poor, 36% state that it is Satisfactory, 18% rate it as Good, while 7% and 1% rate it as Very good and Excellent respectively. This suggests that the frontline staff performance on customer service delivery is average.

Non-teaching staff-respondents rated attendants' performance on the six (6) customer service quality determinants as follows: of the 176 answers analyzed, 9% rate it as Very poor, 14% rate it as Poor, 42% rate it as Satisfactory, 27% rate it as Good, while 6% and 3% rate it as Very good and Excellent respectively. As indicated in table 6, it means that the frontline staff performance on customer service delivery is average.

Teaching staff-respondents rated attendants' performance on the six (6) customer service quality determinants as follows: of the 223 answers analyzed, state that the quality of service is Very poor, 13% state that it is Poor, 63% state that it is Satisfactory, 15% state that it is Good, 6% state it as Very good, and nobody believes that the quality of service is Excellent. Similarly, this means that the frontline staff performance on customer service delivery is average.

Tangibles (physical evidence) – the appearance of physical facilities, equipment, etc

Responses showed that essentially, 87% of the customers are of the view that the restaurant environment is hygienic. 8% are not sure whether or not it is hygienic, 2% and 4% disagree and strongly disagree respectively that the restaurant is hygienic. This implies that customers generally perceive the restaurant environment as hygienic. However, a significant percentage of (8%) seem not to be sure of the hygiene of the place. Another significant percentage (6%) is not convinced that the place is hygienic.

Opinions on whether the interior of the restaurant is a comfortable atmosphere

About 57% of the customers feel that the interior of the restaurant is relaxed and comfortable. 13% are not sure. Essentially, 31% of the customers do not feel relaxed and comfortable at the restaurant for the following reasons:

- (i) the place is usually warm at lunch time
- (ii) the place is not spacious enough
- (iii) Student-respondents complained that they are not comfortable eating among their lecturers.

Opinions on whether provision of radio and TV will increase level of satisfaction.

About 89% of respondents miss the presence of radio and TV sets. Thus, they agree that providing these gadgets will make them more satisfied with the services of the restaurant. 4% are unsure whether radio and TV sets will make a difference. About 7% do not want them. Reasons most of the respondents gave for requesting for radio and TV sets are that they will be used for listening to news, for entertainment, and relaxation while waiting for their turns. An academic staff suggested that a radio set might just be okay; that a TV set may attract others with no intention of eating. On the contrary, about 7% of the respondents who object to adding these gadgets argue that they would make the place more congested because the place is already small.

Opinions on whether provision of menu card will increase level of satisfaction

About 78% of respondents feel the absence of menu cards. Thus, they explained that access to menu cards will make them more satisfied with the services of the restaurant because it saves customers the trouble of always having to ask attendants

of types of food available all the time. 16% were unsure whether menu cards will make a difference in their level of satisfaction or not. About 6% of them do not see the need for it.

Levels of satisfaction with service quality

64% of the respondents patronize the restaurant for lack of better options on campus as against 36% who claim that they patronize the place as a matter of choice. This suggests that most of the customers patronize the place for lack of better alternatives on campus. That is to say that the restaurant's overall performance is below their expectations.

From the data analyzed, 80% of the respondents would switch to better options on/or around campus if they find any as against 20% who claim that they do not intend to switch to any substitutes. This suggests that most of the customers would switch to better alternatives should they find any. In other words, only 20% of the respondents are loyal to the restaurant. That is to say that the restaurant's overall performance is below their expectations; and even worse than the situation presented in Table 12 above.

When respondents were asked to rate the restaurant's overall service quality, 3% of them rated it very low; 20% rated it low; 70% rated it average; 7% rated it high; but no one rated it very high. All the above seem to indicate that the restaurant's rating on customer service quality is average.

Findings

The study revealed the following:

- i. Regular customers of the restaurant on daily bases were about 120.
- ii. Most of the customers (78%) are males, while only few (22%) of them are females.

Reliability and Responsiveness gap

Most (87%) of the customers indicated that they are served between 5 to 15 minutes. On the contrary, about 85% of the customers would want to be served between 1 and 5 minutes; and 51% would want to be served in less than 5 minutes.

Responsiveness, Assurance, and Empathy gap

- i) Students' ratings of the Restaurant on these attributes were as follows: poor (37%), satisfactory (36%), good (25%), and excellent (1%).
- ii) Non-Teaching staff's ratings of the Restaurant on these attributes were as follows: poor (23%), satisfactory (42%), good (33%), and excellent (3%).
- iii) Teaching staff's ratings of the Restaurant on these attributes were as follows: poor (16%), satisfactory (63%), good (21%), and excellent (0%).

Tangibles (physical evidence) of the Restaurant

Respondents were asked the extent to which they agree or disagree whether the appearance of workers, cutlery, furniture, fridges, interior and exterior décor etc, are hygienic.

Responses of all three categories of respondents combined were as follows: agree (87%), not sure (8%), disagree (6%).

Provision of TV and Radio sets

Respondents were asked the extent to which they agree or disagree whether provision of TV and radio sets will increase their level of satisfaction. Responses of all three categories of respondents combined were as follows: strongly agree (62%), agree (27%), not sure (4%), disagree (3%), and strongly disagree (4%).

Provision of menu cards

Respondents were asked the extent to which they agree or disagree whether provision of menu cards will increase their level of satisfaction. Responses of all three categories of respondents combined were as follows: strongly agree (44%), agree (38%), not sure (16%), disagree (3%), and strongly disagree (3%).

Loyalty of respondents

Respondents were asked whether they patronize the restaurant for lack of better options on campus or not. Responses of all three categories of respondents combined were as follows:

Yes (64%), No (36%)

Respondents were also asked whether they were looking for substitutes or not. Responses of all three categories of respondents combined were as follows:

Yes (80%), No (20%)

Observations and interviews

Through these instruments, it was confirmed that the place is usually warm because two ceiling fans were not effective enough for the place. Quality of interface between attendants and customers was also observed. Some students interviewed indicated that they were not comfortable eating in the mist of their lecturers. It was also gathered from the interviews that customers often do not get food of their choice to buy. Another fact gathered through the interview was lack of punctuality in making food ready for customers.

Conclusions

From the findings, the following conclusions were drawn:

- i. The Restaurant's customer base of about 120 is too small for a community of about 5000 people.
- ii. Males (78%) are the most customers. This may be due to that fact that the average Ghanaian woman (22%) would like to cook and eat at home.

Reliability and Responsiveness of Staff:

There is a negative gap between the level of reliability and responsiveness that customers expect and what the restaurant actually delivers to them. This is because most customers stated that they are usually served between 5 to 15 minutes but they actually would want to be served between 1 to 5 minutes, leaving a negative 10 minutes gap that management must work at. This implies that the Restaurant rates 'low' on reliability and responsiveness.

Responsiveness, Assurance, and Empathy of Staff

On these attributes, the restaurant's performance is skewed toward average in that 36% of the students rate the Restaurant 'satisfactory', 42% of the non-teaching staff rate it 'satisfactory', while 63% of the teaching staff rate it satisfactory. This implies that customers perceive the restaurant's performance on these attributes as average or mediocre.

Tangibles (physical evidence) of the Restaurant

The restaurant's main strength is in the quality and hygiene of tangibles, as most of respondents (66%) agree that not only are they of high quality, they are equally hygienic.

TV, Radio sets and Menu Cards

The study indicates that provision of these items will increase customers' level of satisfaction as 62% and 44% respectively strongly agree that TV & radio, and menu cards will increase their satisfaction levels. This is an indication that the restaurant needs these items to increase customer satisfaction.

Loyalty level of Customers

The study revealed that customer service quality is not compelling because majority of the respondents (64%) would switch to an alternative place, implying that only few i.e. about 36% would remain loyal. The study revealed further that, a much higher number of the respondents (80%) were actually searching for alternatives, as against very few (20%) who were not. This is an indication that the restaurant's loyal customers are very few.

Perception of Customer Service Quality

The study finally indicated that 70% of the respondents' rate the restaurants' customer service quality as average which directly establishes that customers'

satisfaction level is equally average, given the link between service quality and satisfaction.

This sort of consequential relationships between the two constructs was established in the review of literature.

It is clear that although the restaurant rates high on the *tangibles*, which are the least and the last of the customer service quality attributes in order of importance out of the five. This still presents little negative gaps because the finding indicate that provision of TV and radio sets will increase customer satisfaction. It rather rates 'low' on *reliability*, the most important of all the attributes. This indicates a big gap because most of the respondents would want to be served in 5 minutes but the study indicates that they are normally served between 5 and 15 minutes instead. This presents a big negative gap of 10 minutes; lack of punctuality and disappointments also contributed to the big negative gap in *reliability*. On *responsiveness*, *assurance*, and *empathy*, it rates average. This still indicates some negative gaps that need attention.

In view of this, the conclusion can be drawn that the customer service of the restaurant is of average quality resulting in equally an average satisfaction. Therefore customers of the restaurant are not yet satisfied let alone delighted.

Recommendations

The conclusions drawn suggest that there are gaps that should be closed if the Restaurant must satisfy its customers and even delight them. In view of this, the following steps must be taken to gradually close them in the next five years. A five-year strategic plan should be developed immediately in which attention should be paid to the following issues:

- i. Change in management attitude to provision of support and other resources to build the Staff's capacity for meeting customers' needs and wants speedily.
- ii. Staff capacity development programmes should be pursued to make staff more reliable and responsive to facilitate assurance and the trust customers expect from them.
- iii. More customer service training programmes should be pursued to equip staff with modern customer service skills needed for delivering customers expectations.
- iv. High but realistic customer service quality standards should be set on the five service quality attributes as a way of closing gaps identified in the study.
- v. The Manager with staff should support and monitor one another in making sure that they get everything right the first time.

- vi. The Manager with staff should perform weekly evaluation to identify areas of successes and failures of the week as the bases for improvement on the subsequent week's performance standards.
- vii. Staff should be better motivated through competitive conditions of service, empowerment and involvement in decision making.
- viii. One TV and radio sets each should be provided to sort of divert their attention a little bit to serve as a source of entertainment and news while customers wait for their turn.
- ix. About four additional ceiling fans or even air conditioners should be provided to reduce the warmness of the room during launch time to make customers more comfortable.

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APPENDIX

Table 1: Gender Distribution of Respondents

Gender	Total No. of Respondents		Students		Non-Teaching Staff		Teaching Staff	
	Freq	%	Freq	%	Freq	%	Freq	%
Males	80	78	25	69	22	73	33	92
Females	22	22	11	31	8	8	3	8
Total	102	100	36	100	30	100	36	100

Source: Field survey, 2010

Table 2: A distribution of Questionnaire Administration

Questionnaire Administration	Total		Students		Non-Teaching Staff		Teaching Staff	
	Freq	%	Males	Females	male	female	Male	Female
Retrieved	102	88	25	11	22	8	33	3
Not retrieved	14	22	5	4	4	1	0	0
Total	116	100	30	15	26	9	33	3

Source: Field survey, 2010

Table 3: How many minutes does it take an attendant to serve you?

Responses	Total no. of Respondents		Students		Non-Teaching staff		Teaching Staff	
	Freq	%	Males	Females	Male	Female	Male	Female
Less than 5	7	7	2	1	0	1	3	0
5	8	8	2	0	4	1	1	0
5 to 10	44	43	12	2	10	3	17	0
10 to 15	43	42	9	8	8	3	12	3
Total	102	100	25	11	22	8	33	3

Source: Field survey, 2010

Table 4: In how many minutes would you expect to be served?

Responses	Total no. of Respondents		Students		Non-Teaching staff		Teaching Staff	
	Freq	%	Males	Females	Males	Females	Males	Females
Less than 5	52	51	10	7	10	6	18	1
5	35	34	11	4	7	0	12	1
5 to 10	14	14	4	0	4	2	3	1
10 to 15	1	1	0	0	1	0	0	0
More than 15	0	0	0	0	0	0	0	0
Total	102	100	25	11	22	8	33	3

Source: Field survey, 2010

Table 5: How students rate the attendants on customer service quality attributes

Responses	Total no. of respondents		Customer Service Quality Attributes											
			Courtesy		Warmth		Friendliness		Care		Creativity		Urgency	
	Freq	%	M	F	M	F	M	F	M	F	M	F	M	F
Very poor	32	14	1	2	2	3	1	2	1	3	1	4	5	7
Poor	51	23	5	1	6	1	5	4	5	4	5	3	11	1
Satisfactory	79	36	10	5	9	5	10	3	12	3	12	2	6	2
Good	40	18	7	2	5	2	7	1	6	1	3	1	2	0
Very good	15	7	2	1	3	0	2	0	1	0	4	0	1	1
Excellent	2	1	0	0	0	0	0	1	0	0	0	1	0	0
Total	219	100	25	11	25	11	25	11	25	11	25	11	25	11

Source: Field survey, 2010

Table 6: How non-teaching staff rate the attendants on customer service quality attributes

Responses	Total no. of respondents		Customer service quality Attributes											
			Courtesy		Warmth		Friendliness		Care		Creativity		Urgency	
	Freq	%	M	F	M	F	M	F	M	F	M	F	M	F
Very poor	16	9	1	1	1	0	1	1	1	1	2	1	3	3
Poor	24	14	2	0	3	2	2	0	3	2	4	4	5	2
Satisfactory	74	42	10	5	10	4	5	4	8	4	11	2	9	2
Good	47	27	7	1	6	2	8	2	9	1	4	1	5	1
Very good	10	6	1	1	2	0	4	1	0	0	1	0	0	0
Excellent	5	3	1	0	0	0	2	0	1	0	0	1	0	0
Total	176	100	22	8	22	8	22	8	22	8	22	8	22	8

Source: Field survey, 2010

Table 7: How teaching staff rate the attendants on customer service attributes

Responses	Total no. of respondents		Customer Service Quality Attributes											
			Courtesy		Warmth		Friendliness		Care		Creativity		Urgency	
	Freq	%	M	F	M	F	M	F	M	F	M	F	M	F
Very poor	7	3	0	0	0	0	0	0	0	1	3	1	1	2
Poor	28	13	0	0	0	0	3	0	4	0	7	2	12	0
Satisfactory	140	63	25	2	25	0	18	1	22	2	20	0	15	0
Good	34	15	5	0	6	1	8	1	5	0	4	0	3	1
Very good	14	6	3	1	1	2	4	1	2	0	0	0	0	0
Excellent	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	223	100	33	3	22	3	33	3	33	3	33	3	33	3

Source: Field survey, 2010

Table 8: Opinions on whether the restaurant environment is hygienic

Responses	Total no. of respondents		Students		Non-Teaching Staff		Teaching Staff	
	Freq	%	Males	Females	Males	Females	Males	Females
Strongly Agree	21	21	10	2	2	2	5	0
Agree	67	66	13	8	14	5	24	3
Not Sure	8	8	0	1	3	1	3	0
Disagree	2	2	1	0	1	0	0	0
Strongly Disagree	4	4	1	0	2	0	1	0
Total	102	100	25	11	22	8	33	3

Source: Field survey, 2010

Table 9: Opinions on whether the interior of the restaurant is a comfortable atmosphere

Responses	Total no. of respondents		Students		Non-Teaching staff		Teaching Staff	
	Freq	%	Males	Females	Males	Females	Males	Females
Strongly Agree	9	9	4	1	2	1	1	0
Agree	49	48	10	1	12	3	20	3
Not Sure	13	13	3	0	4	2	4	0
Disagree	25	25	7	9	2	1	6	0
Strongly Disagree	6	6	1	0	2	1	2	0
	102		25	11	22	8	33	3

Source: Field survey, 2010

Table 10: Opinions on whether provision of radio and TV will increase level of satisfaction.

Responses	Total no. of respondents		Students		Non-Teaching staff		Teaching Staff	
	Freq	%	Males	Females	Males	Females	Males	Females
Strongly Agree	63	62	13	6	13	6	24	1
Agree	28	27	9	3	6	2	8	0
Not Sure	4	4	1	0	2	0	0	1
Disagree	3	3	1	0	1	0	1	0
Strongly Disagree	4	4	1	2	0	0	0	1
	102	100	25	11	22	8	33	3

Source: Field survey, 2010

Table 11: Opinion on whether provision of menu card will increase level of satisfaction

Responses	Total no. of respondents		Students		Non-Teaching staff		Teaching Staff	
	Freq	%	Males	Females	Males	Females	Males	Females
Strongly Agree	45	44	15	6	5	5	13	1
Agree	35	34	6	3	8	3	15	0
Not Sure	16	16	1	1	8	0	4	2
Disagree	3	3	0	1	1	0	1	0
Strongly Disagree	3	3	3	0	0	0	0	0
Total	102	100	25	11	22	8	33	3

Source: Field survey, 2010

Table 12: Do you patronize the Restaurant for lack of better options on campus?

Responses	Total no. of respondents		Students		Non-Teaching staff		Teaching Staff	
	Freq	%	Males	Females	Males	Females	Males	Females
Yes	65	64	16	3	13	6	24	3
No	37	36	9	8	9	2	9	0
Total	102	100	25	11	22	8	33	3

Source: Field survey, 2010

Table 13: Are you searching for a substitute?

Responses	Total no. of respondents		Students		Non-Teaching staff		Teaching Staff	
	Freq	%	Males	Females	Males	Females	Males	Females
Yes	82	80	22	8	17	8	24	3
No	20	20	3	3	5	0	9	0
Total	102	100	25	11	22	8	33	3

Source: Field survey, 2010

Table 14: Level of satisfaction with the overall service quality

Responses	Total no. of respondents		Students		Non-Teaching staff		Teaching Staff	
	Freq	%	Males	Females	Males	Females	Males	Females
Very low	3	3	1	1	1	0	0	0
Low	21	20	3	4	6	3	4	1
Average	71	70	21	5	10	5	28	2
High	7	7	0	1	5	0	1	0
Very high	0	0	0	0	0	0	0	0
Total	102	100	25	11	22	8	33	3

Source: Field survey, 2010

Figure 3: Student-respondents' rating of the Restaurant's Service Quality

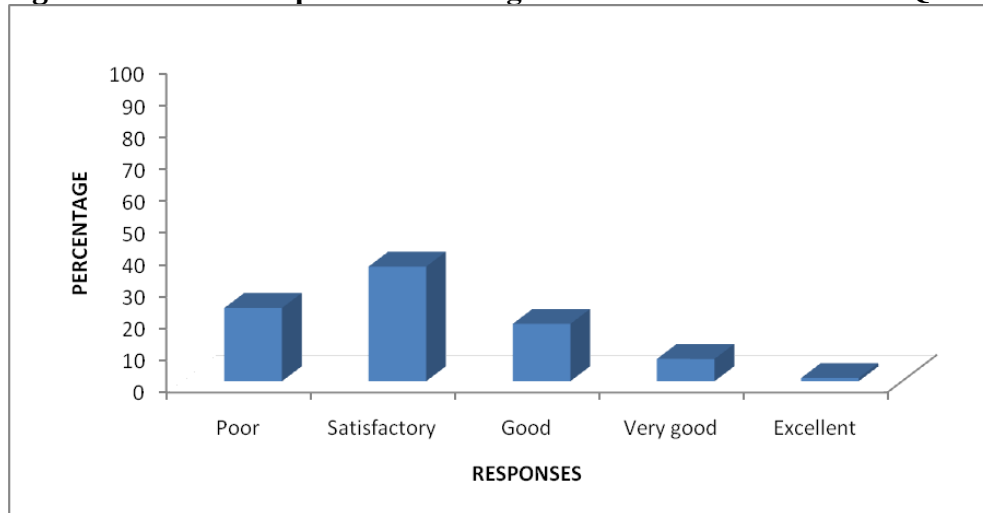


Figure 4: Non-teaching staff-respondents' rating of the Restaurant's Service Quality

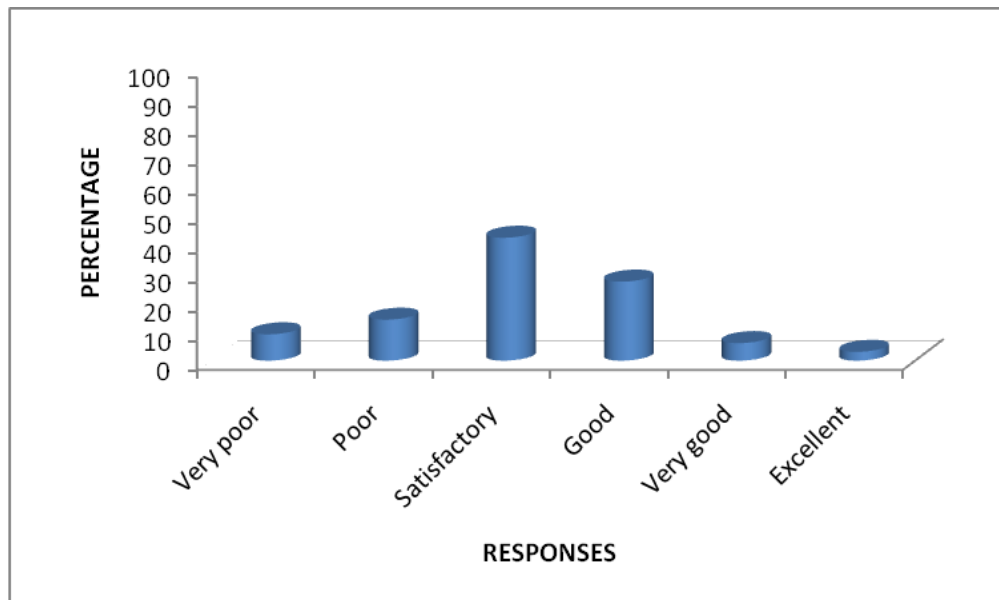


Figure 5: Teaching staff-respondents' rating of the Restaurant's Service Quality

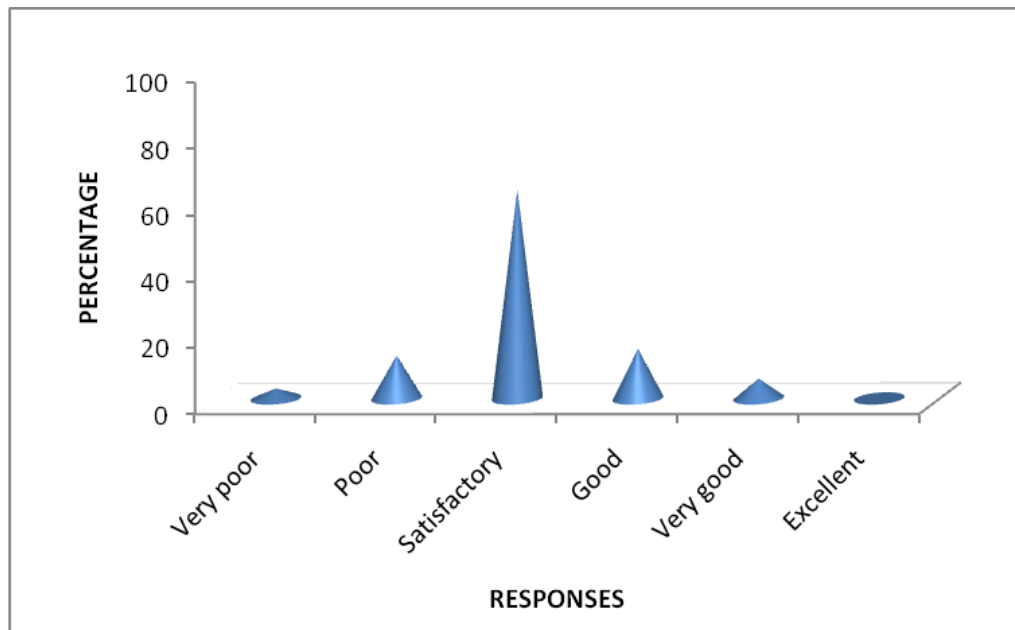


Figure 6: Opinions on whether the restaurant environment is hygienic

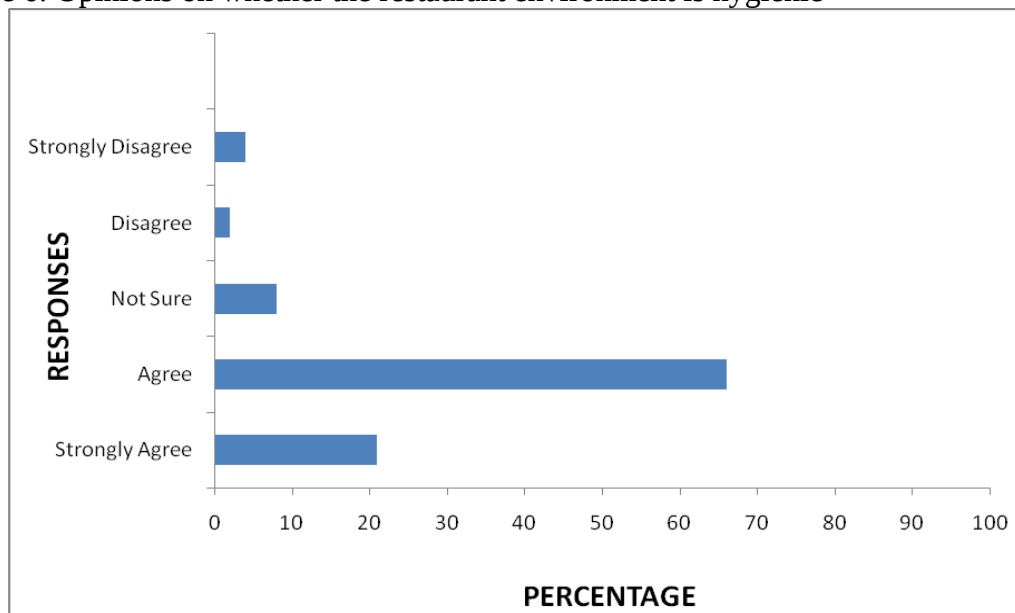


Figure 7: Pie Chart showing whether customers patronize the Restaurant for lack of better options on campus

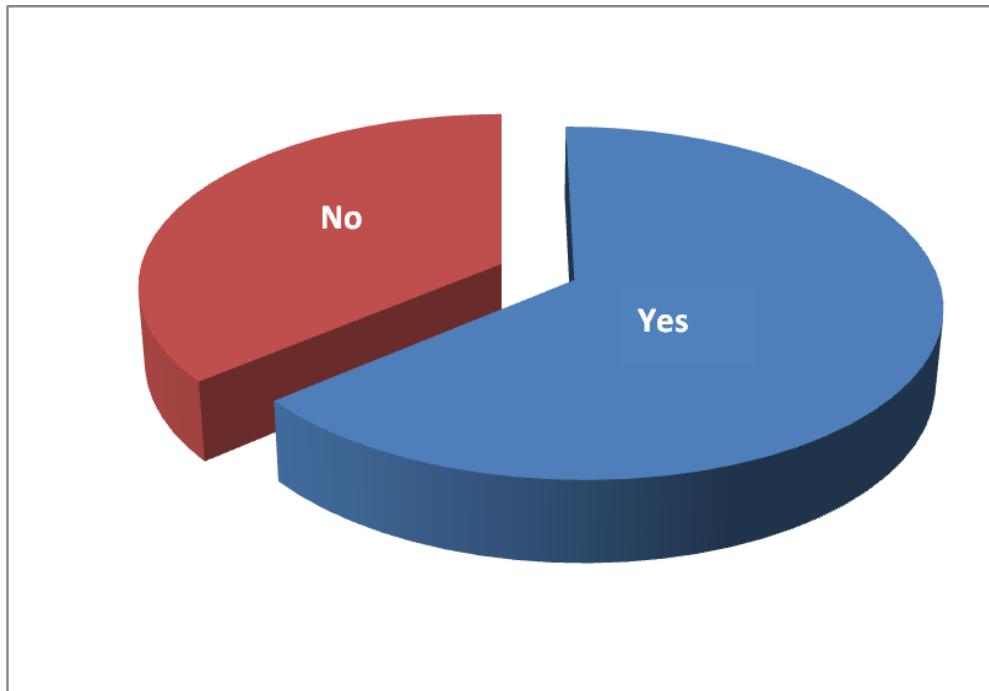


Figure 8: Pie Chart showing whether consumers are searching for an alternative restaurant

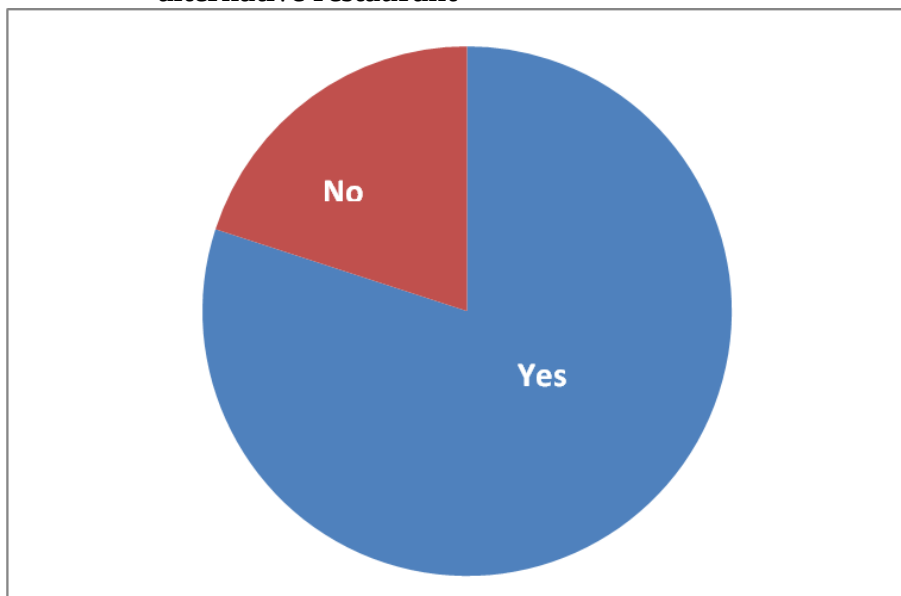


Figure 9: Bar chart showing customers' level of satisfaction with the overall service quality

**QUALITY PERSPECTIVE OF ENGINEERING EDUCATION IN GHANA:
A CASE STUDY OF AUTOMOTIVE ENGINEERING DEPARTMENT,
KOFORIDUA POLYTECHNIC**

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Abstract

The quality of engineering education in Ghana is paramount in achieving the nation's developmental targets. However, there have been concerns about the quality of engineering graduates in industry. Using the Automotive Engineering Department, Koforidua Polytechnic as a case study, this paper examines the training of engineering students on the basis of seven factors which contribute to the quality of training, and what steps are being taken to satisfy students and employees. A survey was conducted among students, staff and employers to evaluate which factors they considered more important. Using a prioritization matrix, these factors have been weighted and the values compared for the different stakeholders. The results indicate that industrial exposure and linkages; Teaching Material and equipments were the most critical factors for quality engineering education. To ensure continuous improvement in the quality of education at the department a proposed strategic mapping for improvement has been suggested.

Key words: Automotive Engineering Department, Competence Based Training, Koforidua Polytechnic, Prioritization Matrix, Quality Education.

Introduction

Engineering education in Ghana has been going through some changes including the development of new engineering programmes, reorganization of course content, re-installation of equipment among others. However, the questions of concern has been - is the quality of engineering education meeting the needs of stakeholders? Are employers satisfied with the training of engineering graduates? Are students equipped enough to stand tall in the world of competition? Using the Automotive Engineering Department, Koforidua Polytechnic as a case study, this paper examines the training of engineering students – what factors contributes to a quality training, what steps are being taken to satisfy students and employees. According to Ibrahim (1999) there is a difficulty in defining quality of engineering education, however, there is the need to describe results of this quality in terms of ability to satisfy the current and future needs of industry, mobility, and life-long commitment to learning.

Considering the diversity among employers and the wide-ranging jobs into which graduates will be placed, Educational institutions could also start listening to employers. But, it is worth understanding what employers want in their employees and then seeing if those skills are ones that can be integrated into the academic experience without undermining the academic enterprise. It is certainly premature to assume that the skills that employers want are antithetic to a thoughtful educational enterprise (Gross and Godwin, 2009).

The overall quality of training of engineering students can be properly analysed using the complete education cycle as shown in figure 1: Admission to Academic Programme; Theoretical and Practical training at an Engineering Department, Students' Attachment or internship; National Service training; Workplace Training (Industry).

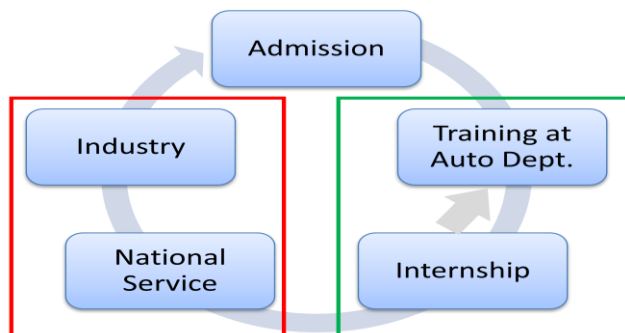


Figure 1: Complete Academic Cycle at the Automotive Engineering Department

The objective of this research is to examine the first three stages of the process – Admission, Training at the Automotive Department and the Internship with automotive companies – to ascertain the quality of engineering education as delivered by the department and more importantly to prioritize the factors that account for quality training. The second objective is to develop a strategic mapping for improvement on the quality of engineering education based on the identified factors.

Stakeholders

There are several stakeholder involve in the training of engineers for National Development. It would be true but unhelpful to say that everyone is a stakeholder in education for sustainable development. All of us will feel the impact of its relative success or failure, and all of us affect the impact of Education for Sustainable Development by our behaviour which may be supportive or undermining. This generalisation does not however help to identify targeted strategies of cooperation,

communication or action. Particular roles and responsibilities devolve to a number of bodies and groups at different levels: local (sub-national), national, regional and international (UNESCO, 2005). According to Michael Ward (2005), stakeholders bring unique perspectives about education and that many stakeholders have multiple perspectives such as a parent, as a taxpayer, or perhaps as employee or an elected office. Each of these perspectives brings with it different types of concerns. Will my child get an education that prepares her/him for life and work in this century? Will our taxes continue to increase? Will our schools prepare students to live and work in our community? So, who are the stakeholders and how are they involved in bringing about quality engineering education?

For the purpose of the research seven stakeholders were identified, however, only three – students, lecturers and industry – were considered.

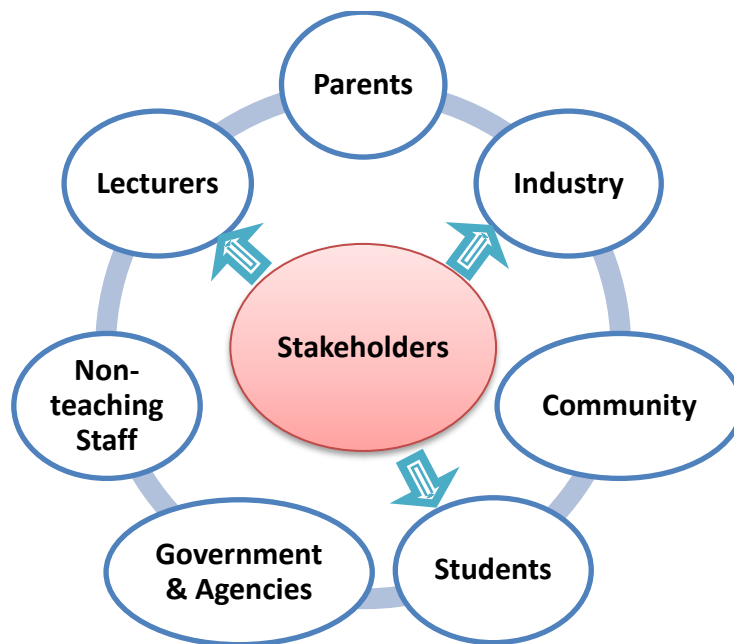


Figure 2: Major stakeholders for quality Engineering Education

Methodology

The primary data were collected by observation, interviews, questionnaire and discussion. Three HND classes were involved in the project to collect the student perspective data. These included the first (11 students), Second (14 students) and 9 third year HND students of the Automotive Engineering Department of the Koforidua Polytechnic. In all 34 out of the 37 students were available for discussion and filling of prioritization matrix form. The academic staff (6 out 9) and all Auto

workshop attendants (4) were interviewed. Seven Automotive companies who had admitted third year students on a four months industrial attachment (internship) were also interviewed for their perception of quality of engineering education. The Secondary data were obtained from Nuffic report, 2009, Koforidua Polytechnic Annual Report, 2010 and Journal articles as well as the internet. The tools for analysis were prioritization matrix and Charts (bar and radar).

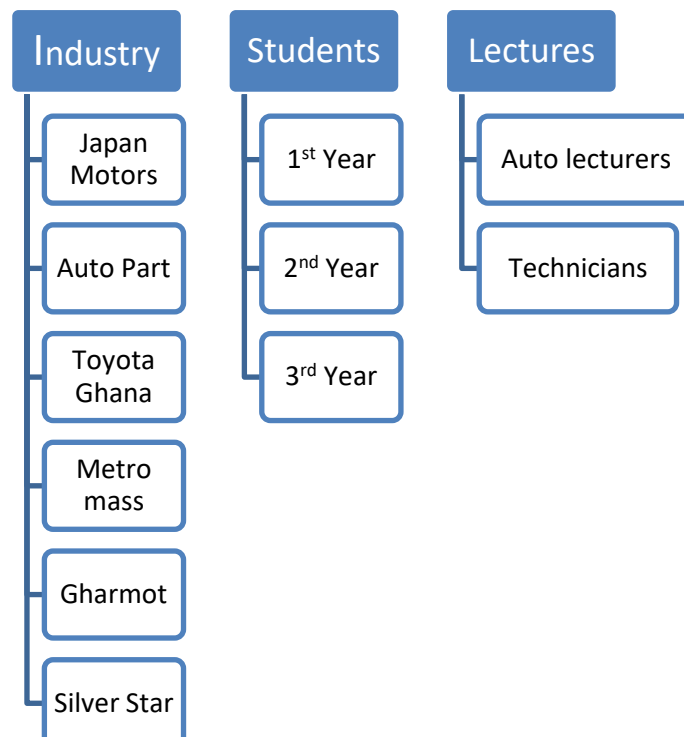


Figure 3: Selected stakeholders for data collection

Results and Discussion

Engineering Training at Automotive Department

Although, HND Engineering programmes started only three years ago, it has grown quickly to match the standard of any of its competitors in other polytechnic. The Automotive Engineering Department has adopted the Competency based training for all courses and has attracted a lot of young professionals with the passion to make a difference in their career paths. The department has also acquired new state-of-the-art equipments for running of both HND and non HND programmes within its three years of existence.

Factors for Quality Analysis

Several factors may be considered for assessing the quality of engineering education. For the purpose of this research the following were considered. The content and relevance of the curriculum; the available methods for teaching and practical component of programme. These factors were chosen from Canadian Education Quality and Accountability Office Report, 2008.

Again, student recruitment as well as relevant of student research have also been considered which were the authors own addition. In addition to the above, other factors like industrial exposure and capabilities of staff have been looked at which were concerns from industry. The result of how the Automotive Engineering department has worked with the factors for quality analysis is as shown in Table 1.

Table 1: Results of Quality Assessment of Automotive Engineering Department

Quality Factor	Remarks
Content of curriculum	The Department since its inception in 2007 have used a detailed Competency Based Training (CBET) curriculum with workshop practice from maintenance repair up to diagnostic level constituting 60 percent. The curriculum which has received approval from NCTE, NAPTEX and NAB is based on an occupational analysis that was carried out in collaboration with representatives from about fifty companies in Ghana from the Automotive industry. ² This was later reviewed by industrial representatives as well those from academia. It is largely based on future developments and demands of car industry and focuses on innovating engineering for specific situations in Ghana.
Teaching materials and Equipment availability	The department is well equipped with modern digital automotive teaching and new workshop management books. The department has procured a list of 133 equipment including a 3.5 ton 4-post car lift, exhaust gas analyser, engine diagnostic unit, among others. Lecturers have prepared course module for the different courses. The use of projector and videos in teaching has prominent.
Teaching methodology and assessment	Based on the CBT training approach adopted by the department, students are taken to theory and practical sessions. Assessment is based on a 30:70 theory practical ratio to ensure students do not only learn theory but are well equipped with practical exposure.

Industrial Exposure and linkages	The Automotive department has done so well with industrial linkages. The department has direct contact with approximate fifty direct commercial workshops in Ghana which are used for students' attachments, technical information sources and references during assessment periods. These contacts also provide the department with spares for repairs or educational purposes. The department has devoted one semester (third year first semester) solely for industrial attachments under the supervision of both by staff members as well as field supervisors. A local union of independent automotive workshops now work in close collaboration with the department on upgrading local mechanics through periodic evening courses.
Relevance of research	The inability of the department to fund student project has left student with no choice than to select projects that not financial demanding. Again, some lecturers are not involved in research work hence their inability to present relevant research topics for students.
Staff Capabilities	The department has three senior members with masters' degree in automotive engineering with two others pursuing their masters. Also, there are three senior staff members as well as two technicians. Based on the many training workshops and on-the-job training both locally and in the Netherlands, all staff members are now experience in the CBET facilitation. Staff are not only competent with the concept of CBET, but also implement the CBET principle on a daily basis in their lesson plans. Again, they are now familiar with the latest technical developments in their profession and are trained in using workshop equipment to diagnose and repair modern vehicles.
Student Recruitment	The department started with 14 students six weeks into the first semester of the 2007/08 academic year. It was easy to conclude that the poor performance of that batch of students was due to late start of the programme. However, subsequent students have not been any better. Most students have come from technical school with a few from the senior secondary

	school. For the past years, technical students though not theoretical okay have proven to be more practically oriented than their counterparts from the secondary schools.
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Prioritization of Quality Factors

Having considered the various factors for Quality Engineering Education analysis and how the Automotive engineering Department has worked with them, the authors have prioritized the factors using a matrix based on results from focused discussions and interview of different the stakeholders. The results are as shown in Table 2, 3 and 4.

Table 2: *Quality Factors Prioritization (Student Perspective)*

Quality Factors	Content of curriculum	Teaching Materials and Equipment	Industrial Exposure	Teaching Methodology	Relevance of student research	Staff Capabilities	Student Recruitment	Total	Percentage (%)
Content of curriculum		0.2	1	1	0.2	0.2	0.1	2.7	2.4
Teaching Materials and Equipment	5		5	10	5	5	1	31.0	27.5
Industrial Exposure	1	0.2		5	0.2	1	0.2	2.8	2.5
Teaching Methodology	1	0.1	0.2		1	0.1	0.1	2.5	2.2
Relevance of student research	5	0.2	5	1		0.1	0.1	11.4	10.1
Staff Capabilities	5	0.2	1	10	10		0.1	26.3	23.3
Student Recruitment	10	1	5	10	10	10		46	40.8

1 Equally Important

5 Significantly More Important

10 Exceedingly More Important

1/5 Significantly Less Important

1/10 Exceedingly Less Important

Table 3: Quality Factors Prioritization (Staff Perspective)

Quality Factors	Content of curriculum	Teaching Materials and Equipment	Industrial Exposure	Teaching Methodology	Relevance of student research	Staff Capabilities	Student Recruitment	Total	Percentage (%)
Content of curriculum		0.2	0.1	0.1	0.2	1	0.1	1.7	1.6
Teaching Materials and Equipment	5		5	1	0.2	1	10	22.2	20.9
Industrial Exposure	10	0.2		5	1	5	5	26.2	24.7
Teaching Methodology	10	1	0.2		1	1	5	18.2	17.2
Relevance of student research	5	5	1	1		1	5	18	17.0
Staff Capabilities	1	1	0.2	1	1		5	9.2	8.7
Student Recruitment	10	0.1	0.2	0.1	0.1	0.1		10.6	10

1 Equally Important

5 Significantly More Important

10 Exceedingly More Important

1/5 Significantly Less Important

1/10 Exceedingly Less Important

Table 4: Quality Factors Prioritization (Employers Perspective)

Quality Factors	Content of curriculum	Teaching Materials and Equipment	Industrial Exposure	Teaching Methodology	Relevance of student research	Staff Capabilities	Student Recruitment	Total	Percentage (%)
Content of curriculum		0.2	1	0.2	10	1	5	17.4	17.0
Teaching Materials and Equipment	5		5	5	10	1	10	36.0	35.2
Industrial Exposure	1	0.2		5	1	0.2	5	12.4	12.1
Teaching Methodology	5	1	0.2		1	0.2	1	8.4	8.2
Relevance of student research	0.1	0.1	1	1		1	5	8.2	8.0
Staff Capabilities	1	1	5	5	1		5	18.0	17.6
Student Recruitment	0.2	0.1	0.2	1	0.2	0.2		1.9	1.9

1 Equally Important

5 Significantly More Important

10 Exceedingly More Important

1/5 Significantly Less Important

1/10 Exceedingly Less Important

From the prioritization matrix Table 2, it was observed that the most important factor for quality engineering education according to student perspective Industrial Exposure and linkages (with priority rating of 24.7 percent) and Content of curriculum as the least important with 1.6 percent priority rating. The relative importance of the quality factors is reflected in the percentile weight ratings. The order of importance is as follows: Industrial Exposure (24.7 percent), Teaching Materials and Equipment (20.9 percent), Teaching Methodology (17.2 percent), Relevance of student research (17.2), Student Recruitment (10 percent), Staff Capabilities (8.7 percent), and Content of curriculum (1.6 percent).

The staff were of different opinion and felt the student recruited for engineering programs are very critical for producing quality and independent engineering graduate yielding a priority rating of 40.8 percent and the teaching methodology (with priority rating of 2.2%) , the least important. The order of importance is as follows: Student Recruitment (40.8 percent), Teaching Materials and Equipment (27.5 percent), Staff Capabilities (23.3 percent), Relevance of student research (10.1), Industrial Exposure (2.5 percent), Content of curriculum (2.4 percent) and Teaching Methodology (2.2 percent).

According to employers, Teaching Materials and Equipment, Staff Capabilities and Content of curriculum are the most critical factors for an enhance quality engineering graduate with priority rating of 35, 17.6 and 17.0 percent respectively. The least important to them is Student recruitment with rating of 1.9 percent.

Comparison of the result

Table 5: *Quality factors comparison for different stakeholders*

Quality Factors	Student Perspective	Staff Perspective	Employer's Perspective	Overall (Total)
Content of curriculum	1.6	2.4	17.0	21
Teaching Materials and Equipment	20.9	27.5	35.2	83.6
Industrial Exposure and linkages	24.7	2.5	12.1	39.3
Teaching Methodology	17.2	2.2	8.2	27.6
Relevance of student research	17	10.1	8.0	35.1
Staff Capabilities	8.7	23.3	17.6	49.6
Student Recruitment	10	40.8	1.9	52.7

Discussion of Results

The overall view of the results has been presented in a radar chart in figure 1. This brings out the variation of stakeholders perception of the different quality factors. The result obtained above is an indication that different stakeholders value some factors more than others. The reason for the poor overall rating for content of curriculum could be explained by the fact that irrespective of the curriculum content, if the needed teaching materials and equipment are not available, no better output could be expected. The consistent appeal of students for industrial trips and places for attachment is not out of place since they see it as a critical factor for success in their engineering carrier.

Student recruitment plays a major role in the delivering of quality education. It is important to note that in spite of the available modern teaching material and equipment at the Automotive Department, the quality of graduate is still questionable. It is therefore not surprising it was the highest rated factor for the staff. However, some employers are of the view that with right practical orientation using the right teaching materials and equipment any student could be turned into a useful engineering graduate.

Teaching methodology did not also receive a higher rating because the mode of lecture delivery at the Automotive Department does not differ so much from the traditional method of teaching except that the competency based training incorporate the use of videos and animations as well as practical lessons. However, these have not translated into producing quality graduate.

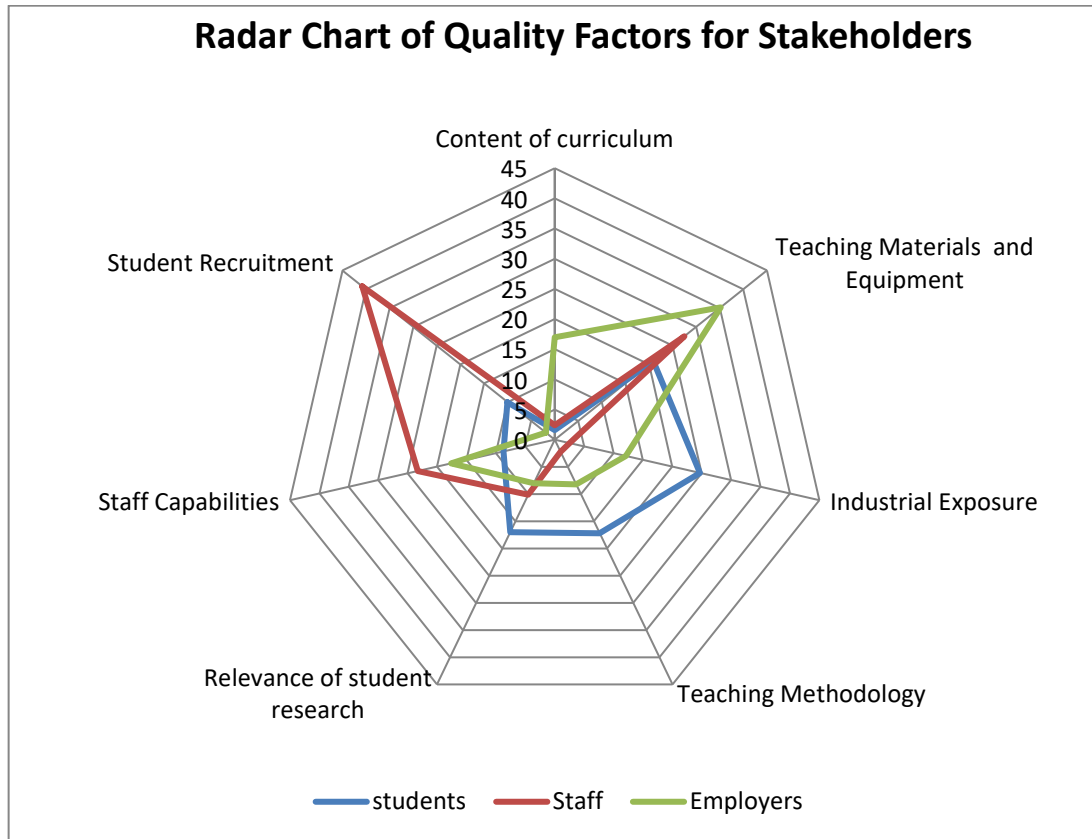


Figure 4: Radar Chart of Quality Factors for Stakeholders

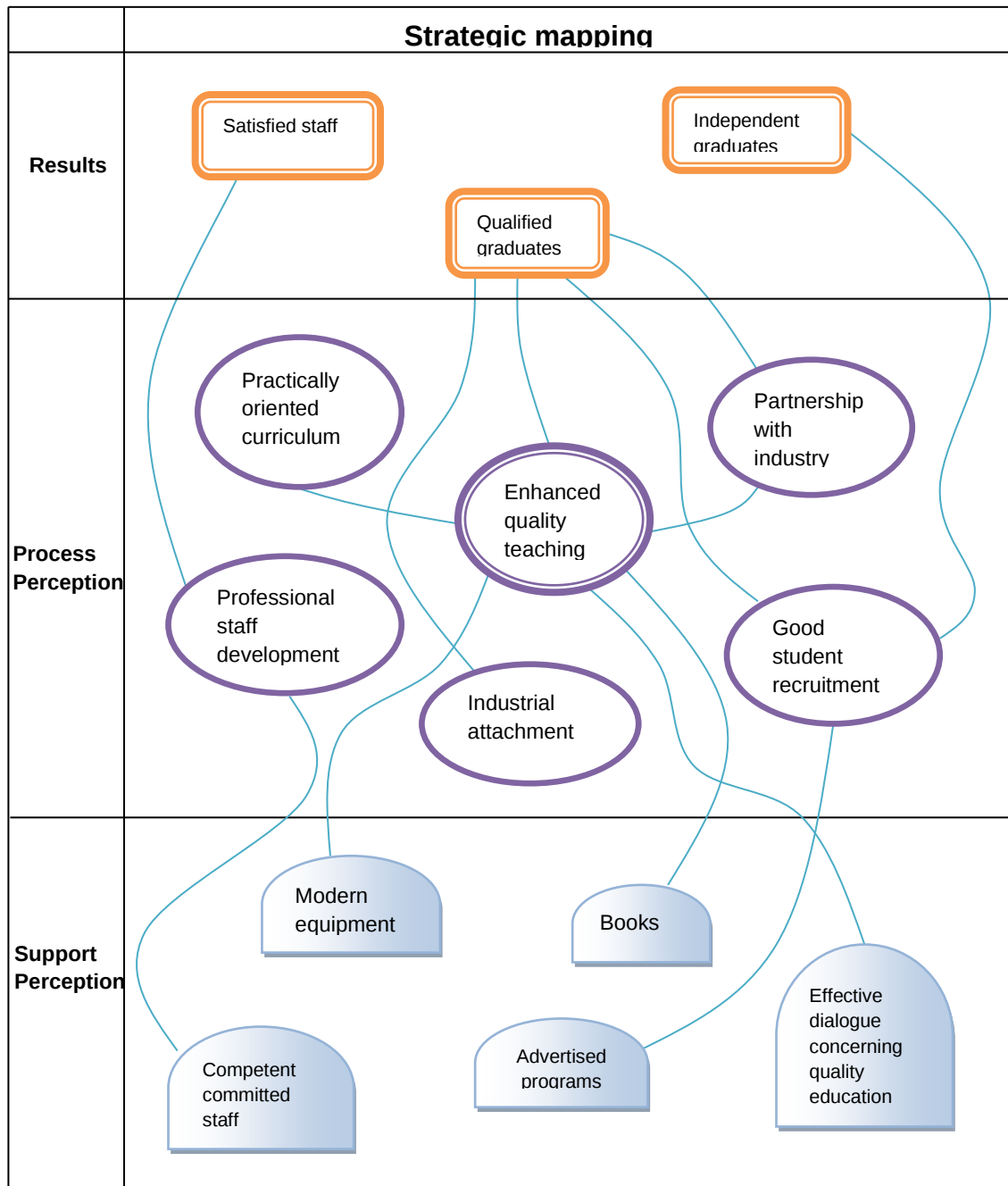
Strategic Mapping for Continuous Improvement

Based on the result gathered and the corresponding discussions made, a strategic mapping for continuous improvement in the quality of engineering education has been developed as shown in table 6. Competent and committed staff; Modern equipment; Advertised programs to enhanced quality students; Relevant textbooks as well as an effective dialogue concerning quality education has been identified as the support for building this quality.

The main process of an enhance quality teaching could be achieved through a practically oriented curriculum, professional staff development to improve staff capabilities, partnership with industry, properly supervised student attachment and recruitment of good students.

These factors would in the long run ensure not only the desire result of qualified and independent engineering graduate but also a fulfilled staff and more importantly a satisfied employer.

Table 6: Strategic mapping for improvement



Conclusion and Recommendation

To ensure an improvement in the quality of engineering education, all stakeholders must get on board. The major identified factors to achieve this quality have been as the teaching materials and equipment; staff capabilities and Industrial exposure. Though student recruitment was not a prominent factor for both students and employers, but was the main factor for staff. It is therefore important that it is not ignored. Academic Institutions have to make conscious effort to advertise engineering programmes to make them attractive to good students. The researchers are of the view that if the suggested strategic mapping is adopted the story will change in the shortest possible time.

Recommendations

Based on the results and obtained the authors have made the following recommendation.

- Before the commencement of any programme, requisite teaching materials and equipment must be available or else quality of training would be compromised.

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**IDENTIFICATION OF LUBRICATING OIL-DEGRADING
MICROORGANISMS IN OIL POLLUTED SOILS FROM FIVE AUTO-
MECHANIC WORKSHOPS IN ACCRA, GHANA**

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Abstract

Bioremediation is the use of microorganisms to clean up oil contaminated environments and is safer and less expensive than the physical, mechanical and chemical methods. Even though species of microorganisms are habitat specific Oil-degrading microorganisms can be present in any environment. Ten samples of oil contaminated soil from 5 auto-mechanic workshops in Accra were collected from 5 Mechanic Fitting Shops in Accra, Ghana and total viable count determined. *Staphylococcus aureus* and *E. coli* were isolated using Baird – Parker Agar and Eosin Methylene Blue Levine (EMB) Agar respectively and Fungi isolation with Dichloran Rose – Bengal Chloramphenicol Agar (DRBC) medium. Soils from all 5 sites were contaminated with various fungi which exhibited presumptive ability to utilise lubricating oil as their sole carbon source. The Presumptive Lubricating Oil-Utilising fungi were *Trichothecium*, *Trichoderma*, *Aspergillus niger*, *Fusarium*, and *Penicillium spp.*. The 5 fungi had adapted to living in the oil polluted environment occurring in the soils at the mechanic shops. *Trichothecium* occurred at 60% of the sites and in 60% of sampled soils, while *Trichoderma* was present at 10% of the sites and in 10% of sampled soils. This shows that whenever *Trichothecium* and *Trichoderma* occurred at a fitting shop they were well distributed in the contaminated soils. *Aspergillus niger* and *Penicillium spp.* occurred in 60% of the mechanic shops while *Fusarium* was present .at 10% of the shops. However, *Aspergillus niger*, *Penicillium spp.* and *Fusarium* were not found in all soil samples taken from the shops where they occurred. Even though *E. coli* was isolated from soils from 3 sites, they did not exhibit the ability to utilise lubricating oil as sole carbon source. None of the *Staph. Aureus* isolated from 4 out of the 5 sites were able to utilise lubricating oil as the sole carbon source. There were significant increases ($P < 0.05$) in viable counts, fungal dry weights and optical densities, and significant decreases ($P < 0.05$) in pH's over the incubation period. There were positive correlations of (0.56) between viable counts and fungal dry weights, (0.81) between viable counts and optical densities, and (0.69) between fungal dry weights and optical densities respectively, and However, negative correlations (-0.57) and (-0.65) respectively between pH and viable counts, and pH and optical densities. The results of this study indicate that the five fungi (*Trichothecium*, *Trichoderma*, *Aspergillus niger*, *Fusarium*, and *Penicillium spp.*) isolated from the oil contaminated soils from the mechanic workshops in Accra, are confirmed to be lubricating oil consuming

fungi, and among them *Asp. niger* exhibited the highest lubricating oil utilising capacity, and the least was *Trichothecium*. Although commercial fungal and bacterial inocula are used in the developing countries for bioremediation of oil spills it is important to develop indigenous microorganism for use in large scale operations, especially since species of microorganisms are habitat specific (Obire, 1988).

Therefore our first step in developing indigenous microorganism for use in large scale oil spill response operations is the isolation and identification of oil degrading microorganisms from oil polluted soils of some mechanic shops in Accra.

Methodology

Collection of Soil samples

Soil samples (400 g) from surface soil (0-15 cm depth) was collected with an auger from 5 Mechanic Fitting Shops in Accra, Ghana, consecutively after tilling with a sterile scoop and transferred into sterile polythene bags. Soil sample collections were made from 3-4 random points per shop and then mixed to form composite soil samples. All microbiological analyses were carried out within 24 h after sample collection. All soil samples for future analyses were stored at 4 ± 2 °C according to ISO and OECD standards (Obire and Anyanwu, 2009).

Culturing of Microorganisms

Appropriate dilutions of soil samples were prepared and 0.1 ml aliquots cultured into Plate Count Agar for total viable count. Appropriate dilutions of soil samples were prepared and 0.1 ml aliquots cultured into nutrient agar by pour plate technique for growth of bacterial species. Fungi species were cultured using Potato Dextrose Agar (PDA) to which streptomycin (50 mg/ml) had been added to suppress bacterial growth. The colonies counted were computed and expressed as colony forming unit (cfu) per gram of soil.

Isolation of Microorganisms

Staphylococcus aureus and *E. coli* were isolated from the soil samples by sub-culturing 0.1 ml of appropriate dilutions of the soil samples into fresh Baird – Parker Agar and Eosin Methylene Blue Levine (EMB) Agar respectively, by pour plate technique. Positive controls of *Staphylococcus aureus* and *E. coli* respectively were used for the tests. Fungi were isolated using Dichloran Rose – Bengal Chloramphenicol Agar (DRBC) medium. The isolated cultures of bacteria and fungi were subsequently screened for the ability to utilise lubricating oil as sole carbon source.

Screening Of Bacterial and Fungal Isolates for their Ability to Utilise Lubricating Oil

Preparation of Minimal Salt Enrichment Medium (MSEM)

The method of Mills *et al* (1978) as modified by Okpokwasili and Okorie, (1988) was used in preparing a minimal salt medium (MSEM) of composition 6.0 g Na₂HPO₄, 3.0 g KH₂HPO₄, 0.5 g NaCl, 1.0 g HN₄Cl, 1.0 ml of 24.6% (w/v) MgSO₄.7H₂O and 1.0 ml of 1.47% (w/v) CaCl₂.2H₂O in 1000 ml distilled water), which was then dispensed into 250 ml conical flasks and sterilised. To each flask was added 1.0% v/v (i.e. 1.50 ml) lubricating oil.

Preparation of MSEM Oil-Agar

MSEM Oil-Agar was prepared by adding 1000 ppm lubricating oil to molten agar prepared with MSEM solution and sterilising in an autoclave.

Culturing of bacteria on MSEM Oil-Agar

Isolated bacteria were cultured in nutrient broth for 48 hours and 0.1 ml aliquots of appropriate dilution cultured into Oil-agar plates by pour plate technique.

Culturing of fungi on MSEM Oil-Agar

Isolated fungi were cultured in malt extract broth for 48 hours and 0.1 ml aliquots of appropriate dilution cultured into Oil-agar plates by pour plate technique.

Preliminary tests of Isolates as Presumptive Lubricating Oil-Utilising Microorganisms

Colonies which developed and showed growth of colonies and zones of clearance of oil on the MSEM oil-agar plates were counted as presumptive petroleum-utilizing moulds. Colonies which developed and showed growth of colonies and zones of clearance of oil on the oil-agar plates were identified by morphological and biochemical techniques using Bergey's taxonomic scheme for bacterial cultures and Barnett and Hunter's scheme for Fungal isolates (Benson, 1990).

Tests to Confirm Microorganisms as True Lubricating Oil-Utilising Microorganisms

Preparation of Minimal Salt Enrichment Medium plus lubricating oil

A 10 ml volume of MSEM medium plus 1.0% v/v (i.e. 0.1 ml) lubricating oil was dispensed severally into test tubes and sterilised (Okpokwasili and Okorie, 1988).

Culturing of Microorganisms

The sterilised MSEM-Oil medium in the test tubes were inoculated with the pure cultures of Presumptive Lubricating Oil-Utilising Microorganisms and placed in an incubator (QL Model 10 – 140) at 30°.

Measurements for Confirming the Utilisation of lubricating oil

Utilisation of lubricating oil was monitored for incubation periods of 0, 2, 6, 13, 21 and 25 day's, by measuring fungal growth, fungal dry weight, optical density and pH.

Fungal growths

Fungal growths were measured by obtaining the viable counts on nutrient agar. The fractional change in viable count for each incubation period was obtained from the formula

$$(V_n - V_0) / V_0$$

Where V_n is the viable count for incubation period n days and V_0 is the viable count for incubation period of 0 days.

Optical density (OD)

Optical density was determined at 600 nm wavelength with Unico UV 2100 spectrophotometer by measuring the percent transmittances (%T) which were then converted to optical densities using the formula: $OD = 2 - \log$ of percent transmittance (Benson, 1990).

The fractional change in optical density for each incubation period was obtained from the formula

$$(OD_n - OD_0) / OD_0$$

Where OD_n is the optical density for incubation period n days and OD_0 is the optical density for incubation period of 0 days.

Fungal dry weight (FD)

Fungal dry weight was determined by drying Whatman No. 1 filter paper in a hot air oven at 105°C to constant weight (W_c) and then harvesting the fungi on the filter paper by filtration, drying the filter paper overnight in the oven at 105°C, and obtaining the dry weight (W_d) of the filter paper again on a digital weighing balance (ADAM AFA – 120 LC model).

The fungal dry weight (Fdw) was determined from the formula $W_d - W_c$.

The fractional change in fungal dry weight for each incubation period was obtained from the formula

$$(FD_n - FD_0) / FD_0$$

Where FD_n is the fungal dry weight for incubation period n days and FD_0 is the fungal dry weight for incubation period of 0 days.

The pH's were determined with a ACCULAB V-1200 pH meter.

Results

Table 1. Total viable count (cfu/g) on Plate Count Agar (PCA) of microorganisms from oil contaminated soils from 5 Mechanic shops in Accra, Ghana

Soil Samples	Average (cfu/g)
Mech Shop 1	3.28×10^1
Mech Shop 2	3.6×10^1
Mech Shop 3	4.8×10^1
Mech Shop 4	3.6×10^1
Mech Shop 5	4.6×10^1

Table 2. Average Populations (cfu/g) of *Staph. aureus* on oil contaminated soils from 5 Mechanic shops in Accra, Ghana. Culturing of *Staph. aureus* was on Baird – Parker Agar. *E. coli* was on Eosin Methylene Blue Levine (EMB), and *fungi* was on Dichloran Rose – Bengal Chloramphenicol Agar (DRBC).

Soil Samples	<i>Staph. aureus</i>	<i>E. coli</i>	<i>Fungi</i>
Mech Shop 1	4.8×10^2	19.3×10^2	8.3×10^2
Mech Shop 2	34.8×10^2	22.8×10^2	14.6×10^2
Mech Shop 3	19.4×10^2	10.9×10^2	13.1×10^2
Mech Shop 4	No growth	No growth	3.65×10^2
Mech Shop 5	8.4×10^2	No growth	16.0×10^2

Table 3. Oil contaminated soils from 5 Mechanic shops in Accra, Ghana and colonies of microorganisms with zones of inhibition on MSEM Oil-Agar. Colonies with zones of inhibition are regarded as Presumptive Lubricating Oil-Utilising Microorganisms

Soil Samples	<i>Staph. aureus</i>	<i>E. coli</i>	<i>Fungi</i>
Mech Shop 1	No growth	No growth	Growth with zones of inhibition
Mech Shop 2	No growth	No growth	Growth with zones of inhibition
Mech Shop 3	No growth	No growth	Growth with zones of inhibition
Mech Shop 4	No growth	No growth	Growth with zones of inhibition
Mech Shop 5	No growth	No growth	Growth with zones of inhibition

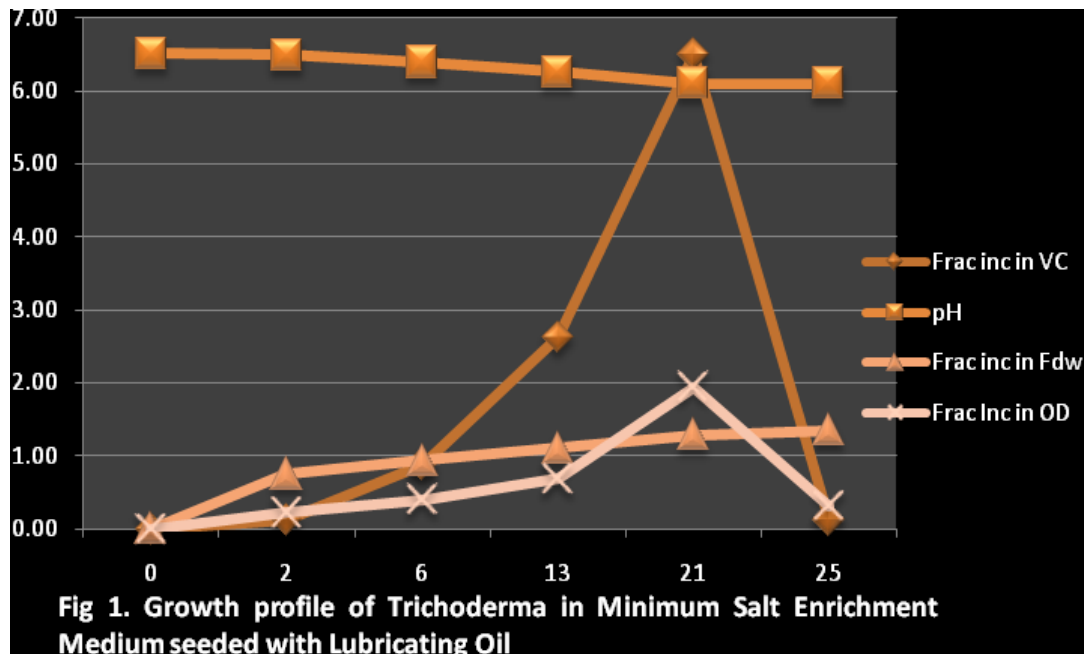
Table 4. Presumptive Lubricating Oil-Utilising Fungi isolated from oil contaminated soils from 5 Mechanic shops in Accra, Ghana identified as

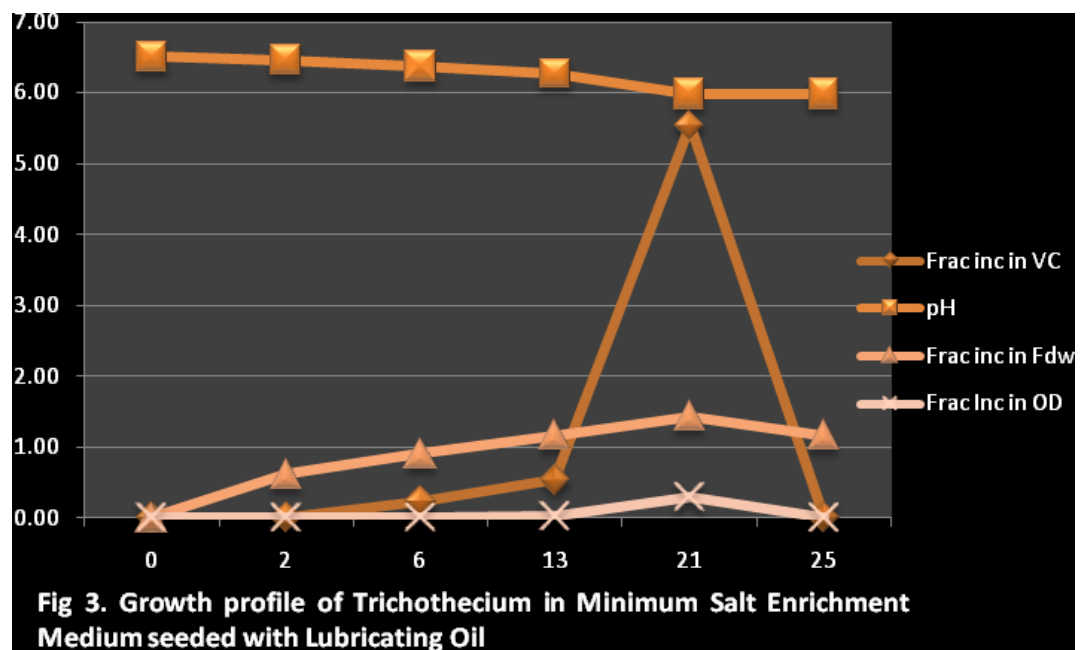
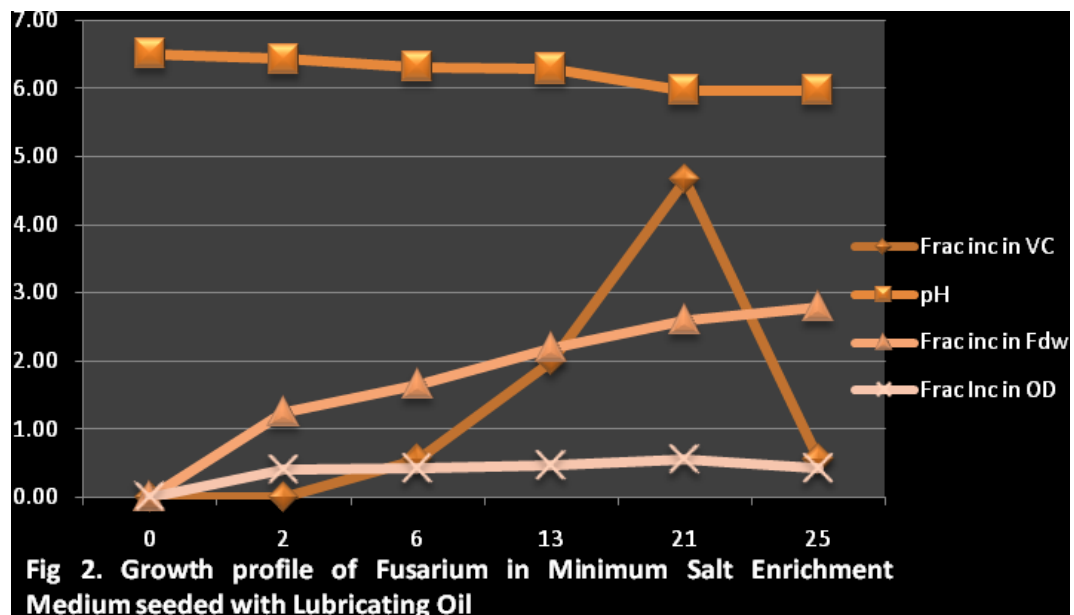
Presumptive Lubricating Oil-Utilising Fungi. Culturing was on Dichloran Rose – Bengal Chloramphenicol Agar (DRBC).

Soil Samples	Fungi
Mech Shop 1	<i>Trichothecium</i> , <i>Trichoderma</i> , <i>Aspergillus niger</i>
Mech Shop 2	<i>Fusarium</i>
Mech Shop 3	<i>Trichothecium</i> , <i>Penicillium spp.</i>
Mech Shop 4	<i>Aspergillus niger</i> , <i>Penicillium spp.</i> , <i>Trichothecium</i>
Mech Shop 5	<i>Aspergillus niger</i> , <i>Penicillium spp.</i>

Table 5. Lubricating oil utilising fungi and their percentage occurrence at 5 Mechanic shops and in soil samples obtained from the shops.

Fungi	% of sites with the microorganism	% of soil samples with the microorganism
<i>Trichothecium</i>	60%	60%
<i>Aspergillus niger</i>	60%	50%
<i>Trichoderma</i>	10%	10%
<i>Fusarium</i>	10%	20%
<i>Penicillium spp.</i>	60%	50%





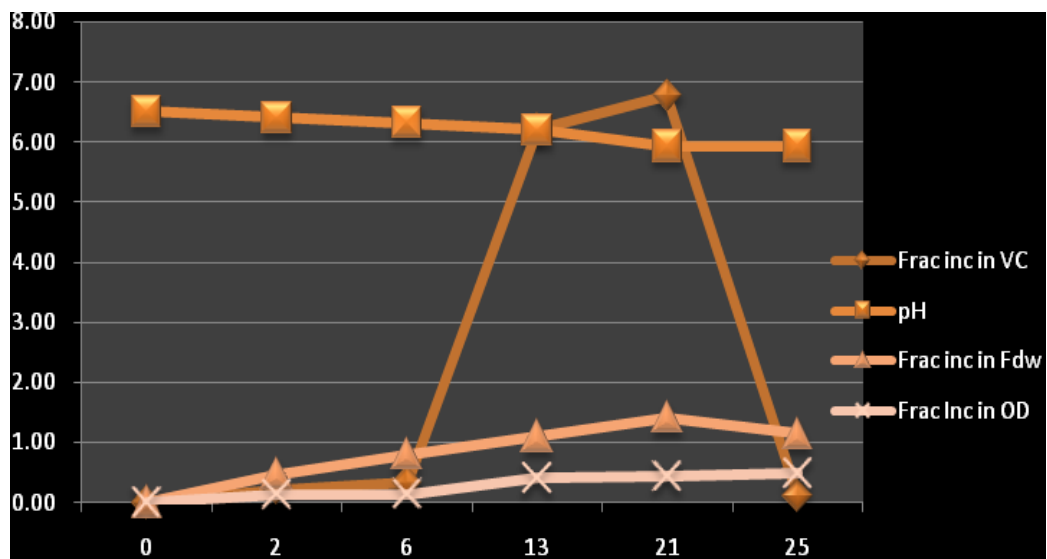


Fig 4. Growth profile of Penicillium in Minimum Salt Enrichment Medium seeded with Lubricating Oil

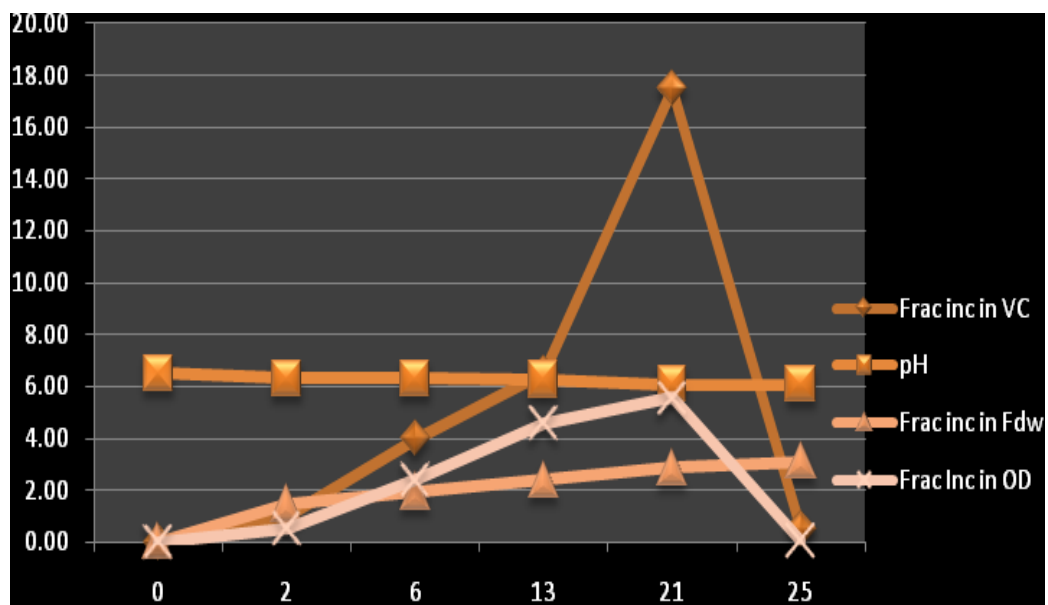


Fig 5. Growth profile of Aspergillus niger in Minimum Salt Enrichment Medium seeded with Lubricating Oil

Table 6. Anova: Effect of fungal growth on changes in viable count

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Rows	255.8985	5	51.1797	11.17049	3.06E-05	2.71089
Columns	58.51057	4	14.62764	3.192631	0.035107	2.866081
Error	91.63379	20	4.581689			
Total	406.0429	29				

Table 7. Anova: Effect of fungal growth on changes in pH

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Rows	1.08432	5	0.216864	88.49184	6.11E-13	2.71089
Columns	0.026147	4	0.006537	2.667301	0.062293	2.866081
Error	0.049013	20	0.002451			
Total	1.15948	29				

Table 8. Anova: Effect of fungal growth on changes in Fungal Dry Weight

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Rows	13.40205	5	2.680409	24.26803	7.43E-08	2.71089
Columns	7.109843	4	1.777461	16.09287	4.83E-06	2.866081
Error	2.209005	20	0.11045			
Total	22.7209	29				

Table 9. Anova: Effect of fungal growth on changes in Optical Densities

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Rows	11.45171	5	2.290343	2.205525	0.094144	2.71089
Columns	17.43503	4	4.358758	4.19734	0.012544	2.866081
Error	20.76914	20	1.038457			
Total	49.65589	29				

Table 10. Correlations between pH, Viable count (VC), Fungal dry weight (Fdw) and Optical density (OD) for 5 fungi cultured in a Minimal Salt Enrichment Medium plus lubricating oil

	pH and OD	pH and VC	VC and FDW	OD and VC	OD and FDW
<i>Trichoderma</i>	-0.6688	-0.6027	0.4870	0.9851	0.5770
<i>Fusarium</i>	-0.6701	-0.6419	0.5792	0.6047	0.9208
<i>Trichothecium</i>	-0.5987	-0.5948	0.5700	0.9996	0.5622
<i>Penicillium</i> <i>spp.</i>	-0.9352	-0.4996	0.6739	0.5969	0.9208
<i>Asp. niger</i>	-0.4235	-0.5393	0.4940	0.9052	0.4921
Mean	-0.6592	-0.5757	0.5608	0.8183	0.6946

Discussions

Soils from all 5 sites were contaminated with various microorganisms (Table 1), and the presence of *E. coli*, *S. aureus* and fungi in the soils were confirmed (Table 2). In the preliminary tests for the Presumptive Lubricating Oil-Utilising ability of the isolates, the *E. coli*, and *S. aureus* colonies did not show any zones of inhibition on the MSEM oil-agar plates. However, various fungal isolates showed zones of clearance on the MSEM Oil-agar plates which presumed that they had the ability to utilise lubricating oil as their sole carbon source. The Presumptive Lubricating Oil-Utilising fungi were *Trichothecium*, *Trichoderma*, *Aspergillus niger*, *Fusarium*, and *Penicillium spp.* (Table 4). The 5 fungi had adapted to living in the oil polluted environment occurring in the soils at the mechanic shops.

Trichothecium occurred at 60% of the mechanic shops and in 60% of sampled soils, while *Trichoderma* was present at 10% of the shops and in 10% of sampled soils (Table 5). This shows that whenever *Trichothecium* and *Trichoderma* occurred at a fitting shop they were well distributed in the contaminated soils. *Aspergillus niger* and *Penicillium spp.* occurred in 60% of the mechanic shops while *Fusarium* was present at 10% of the shops. However, *Aspergillus niger*, *Penicillium spp.* and *Fusarium* were not found in all soil samples taken from the shops where they occurred.

In petroleum-producing regions of Nigeria, Obire (1988) found several species of oil-degrading aquatic fungi in the genera *Candida*, *Rhodotorula*, *Saccharomyces* and *Sporobolomyces* (yeasts) and, among filamentous fungi, *Aspergillus niger*, *Aspergillus terreus*, *Blastomyces sp.*, *Botryodiplodia theobromae*, *Fusarium sp.*, *Nigrospora sp.*, *Penicillium spp. chrysogenum*, *Penicillium spp. glabrum*, *Pleurofragmium sp.*, and *Trichoderma harzianum*. Sebiomo *et al* (2010) isolated

Aspergillus flavus, *A. niger*, *A. terreus*, *A. ochraceus*, and *Trichoderma sp.* from oil contaminated soil from a mechanic workshop Ago-Iwoye, Ogun State Nigeria which were capable of utilising lubricating oil as the sole carbon source for producing energy.

In this project, *E. coli* bacteria were isolated from soils from 3 of the shops (Table 2), but they did not exhibit the ability to utilise lubricating oil as sole carbon source. Also, none of the *Staph. Aureus* isolated from 4 out of the 5 sites were able to utilise lubricating oil as the sole carbon source.

Akoachere *et al* (2008) did isolate some oil-degrading bacteria from oil contaminated and uncontaminated soil samples and these were *Pseudomonas fluorescens*, *Serratia marcescens* *Bacillus mycoides*, and *Serratia*, but did not isolate *E. coli* or *S. aureus*.

Sebiomo *et al* (2010) isolated 10 bacterial species including *Pseudomonas stutzeri*, *P. putida*, *P. aeruginosa*, *P. mallei*, *Bacillus licheniformis*, *B. cereus*, *B. Subtilis*, *Corynebacterium sp.*, *Alcaligenes eutrophus* and *Enterobacter aerogenes* from oil contaminated soil from a mechanic workshop Ago-Iwoye, Ogun State Nigeria which were capable of utilising lubricating oil as the sole carbon source for producing energy.

Profiles showing the fractional changes in viable counts, pH, fractional changes in fungal dry weights, and fractional changes in optical densities as the 5 fungi utilised the lubricating oil for growth are shown in figures 1 to 5.

There were significant increases ($P < 0.05$) in viable counts with increase in incubation period from day 0 – 21, and a decrease from day 21 – 25, and also significant differences ($P < 0.05$) in increase in viable counts among the 5 fungi, with *Asp. niger* exhibiting the highest mean fractional increase of 5.80 over the incubation period of day 0 – 25, and *Trichothecium* with the lowest with 1.26 over the same period (Table 6). The decrease in fungal growth from day 21 – 25 could be due to feedback inhibition (Affenzeller *et al*, 1989).

There were significant decreases ($P < 0.05$) in the pH's over the incubation period but the pH's were not significantly different ($P < 0.05$) among the 5 fungi (Table 7) due to the production of acidic metabolites (Punekar *et al*, 1985).

There were significant increases ($P < 0.05$) in fungal dry weight (Table 8) with increase in incubation period from day 0 – 25, and significant differences ($P < 0.05$) in increases in dry weights among the 5 fungi, with *Asp. niger* exhibiting the highest mean fractional increase of 1.73 over the incubation period of day 0 – 25, and

Penicillium spp. with the lowest increase of 0.76, while *Trichoderma* and *Trichothecium* both had fractional increases in dry weight of 0.82 over the same period.

The optical densities showed significant increases ($P < 0.05$) over the incubation period from 0 – 25 days, and also significant differences ($P < 0.05$) among the 5 fungi, with *Asp. niger* exhibiting the highest mean fractional increase of 2.61, followed by *Trichoderma* with 0.65, *Fusarium* 0.37, *Penicillium* spp. 0.23 and *Trichothecium* had the lowest of 0.07 (Table 9).

There were positive correlations of (0.56) between viable counts and fungal dry weights, (0.81) between viable counts and optical densities, and (0.69) between fungal dry weights and optical densities respectively (Table 10). However, the correlations between pH and viable counts, and pH and optical densities respectively were negative (-0.57) and (-0.65).

These results are similar to those of Sebiomo *et al* (2010) where negative correlations were obtained between optical density and pH, and between viable counts and pH, and positive correlation between viable counts and optical density for both bacterial and fungal isolates.

Conclusions

The results of this study indicate that the five fungi (*Trichothecium*, *Trichoderma*, *Aspergillus niger*, *Fusarium*, and *Penicillium* spp.) isolated from the oil contaminated soils from the mechanic workshops in Accra, are confirmed to be lubricating oil consuming fungi, and among them *Asp. niger* exhibited the highest lubricating oil utilising capacity, and the least was *Trichothecium*.

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HISTORICAL OVERVIEW OF HOUSING PROVISION IN PRE AND POST INDEPENDENCE GHANA

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Abstract

Housing undoubtedly remains one of the essential needs of man among food and clothing from creation. Meeting this essential need has witnessed different interventions that span several centuries from individuals, community self help, corporate organisations, NGO's to governments. From the Palaeolithic era interventions have taken the forms of caves, make shift tents, nomadic artefacts, traditional mud houses, wooden houses etc. These efforts to meet the housing needs have been greatly influenced by nature of requirement, ethnicity, geographical location, colonial impact and national policy direction. In Ghana, the rate of housing delivery has been erratic and often fallen short of the demand. This has culminated into several developmental problems such as high unaffordable rent, development of slumps and ghettos and huge housing deficits that will take sustained efforts over long periods to correct. In Ghana, diverse efforts have been expounded by many key players before and after independence to provide this need of man. Until recently, housing provision was the responsibility of the government and few individuals who could afford. A critical analysis of the situation from pre independence to date posits interesting features- (1. In 2005, Ghana had an estimated 5.4 million slum dwellers, 2. Current statistics rate Ghana's housing deficit over one million as against an annual estimated delivery of 37,000 and 3. Besides less than 15% of the population can afford house ownership by mortgage and less than 8% without mortgage) - which give a solid background for future national policy direction on housing provision. Historically, housing provision in Ghana has evolved through several paradigm and fragmented unsustained interventions due to several factors. This paper presents a historical overview of housing provision in Ghana. It attempts to systematically bring to bare the challenges of housing delivery by reviewing past and present housing schemes and also collect the views of various key actors through semi-structured interviews

Keywords: Housing provision, Challenges, Opportunity, Mortgage

Introduction

Housing the low to moderate or average majority of the population of developing countries remains one of the greatest socio-economic challenges which several efforts/interventions in the form of housing projects schemes have been evolved to

address [Fergusson, 2008]. Despite the universally acknowledged importance of housing for the physical and social well-being of mankind, its provision, affordability and accessibility remains a seemingly insurmountable problem for the nations in Sub-Saharan Africa [Werna, 1998]. A full supply of proper decent housing for the low/average-income people is still an unresolved issue in many notable cities throughout the world [Werna, 1998].

Housing is one of the three basic needs of mankind, a pre-requisite to survival of man [Onibokun, 1983; UN, 1992] and remains the most in short supply or deprived to demand in many countries in the world. It remains the essential element of the physical survival of mankind and contributes to the attainment of physical and moral health of a nation and stimulates the social stability, work efficiency and the development of the individual. It is also one of the best indicators of a person's standard of living and of his place in society [Adeniyi, 1974].

In spite of the fundamental role of housing in the life of an individual, society or nation and in spite of the United Nations realization of the need to globally attain adequate shelter/housing for all, the housing situation in the world is at a crisis level and remains one of the global problems. It is a grave and a rising challenge facing urban, peri-urban and rural residents, particularly in most developing economies [Ademiluyi, 2009].

The situation seems worst than thought given the current trends in population dynamism in major cities in the world especially in developing countries. According to the United Nations Population Fund, the world's population passed 6.1 billion in 2001 and is expected to reach between 7.9 and 10.9 billion by 2050 and with this over 90% of this growth during the next two decades is forecast to occur in developing countries [Wikipedia, 2003]. Currently, one-sixth of the world's population – one billion people – live in urban slums in emerging countries. In addition, virtually all net growth of 2.6 billion in world population between now and 2050 is projected to occur in these cities [Fergusson, 2008].

The ever mounting crisis in the housing sector in the world is evident in the fact that there is absolute housing unit shortage, growing emergence and proliferation of slum and squatter settlements, rising cost of housing rent and growing inability of the average citizens to own their own houses or procure decent accommodation of their taste in the housing market [Ademiluyi, 2009]. It is estimated that the number of people considered to be homeless are estimated to be in excess of 100 million in the world [UNCHS, 1999]. In cities such as Mumbai, Lagos, Accra, Abidjan Shanghai, Mexico City, Moscow, an estimated 40 to 50% of their population live in slums, dilapidated chawls and on pavements [Yuen, 2007]. Figure 1 below gives an indication of the situation of housing shortage in the various part of the world.

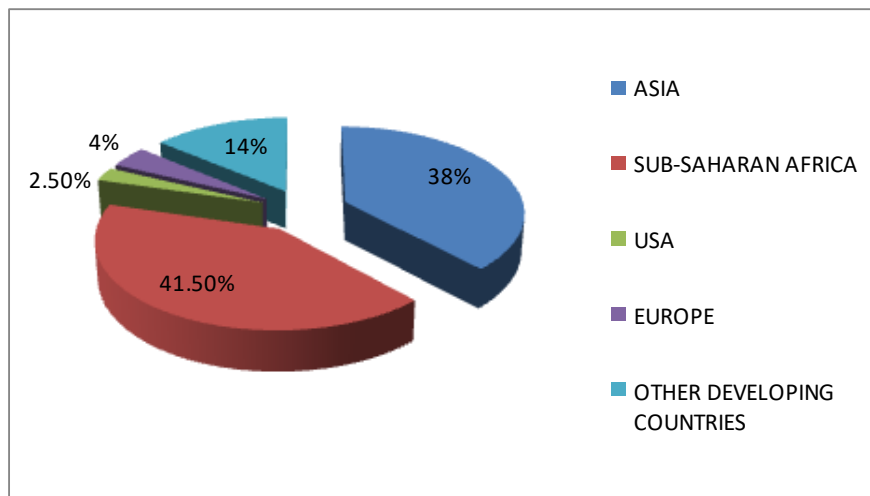


Figure 1: Distribution of Housing Shortages in the World.
Source: Wikipedia 2009

In Ghana, Housing situation is said to be at a crisis level [Ghana National Housing Policy and Action Plan, 1987-1990]. In a 2006 Housing Conference in Accra, it was revealed by the then president, J.A. Kuffour that Ghana's population was at 20 million and was set to increase by 50% by 2025 with a growth rate of 2.7-3%. Ghana's urban centres are at bursting seams from rural-urban drifts and bear the brunt of rapid urbanisation. It is estimated that Ghana's urban population will be about 52% of the national total growth and central to this rapid urban growth are serious housing shortages and poor sanitation [UN-HABITAT, 2006]. In 2005, as a result of acute shortage of housing and poor conditions of housing, sub-Saharan Africa had 199 million slum dwellers constituting 20% of the world's total slum population and had the highest urban growth rate of 4.58% and the high annual slum growth rate of 4.53%. Ghana in the same year had 5.4 million slum dwellers and is anticipated to reach 7.1 million by 2020. The worst hit cities are Accra, Kumasi and Sekondi-Takoradi [UN-HABITAT, 2006].

Provision of affordable housing for the mass of the population has remained a major challenge for many countries. Several interventions have been seen as the way to remedy the ever growing demands which far outstrip the supply creating an acute shortage leading to creation of slums, insanitary conditions and overcrowding especially in the major cities of the world. This paper attempts to recount or offer a historical overview of Ghana's housing situation. It presents a historical overview of housing delivery in Ghana from pre to post independence era and reveals the emerging developments in the Ghanaian housing industry. Information for the paper was gathered through an extensive and exhaustive assessment of various housing reports, a review of published literature on Ghana's housing situation and also

through semi-structured interviews with various stakeholders like the Ministry of Water Resources Works and Housing (MWRWH), Centre for Scientific and Industrial Research/ Building and Road Research Institute (CSIR/BRRI), Ghana Statistical Services (GSS), Real Estate Developers, and Building Professionals.

History of Public Housing in Ghana

Ghana's housing delivery and access to decent accommodation in any part of the country is at crisis level [Agyemang, 2001]. Provision of housing in Ghana has witnessed fragmented and unsustained effort from individuals, private developers and the government. This situation has contributed to the huge housing deficit we encounter today. The shortage of housing continues to be one of the most critical socio-economic challenges facing the country [Ghana National Development Plan 2008]. Statistics show that, the country's housing deficit is projected to be around 1.2 million house-units as against an annual purported delivery of 37,000 house units which is dominated by individual self house projects [Amoa-Mensah, 2008]. The 2000 Population and Housing Census reports that there were 2,181,975 houses countrywide even though a total of 3,877,418 dwelling units were recorded. This implies that about 1,695,443 'houses' are unconventional houses. Records show uneven distribution of houses across the country as indicated in Table 1 and Figure 2 with an arithmetic increase in housing provision as against a geometric rate increase in the population.

Table 1: Regional Distribution of Stocks of Houses and Households(HH)

	2000 Population	No. of Houses	No. of HH	% Dis- tribu- tion of Hous- ing Stock	Urban Share of Hous- ing Stock	Pop. per House	Avg. HH size	HH per House
All Regions	18,912,079	2,181,975	3,701,241	100	34.1	8.7	5.1	1.7
Greater Accra	2,905,726	287,840	626,613	13.2	80.4	10.1	4.6	2.2
Ashanti	3,612,950	328,751	682,759	15.1	37.1	11	5.3	2.1
Western	1,924,577	259,874	410,142	11.9	27.1	7.4	4.7	1.6
Eastern	2,106,696	283,461	456,683	13	26.6	7.4	4.6	1.6
Volta	1,635,421	264,451	345,821	12	27.0	6.2	4.7	1.3
Northern	1,820,806	177,785	245,617	8.1	24.4	10.2	7.4	1.4
Brong Ahafo	1,815,408	216,275	342,808	9.9	28.9	8.4	5.3	1.6
Central	1,593,823	223,239	365,777	10.2	26.8	7.1	4.4	1.6
Upper East	920,089	88,401	144,386	4.1	14.6	10.4	6.4	1.6
Upper West	576,583	51,898	80,635	2.4	17.4	11.1	7.2	1.6

Source: GSS Census Report and author's own calculations

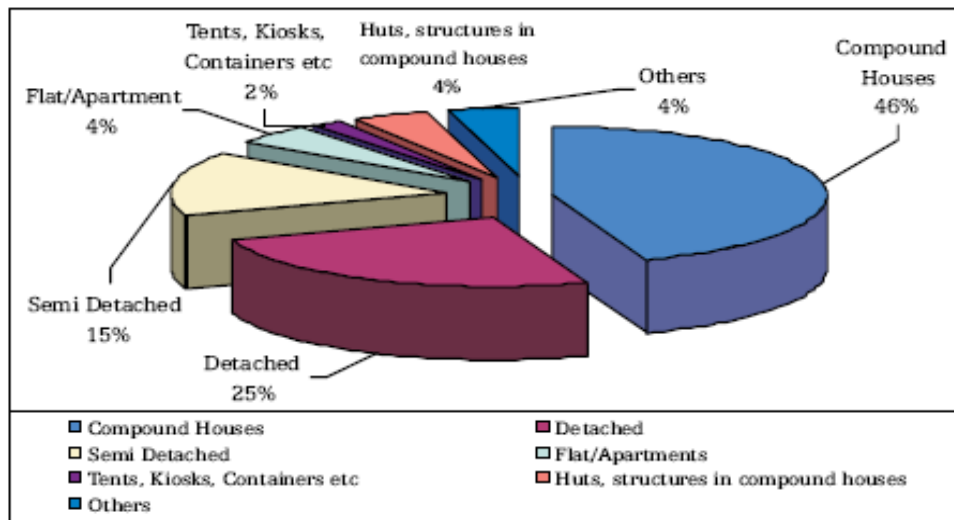


Figure 2: Distribution of Housing in Ghana
Source: Bank of Ghana Report, 2007

Table 2: Selected Housing Conditions of Occupied Unit by Region-2000 Population and Housing Census, 2002

Housing Facility	All Regions		Western	Central	Gt. Accra	Volta	Eastern	Ashanti	Brong Ahafo	Northern	Upper East	Upper West
	Pct	Number										
<u>Sleeping Rooms</u>	100.0	3,698,337	409,282	365,605	625,744	345,722	456,475	682,337	342,695	245,531	144,358	80,588
<u>Used</u>	49.9	1,844,327	233,077	219,110	393,576	135,306	221,649	415,258	152,829	38,603	21,377	13,542
One room	21.5	793,579	94,528	74,796	113,005	100,155	108,541	120,596	77,189	50,347	34,678	19,744
Two rooms	11.3	416,248	38,876	29,348	48,140	51,484	52,538	58,454	42,711	45,990	31,395	17,309
Three rooms	6.6	242,306	18,559	15,360	32,392	25,827	28,437	30,861	23,639	33,788	21,421	11,647
Four rooms	3.7	135,533	9,102	8,307	15,360	12,188	15,512	18,779	13,737	23,525	12,325	6,698
Five rooms	2.4	88,946	5,299	5,957	8,660	8,427	10,293	12,270	9,565	15,911	8,156	4,408
Six rooms	1.4	52,393	3,520	3,520	4,440	4,111	6,081	7,410	6,418	10,300	4,423	2,180
Seven rooms	1.0	38,101	2,264	2,691	3,388	3,038	4,389	5,528	4,836	7,391	2,991	1,585
Eight rooms	2.3	86,904	4,064	6,141	6,783	5,186	9,035	13,181	11,771	19,676	7,592	3,475
Nine or more rooms												

Table 3: Housing Deficit Growth

YEAR	DEFICIT	DELIVERY	% OF DELIVERY	NEED
1980's	250,000	70,000	22%	133,000
1998	300,000	30,000	25%	140,000
2000	700,000	25,000-30,000	21%	199,000
2008	1,000,000	37,000	22%	150,000
2010	1,200,000	199,000	23%	300,000

Source: Authors compilation from several literatures

The purported delivery of 37,000 units in 2008 as indicated on Table 3 is very much inconsistent. For this period (2001-2008), only 5092 houses were initiated by government and remain incomplete after five years of pre contract planning [ISSER, 2007]. This also include projections of 'self-build houses' which in reality can take several years to complete through lock up capital process [Ahadzie et al, 2010]. Anecdotal evidence suggests that it takes between 5-15 years for an individual household to build a house [Bank of Ghana, 2007].

Ghana's public housing constituted about 10% of the total housing stock by 1982 as against over 80% from private individuals. The relative absence of a well developed real estate market/industry accounted for about 3-8% of the housing stock delivered then [Barnes, 1982]. From the late 1980s to 2010, no single unit of housing has been added by the government from purely public housing provision as many initiated schemes within this periods remain incomplete. In 2006, from the annual purported delivery requirement of 199,000 the annual contribution of delivery from Ghana Real Estate Developers Association's (GREDA) peaked at 2,500 units, (less than 8%) with the informal sector (private individuals) which has formed the bulk of the contribution to be about 90%. From the past three decades, contribution from the public sector has been non existence as seen in the numerous uncompleted government housing projects [Akuffo, 2006]. This is coupled by the fact that only 8% of Ghanaians can afford to buy house without a mortgage and 15% can access mortgages [BRRI, 2006; City Properties, 2010]. The private sector has been bashed for making their housing units targeted at the rich and prominent persons of the society at the neglected of the average and the poor. The Building and Road Research Institute (BRRI), established in 2004 that out of the total housing supply of 40,000, supply from the private individuals amounted to 38,200 (95.5%) [Akuffo, 2006; BRRI, 2006]. The GREDA's accumulated contribution accounts for less than 5% of the total housing stock.

Given the estimated and projected delivery and deficit in Table 4, as against the actual delivery, it should be of great concern to demand immediate action from all parties since housing promotes economic growth through the expansion of the

construction industry and contributes to reducing poverty by increasing the demand for low-skilled labour [Bank of Ghana, 2007]

Table 4: Estimated Housing Stock and Deficit

	Population	Households	Estimated Housing Requirement	Yearly Requirement
2001	19,422,705	3,808,374	2,240,220	58,896
2002	19,947,118	3,911,200	2,300,706	60,486
2003	20,485,690	4,016,802	2,362,825	62,119
2004	21,038,804	4,125,256	2,426,621	63,796
2005	21,606,852	4,236,638	2,492,140	65,519
2006	22,190,237	4,351,027	2,559,428	67,288
2007	22,789,373	4,468,505	2,628,532	69,105
2008	23,404,686	4,589,154	2,699,502	70,970
2009	24,036,613	4,713,061	2,772,389	72,887
2010	24,685,601	4,840,314	2,847,244	74,855

Source: 1960, 1970 & 2000 Population Census and projected calculations

Ghana's Public Housing Policies Over the Years

The foregoing reviews suggest a continuous effort by private individuals and the real estate sectors over and above that of the public sector. Ghana's serious housing deficit is a problem which spawned and fuelled by host of factors notably, ever increasing cost of building materials, rapid population growth, urbanization, deterioration of fabric of existing structures, absence of clear sustainable delivery policy framework and poor managerial system. It is however not for lack of effort on the part of successive governments to address the problem of shortages. Verifiable records confirm concerted efforts have been made by all governments, even before and after independence towards the provision of affordable social/public housing in Ghana [Daily graphic, 2011].

Implementation

Pre-independence witnessed the direct involvement of government in public housing. The emphasis on developing the housing industry gained prominence in Ghana probably from the late 50s to the early 60s as it attained independence from colonial rule [Bank of Ghana, 2007]. It is worth noting as stated by [Ayeh, 2009;

Agyemang, 2001] that all housing schemes initiated by various governments from pre to post independence era were unsuccessful due to a host of factors. The history of housing delivery in Ghana is a de-facto, a tale of failed economic policies [Akuffo, 2006].

The housing interventions during the pre-independence era took the form of provision of staff bungalows for the senior public officer of the colonial governments in many parts of the country especially in regional capitals, towns and mining areas through direct funding by the colonial government [Agyemang, 2001]. It must be noted that literature on housing provision during pre-independence era is scanty and its statistics are almost unavailable but the notable ones give account of housing schemes initiated by major companies in the then Gold Coast to provide accommodation for their expatriates, senior officers and junior worker. It is worth noting that this housing was mainly provided for the working class. No consideration was made for the average, poor and non working class until 1920s and after the occurrence of the 1939 earthquake in Ghana [Agyemang, 2001; Ayeh, 2009]. Ghana's Public housing constituted about 10% of the total housing stock by 1982 as against over 80% from private individuals. The relative absence of a well developed real estate market/industry accounted for about 3-8% of the housing stock delivered then [Barnes, 1982].

Gordon Guggisberg

The Gold Coast government's first recorded direct involvement in native housing was in 1920s when Dispossessed Person's Housing Scheme was introduced to provide housing for the natives dispossessed as a result of government development programs. Under the scheme, which begun in 1923, affected persons were advanced with building material loans to commence their own houses. By 1933, 118 loans involving a total of £9,280 had been approved and given. The scheme was discontinued in 1933 because it was perceived by the government to be very expensive. This was during Governor G. Guggisberg's reign [Agyemang, 2001]. From this time onwards, little attention was paid to housing until the 1939 earthquake.

The 22nd June, 1939 earthquake in the now capital city of Ghana, called for the direct intervention of the then government in the provision of affordable housing for the affected population. The government provided funding to build 1000 two (2) - bedroom unit houses at Osu, Mamprobi, Chorkor, North-West Korle Gonno, , Kaneshie and Abbosey-Okai. By 1955, 1250 units were completed and they exist up to date occupied by civil and public servants and the Armed Forces. The rental units were subsidized and tenants given the opportunity to acquire them through hire-purchase [BRRI, 1970].

Alan Burns

The Alan Burns government also introduced a four (4) year Development Plan in 1943 of which housing was a top priority. The plan sought to implement the construction of inexpensive but well built houses' with as much local material content as possible on a budget of £0.8 million [Agyemang, 2001].

In 1946, two (2) housing schemes under the government' plan and policies were published. Scheme A was under the direction of Department of Social Welfare. Under this scheme 3, 2, and 1 bedroom dwellings were to be constructed and rented to all people at economic cost. Only labourers were required to pay non economic rents. The Scheme B was termed Town and Council Housing to be concentrated in Accra, Kumasi and Sekondi-Takoradi. Under this scheme, a person could apply for financial assistance to build within the Municipal on his own design or pro-forma building plan from the Department of Social Welfare which both the plan and contractor must be approved by the Town Council.

Nkrumah

In the post independence era, several interventions were undertaken but considered unsuccessful by experts and stakeholders. Under the reign of Dr. Kwame Nkrumah, the first president of Ghana, three (3) Development plans were formulated aimed at the provision of adequate housing. The first was the five year plan from 1951-1956. This plan saw the establishment of the Tema Development Corporation (TDC) and the State Housing Corporation (SHC) [Bank of Ghana, 2007; Benjamin, 2007; Agyemang, 2001]. The main objective of the TDC was to provide affordable housing for the low income workers of the newly created Tema. The activities of TDC led to the creation of the Communities of Tema, i.e. Communities 1 to 8 etc contributing over 2255 units. The Sockbeton Housing scheme was also established targeted to provide 168 houses in Accra, Kumasi, and Sekondi-Takoradi. This scheme under the consultancy of a Dutch firm introduced pre cast members perceived to be cheaper but became more expensive than estimated and hence the whole scheme was abandoned. The Roof Loan Scheme which sought to grant loans and assistance to public sector workers under the recommendation of the United Nation also made contribution to the a total housing units. However, due to its inefficiencies, only 2517 units out of the proposed 6700 from the 2million pound fund were realized [Nelson and Ayeh, 2009]. The SHC was also established to provide housing for the workers in the civil and public service class and also provide long term housing finance. Their activities were expanded to all the nine (9) regions in the country. Their activities were monitored under the Ministry of Works and Housing with direct funding of their projects from the central governments and in 1995, it was converted into a limited liability company and operated as a commercial enterprise. Their schemes operated with the flexibility of workers owning their home through years of gradual monthly payment from salary deduction [Gyabah, 2009; Agyemang, 2001].

The second Development Plan which was instituted to continue provision of housing was from 1959-1964. This was to support the UN commission's recommendations and initiated programmes to put up housing units. It sought to continue and expand the 'Roof Loan' scheme which focused on assistance from employers to employees through housing loans and self-help housing sites and services [Ayeh, 2011]. The shortfall of this plan was that there was no needs assessment and as a result, there was no indication of projected targets and outputs in the development plan [Gyabah, 2009; Agyemang, 2001]. Nkrumah's vision on housing was to house particularly those in urban areas where shortage was at its peak due to uncontrolled urbanisation. He was not able to see to the end of this plan and was kicked out in a coup d'état in 1966.

Ankrah

The National Liberation Council (NLC) which booted out the Nkrumah government in 1966 implemented a two (2) year Development plan. The NLC's plan through the TDC and the SHC was to produce 2,000 housing units annually. Only a total of 1000 units were realized. Out of this only 2.7% were one room. By location, 63.6% were in Accra, 9% in Kumasi, 7.5 in Sekondi-Takoradi and 11.3% in Cape Coast. The main objective of this scheme was to ensure that housing was generated by the productive sectors of the economy through rational and balanced approach [BRRI, 1970; Ayeh, 2011]. It also targeted clearance and slowing down of the growth of slums in urban areas.

Busia

The Busia administration showed commitment to alleviating the housing crisis confronting the nation especially in the major cities by introducing a one year development plan. The one year Development plan (1970-1971) of the second republic under Busia proceeded the seven year Development Plan. The main objective of this plan was aimed at a house occupancy rate of 10 persons per house as against a housing need estimated at 26,000 units per year. This plan failed to specify the housing units with their associated cost involved. His scheme added just 25% (764- SHC, 1012-TDC=1776) of the targeted 8,000 units mainly due to lack of funds [S-Ayeh, 2011; K-Agyemang, 2001].

Acheampong

The National Redemption Council under I. K. Acheampong took over government in 1972 and established the National Low Cost Housing Committee under the auspices of the Ministry of Works and Housing. This plan received a capital injection of 10 million cedis (\$9,803,921.77, \$1=¢1.02, 1970) to construct low cost housing for low-income households in urban areas across the ten regions. It had an annual projected delivery of 2,300 units [BRRI, 1972; Ayeh, 2011]. The scheme by June, 1975 had realized 5,466 units at a cost of 47,602,678 cedis. It was however

abandoned in 1976 because of its failure to serve the targeted population due to its high cost [Nelson & Ayeh, 2009]. The original estimates indicated a cost of 2,000-4,000 cedis depending on the size. Upon completion of 5,466 units average per unit stood at 10,000 cedis (\$9,803.92). Further, 6,000 units cost a total sum of 62.6 million cedis, thus increasing the average cost to over 12,000 cedis. The government acknowledging its limitation with funding sought to encourage the private sector to complement her effort [K-Agyemang, 2001].

Liman

The Liman government also recognized the enormity of the housing problems and thus contributed to the building of 1990 rental units through SHC and 228 by the TDC [Nelson & Ayeh, 2009; Benjamin, 2007]. The 1970s, however, brought a period of very poor economic performance for Ghana. There was the energy crisis, rising cost of oil, excessive high rise in imported building materials, decline in external funding etc. This extended recession brought the construction industry to a halt. It was against this background that the Liman government sought to invest in the development of the use of local materials leading through the establishment of the Tile and Brick factory [Nelson & Ayeh, 2009; Benjamin, 2007; Gyabah, 2009; Agyemang, 2001].

Rawlings

The PNDC/NDC era under J. J. Rawlings saw the implementation of many schemes in an attempt to solve the housing problems. These were the National Shelter Strategy (NSS), Ghana Vision 2020 and the Structural Adjustment Programme (SAP) & Economic Recovery Programme (SAP/ERP).

The National Shelter Strategy was initiated in 1986 by forming a National Housing Policy Committee by the Ministry of Works and Housing (MOWH) to examine the housing situation in the country. This was to establish a government policy and action plan that seeks to provide adequate and decent housing unit in order to improve the quality of life of people in the urban areas. The main focus of the committee was on the constraints of housing delivery either than any other contributing factor to the sector. It focused on housing finance, land, physical planning, infrastructure, building materials, management effort towards delivery. This policy and plan covered the period 1987 to 1990. This was coined from the MOWH's need to enhance its planning capacity to implement housing policies. The focus of the policy was to create an enabling environment and framework to enhance housing provision rather than the full participation of the government to deliver housing [Bank of Ghana, 2007; Agyemang, 2001]. It sought to promote use of local materials, improve rural housing strategy, improve monitoring, managing and coordination of shelter programmes, improve land acquisition and increase access to finance and participation of women in the sector.

The Ghana Vision 2020 scheme had the First Medium-Term Development plan from 1997-2000 target the provision of low-income housing as reported by [Bank of Ghana, 2007 ; MOWH, 2001]. It sought to bring housing within the purview of the poor to improve their living conditions. The plan introduced a new facility under the Social Security scheme which permitted contributors to withdraw part of their contributions to purchase a house. Unfortunately, due to lack of funds, private sector participation and political will, none of the housing strategies under this plan were implemented [Bank of Ghana, 2007].

When the financial crisis had peaked in the 1980s. Ghana signed onto the infamous Structural Adjustment Programmes (SAP) of the World Bank and the IMF in order to secure much needed cash flows for the housing construction industry. This required the country's participation in trade liberalization initiatives which opened its market to imported building materials and necessitated the loosening of rent controls [Benjamin, 2007]. This brought in its wake high inflation translating into high cost of building, high cost of construction, high rent and loosening the government's grip on the housing market. This increased the creation of slums and ghettos in many cities and urban areas due to high unaffordable rents. In addition due to the lucrative commercial rents being charged, many toilets and bathrooms were converted into rental units leading to overcrowding and creating serious sanitation problems in the cities [Gyabaah, 2009].

Kuffour

No considerable additions had been made to public housing from 1985 to 2000 and the new NPP government sought to reduce the crisis situation of the housing sector through the initiation of about 20,000 affordable housing units in 2001. In 2007 about 4,500 units from bed sitter, single and two bedroom apartment had started at Borteyman and Kpone in Accra, Asokore Mampong in Kumasi in the Ashanti region, Akwadum site Koforidua in the Eastern region, Tamale, to be completed by June, 2009 [GOG, 2007]. This was the new government's effort to ease the housing problems in the country. The main target group of this scheme was the civil and public servants. Unfortunately not a single unit remains completed up to date and most have been taken over by squatters. This scheme was discontinued by the new NDC government in 2009. [Ahadzie et al, 2010; Nelson & Ayeh, 2009; Ayeh, 2011].

Quasi-Government Approach

The involvement of the quasi-government institutions in housing delivery can not be overlooked. Towards the end of the decade (1980-'90), the Social Security and National Insurance Trust (SSNIT) expanded on its programs to build housing for its staff across the country. Though this was originally targeted at its staff, it was expanded in 1988 in a significant investment in housing at 'social' and not market

prices, providing a lower option for the general public. However, SSNIT could not attain its objective for the poor and low-income. The project benefited the middle and upper class [Agyemang, 2001; Benjamin, 2007].

SSNIT's notable schemes were the 1637 units at Sakumono, where its success led to it being repeated across the country in Anaji- Takoradi, Koforidua, Wa, Adenta-Accra, Kumasi etc. [Amoa-Mensah, 1999].

In 1999, Ghana's financial crisis had hit its peak. In that year, SSNIT was unable to continue operating its social rental units at a loss and that even its reduced rents were higher than what most Ghanaians could afford. Being saddled with huge operational and maintenance cost, the Trust began the process of divesting most of its real estate assets. Today they have sold out almost more than 92% of its housing units [Benjamin, 2007; Kielson,]

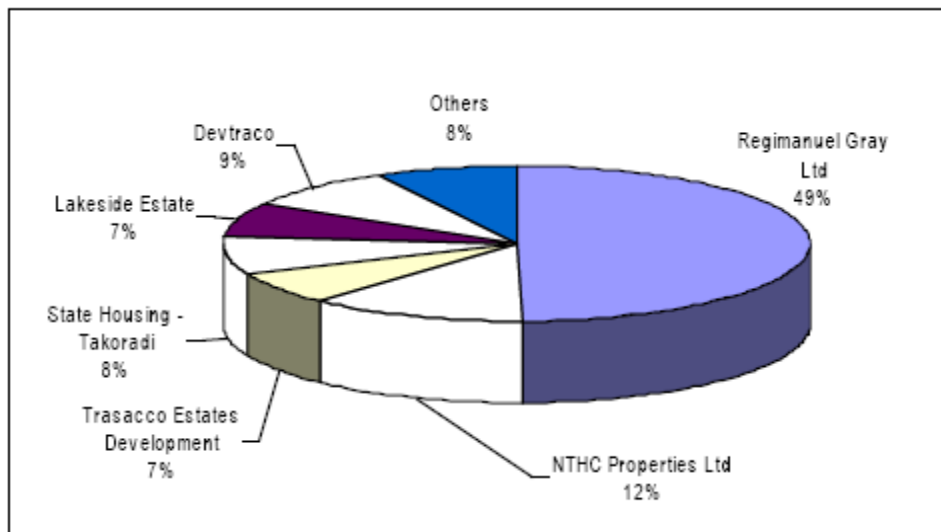
The SHC, after its recapitalization in 1995, adapted a new approach to housing delivery. Under this scheme, prospective home owners are given the opportunity to finance their own home bit by bit after making a down payment of about 20-25% of the cost of the building. This has come with little success as many of the units are over run in time and cost. That is, it takes along time of fragmented funding to complete the homes. This was carried out in all the regions where SHC operate [SHC, 2010]

The Ghana Real Estate Development Association (GREDA) as argued by [Gyabaah, 2009; Ahadzie et al, 2010] was formed among other key objective to help ameliorate the dismal housing deficit especially through the adoption of best practices in construction and management. Notwithstanding the expansive role of the GREDA in recent times, housing supply has not increased any better[Ahadzie et al, 2010; Bank of Ghana, 2007]. Since its formation in 1988, the association has delivered a total of 10,954 housing units[Mahama, 2004]. Selected private estate developers contributions are shown in Table 4 and Figure 5.

Table 4: Housing Units Provided by Selected Real Estate Developers

	2000	2001	2002	2003	2004	2005	2006
Regimanuel Gray Ltd	105	170	180	160	150	155	126
NTHC Properties Ltd	40	45	12	20	22	70	42
Trasacco Estates Development Co. Ltd	--	18	27	20	20	20	36
State Housing Co.Ltd-Takoradi	15	20	20	25	30	30	30
Lakeside Estate	--	--	6	10	20	63	54
Devtraco Ltd	10	14	20	22	32	40	46
Salem Investment Ltd	--	3	6	6	15	30	20
Flexcon Ltd	5	5	10		5	4	10
Civil Masters Co.Ltd	4	4	3	8	6	8	10

Source: Survey Result, March 2007



Source: Bank of Ghana

Figure 5: Shares of Houses Built by Selected Real Estate Developers (2000-2006)

The delivery from formal Real Estate Developers (GREDA) annually at its peak averaged 2,500 units constituting less than 10% of the total annual delivery. This is a drop in the ocean, compared to the annual housing requirement of 199,000 units [Akuffo, 2006]. Actual delivery is purported to be between 25,000 to 30,000 units and is mostly through informal efforts. The BRRI, established in 2004 that out of the total housing supply of 40,000, supply from the private individuals amounted to 38,200 (95.5%) [Akuffo, 2006; BRRI, 2006]. The GREDA scheme allows

prospective homeowners to own their home through mortgage or outright purchase. In spite of so many available information through research to make the sector sensitive to the average income and the poor in society, no achievement has been recorded in this direction. This is coupled by the fact that only 8% of Ghanaians can afford to buy a house without a mortgage and 15% can access mortgage [BRRI, 2006; City Properties, 2010]. This sector has been bashed for making their housing units targeted at the rich and prominent persons of the society at the neglected of the average and the poor. Arguments have been leveled for them to adopt more innovative and cost saving approach to make their schemes affordable [Dapaah, 2006; Abongo & Mahama, 2009].

The forgoing discussions and findings reveal that the housing industry in Ghana is inundated/plagued with an army of challenges with the notable ones being:

1. absence of clearly defined national housing policy,
2. managerial inefficiencies,
3. high cost of building materials,
4. lack of access to sustainable capital/finance,
5. land acquisition/litigation, and
6. Lack of control and Regulatory Policy framework for rent [Bank of Ghana, 2007; Ahadzie et al, 2010; Akuffo, 2006; Benjamin, 2007].

Housing Finance

Housing finance remains the greatest and highest challenge to the smooth delivery of schemes the world over. Housing is usually the largest expenditure item in a family budget either as rent, personal building initiatives or mortgage financing. High housing cost can strain a family budget, constrain available resources for other household needs such as utilities, education, health care, transportation, savings for retirement and emergencies [Bank of Ghana, 2007]. Finding a reliable and sustainable constant source of finance for housing either for individuals, private real estate developers (GREDA), central government, NGOs and quasi-government institution has remained the greatest challenge from pre-independence era.

Access to decent affordable house/home is the biggest challenge facing a greater proportion of the population. The situation is worse in the major cities. A typical Ghanaian household is faced with three choices in the acquisition of shelter. These are by rent, self built and mortgage.

Financing by any of these means has not come easy and at great cost and sacrifice. Individual 'Self Built' housing finance comes through:

- a. Self accumulated income
- b. Remittances from relatives and friends
- c. Access to home loans from non banking institution (SHC, FGBSL, SSNIT etc)
- d. Access to credit from Banks.

Unstable economy and evolving impact of world economy downturn and unfavourable economic policies set to have negative impact on these sources of income reducing ability to save as against other competing needs, high cost of borrowing, high cost of building materials and inability to sustain home loan fund schemes such as FGBS, BHC, SSNIT. This is evident in the long years taken for individuals to complete their homes [Bank of Ghana, 2007; Agyemang, 2001]

Government from pre and post independence era undertook direct injection of capital to fund building projects as well as offer home loans at low interest to workers to build their homes. When SHC and TDC were formed in 1955, they enjoyed a sustained funding for building projects aimed at providing houses for the workers in the cities and other urban centres. This chalked a considerable impact until the mid 1970s when Government could no longer sustain his effort due to the oil crisis and economic decline, coupled with the offer of fixed rate long-term loans to borrowers. With these the SHC and TDC's impact on housing delivery declined. The TDC and SHC under went a recapitalisation in 1995 and has since not been able to get back again as a force [Akuffo, 2006; Bank of Ghana, 2007].

The First Ghana Building Society (FGBS) was also established in 1956 under an ordinance as a typical building society to lend affordable loans to members from a pooled savings for prospective home ownership. The economic downturn of the 1970s with its associated high inflation levels, over valued currency, poor and reduced savings of members caused a severe shortfall in its funding and eventual collapse. The FGBS offered loans and its interest rates were way lower than the prevailing commercial bank rates. It become unattractive to borrowers and main funding from the government dried up under the SAP. Several attempts to resuscitate it have not materialised. Between 1980 and 1988, it granted 549 original and 418 supplementary loans. The total loans in 1988 did not exceed 500,000 cedis (\$181,818- \$1=¢2.75 cedis, 1980). The BHC was established with a core function of providing funds for the housing and construction sector. Unfortunately, it could not maintain its focus on housing but rather shifted to commercial banking and unfortunately liquidated in 2000. In 1990, only 17% of its total portfolio of three billion cedis (\$9,316,770.19, \$1=¢322, 1990) was spent on housing. In its 14 year operation, BHC granted only 363 residential mortgage loans [Agyemang, 2001].

Governments' effort in funding housing through state agencies culminates in the table below.

Table 6: Various Government Funding Support to Housing Schemes in Ghana.....

S/N o.	GOV'T	AMOUNT	REMARKS
1	G Guggisberg	£9,280	Benefitted only high rank people
2	Alan Burns	£0.8million	Rising prices of materials
3	Kwame Nkrumah	£2.5 million-TDC £2.0 million- SHC £1,600 loans scheme £500,000 £216,000 Mortgage loans £50,000-Research into LM £20million- Coup detact £24.5million private sector	Rising prices of materials & labour
4	E. A. Ankra	£20million- Coup detact £24.5million private sector	Continue from Nkrumah
5	I. K. Acheampong	¢47,602,678 ¢15,000,000 ¢62,000,000	Rising prices of materials
6	Liman		Rising prices of materials
7	J. J. Rawlings	Through Quasi-Gov't Inst. SSNIT, SHC, TDC, HFC	Rising prices of materials
8	J.A. Kuffour	GH¢270,000,000	Incomplete
9	J. E. A. Mills	\$10 billion	Proposed STX

* Busia & Liman no recorded capital injection

Source: Author's compilation from several literatures

Corporate Housing Financing

The corporate financial institutions have made immense contribution towards housing provision in Ghana but these efforts have not come cheap but at a cost often unaffordable by greater percentage of Ghanaian. Up to the early 1980s, all commercial banks in the country (BBG, SCBG, GCB etc) did not provide any mortgage loans towards housing. It was from 1986, that the GCB through its newly established mortgage department, started granting mortgage loans at as high as 35-38% interest rate [Akuffo, 2006; Agyemang, 2001].

Given the deprivation of the housing sector in the early 1990s couple with rising cost of borrowing and building, the ruling government with the intervention of the

World Bank (IDA) established the Home Finance Company (HFC) in 1991 with the sole mandate of creating a sustainable housing Finance System. Its initial capital was provided by SSNIT and the IDA and was enlisted on the Ghana Stock Exchange in 1995 to raise funds and others from bonds issued. It granted a 15-20 year mortgage at a rate of 35-45%.

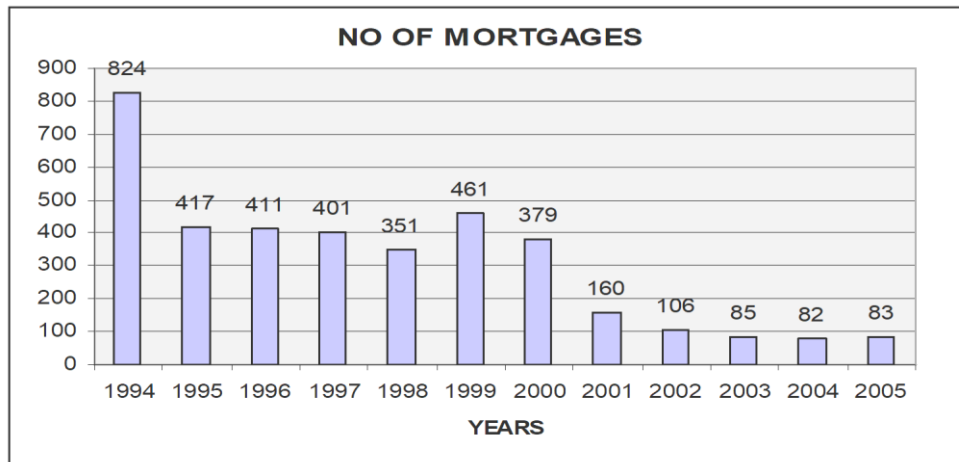


Figure 6: Mortgage Performance by HFC

Source: World Bank/IMF Housing Conference Report

The highest annual origination was in 1994. On the average the company did 350 mortgages per annum. The mortgage business has been slow since 1999 when the local currency -the cedi depreciated by 90%. House prices almost doubled thereby worsening the affordability situation. The significant reduction in originations over the past 5 years was an indication that the company's role as a private specialised mortgage lender needed to be reviewed. Recent economic performance however, gives hope that the mortgage business will pick up again. It is worth noting that in November, 2003, HFC could not go on with its mandate and as such *converted* to a commercial bank [Akuffo, 2006; Agyemang, 2001].

BUILDING MATERIAL INDUSTRY

Before our contact with the European and influence of capitalism, building in Ghana was predominantly locally based materials in the form of *Thatch, Mud, Wood, Earth and Bricks*.

The paradigm changed when formal trading started under colonisation in the 1870s. The trading allowed for the introduction of foreign building materials in the Gold Coast which were later perceived to be better and 'elites' above the cheaper local materials[Agyemang, 2001]. As Ghana advanced in age, with trading activities growing above expectation and coupled with certain government policies, the situation grew worse and foreign materials were at all cost preferred above all local materials. This development choked certain housing programmes introduced by

certain colonial and successive governments. For example the rising cost of imported materials such as cement, roofing sheets etc had to redirect the housing scheme of 1920 by the Guggisberg regime. This trend went on and successive governments did little to control or curtail it. What is witnessed today in the building material industry is an inheritance from the colonial to early independence Ghana [Agyemang, 2001; Akuffo, 2006].

In the rural Ghana, the local materials constitute about 95% of housing stock whilst foreign materials form about 98% of urban housing stock [Atiemo, 2009]. In recent times greater percentage of the national expenditure is on importation of foreign building materials at the expense of cheap local materials. It is estimated that 70% of all building materials in Ghana are imported and more than 180, million dollars are spent on importation of clinker and gypsum [Ayttey, 2009]. It is also recorded that the construction industry utilizes more than 90% of the cement and residential construction account for 75% [Atiemo, 2009]. Table 5 shows the relative composition of building material usage in Ghana.

Table 7: Extent of usage of various building materials for housing in Ghana

Section	Material	Percentage Usage
Floor	Cement/concrete	72
	Earth	23.8
	Terrazzo	1.4
	Timber/wood	1
	Stone	0.6
	PVC	0.4
	Ceramic/Marble	0.3
Roof	Timber/wood	>97.0
Carcass		
Roof Cover	Metal sheets	60.3
	Thatch/Palm leaf	18.6
	Slate/Asbestos	12.9
	Cement/Concrete	2.4
	Bamboo	2.1
	Timber/wood	0.9
	Roofing tiles	0.5

This worsening development led to several interventions to remedy the situation but little has been attained. For example the establishment of Department of Rural Housing (DRH), CSIR/BRRI, KNUST, Brick and Tile Factory- Liman era etc. all in an attempt to reduce the component of foreign material in the construction industry and promote the locally made materials through appropriate locally dominated technology and methodology, skill and know-how, research and manufacturing. Unfortunately little success has been recorded [Nelson & Ayeh, 2009].

The main set back of the Affordable Housing Scheme in 2006 was rising cost of materials and high inflation against planned budget. Cement for example rose from GH¢3.20-\$4.5 (2001) to GH¢8-\$6.9(2008) and about GH¢10- GH¢14 (\$7.6-\$10.8) in 2009[Atiemo, 2009]. Cement and it related products alone constitute about 60% of total cost of construction and the average increase in the price of cement between 2005 and 2008 was 140% [Boadi et al, 2009]. From Table 6, it is anticipated that with so many indicators in the world, market/economy beyond our control, the several calls for extensive use of local materials should be encouraged. The local building material industry should be developed and entrenched so as to harness it related benefits.

Table 8: Inflation and Exchange Rates for the Period 1991 – 2008

<i>Year</i>	<i>Rate of Inflation (IR) (%)</i>	<i>Exchange (ER)\$ -¢ (Average)</i>	<i>Remarks</i>
1983		2.75	
1986		90	
1990		322	
1991	25.00	370.00	
1992	27.00	450.00	
1993	52.00	790.00	
1994	24.18	1000.00	
1995	41.35	1290.00	
1996	59.38	1688.00	
1997	34.41	2115.00	
1998	37.00	2350.00	
1999	20.80	2706.00	<i>IR at the end of 2000 was 51% and the ER ¢7000.00 IR was 41.9% in March and 21.3% in December</i>
2000	40.50	5300.00	
2001	27.10	7170.00	

2002	14.92	7870	
2003	26.71	8820	
2004	12.74	9360	
2005	15.08	9550	
2006	10.96	9555	
2007	10.69	GH0.9397 (9397)	
2008	17.30	GH1.1521 (11,521)	<i>As at October</i>

Sources: Quarterly Digest of Statistics (Sept. 1998) of the Statistical Services, BRRI (2000) and ISSER (1998), Ghana Statistical Service (2008)

From 1984-1998, through the IMF and the World Bank's ERP and SAPs, worsening inflation and devaluation of the cedi resulted in prices of building materials increasing by 5,000-20,000% [K-Agyemang, 2001]. From the above table it is clear that the cedi in a period of 15 years (1983-1998) was devalued over 80,000%. With this in mind one is tempted to ask if the STX housing project will at all be successful.

There is the readily available local materials such as clay, wood, limestone, thatch, bauxite waste, bamboo etc and as such further studies should be conducted into develop them further to boost the industry as being suggested in many government policies. Extensive studies by BRRI, DRH and Geological Survey indicate that these materials are comparable to cement product and are cheaper in cost [Atiemo, 2009; Boadi et al, 2009].

Conclusion and Recommendations for Future Public Housing Policies

In conclusion, it is worth noting, that governments, elected officials and stakeholders who create policies have to look beyond the coming elections, fulfilling political manifesto, scoring points in the form news paper headlines. For this reason, affordable housing delivery is most effective when the commitment is along-term policy bedrock so solid its support is bipartisan and non-partisan'. We ought to learn from the success stories of Singapore and the United Kingdom.

In order to chalk notable success on any future housing policy meant to arrest our ever widening housing deficit, we will have to change our perception towards the use of local materials, Adopt sound efficient and sustainable cost effective

architectural design and constructional methodology. Also we will have to set up non political National Housing Authority with the mandate to implement policies devoid of political interferences, develop an effective Housing Policy in line with all acclaimed recommendations from experts, and equip research institutions to develop good acceptable local material industry. Last but not the least we will have to create a National Housing Fund and help develop the capacities of building professionals and workmen in the local material technology.

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THE EFFECTS OF USING LATERITIC GRAVEL AS ALL-IN AGGREGATES FOR THE PRODUCTION OF CONCRETE

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Abstract

This work reports on the workability and compressive strengths achieved in an attempt at using lateritic gravels as all-in aggregate in concrete. A series of tests were conducted to compare normal all-in aggregate concrete with concrete made from lateritic gravel. The prescribed mixes used were 1:3 (high strength concrete), 1:6 (normal strength) and 1:9 (low strength concrete). The work also looked at the strengths achieved when portions of the lateritic gravels were replaced with pit sand and in this regard, four laterite: sand proportions (100:0, 90:10, 80:20, and 70:30) were used as aggregates. Varying water cement ratios were used to achieve workability of the various mixes as a result of the changes in proportions of the fines in the laterite with each prescribed mix. The density and compressive strength of each cube was measured on the 7th and 28th test dates. It was observed that the presence of the laterite led to a decrease in slump of the concrete. However, there were slight increases in slump as part of the laterite was replaced with sand. The study again showed an increase in compressive strength with increase in part replacement of laterite with sand. However, the rate of increase tended to decrease with increase in part replacement of laterite with sand indicating that there was a threshold of percentage of sand increase after which the compressive strengths are likely to decrease. This work never reached this threshold but it is estimated to be about 40%. The compressive strengths achieved were better than those for the available normal all-in aggregate used and suggest that lateritic gravel can be used as all-in aggregate for non structural concrete.

Introduction

As construction cost keep on rising, construction project managers and their allied team members in the construction industry keep on finding alternative ways of reducing cost without affecting the quality and function of the finished product. Coupled with this is the fact that Ghana is a developing country with a very high infrastructure deficit. For example, Ghana's housing deficit has been estimated at one million. It's an undeniable fact that, concrete which is largely a product of cement, aggregates and water is a major component of materials used in construction especially in Ghana. Aggregate is cheaper than cement and form about three – quarters of the volume for concrete. It is therefore economical to put into the mix as much of the former and as little of the latter as possible (Neville, 1996). The accepted natural aggregate for the production of concrete in Ghana are crushed stones, gravels (coarse aggregate) and natural sand or crushed quarry dust (fine aggregate). Fine aggregate often called sand is material passing the 5mm BS test

sieve and coarse aggregate comprises material retained on a 5mm BS test sieve. However, these aggregates are not available in all parts of the country, are expensive and the sources of marginal aggregates few thus unable to meet the increasing demand for use for road and building construction. More particularly, the procurement and processing facilities for the aggregate are few. It is observed that not all constructions need the high strengths provided by concrete produced from the various fine and coarse aggregates. The income levels in Ghana are also generally low. If the cost of aggregate (which makes about 60-80% of volume of concrete) can be reduced then the overall cost of providing shelter will be reduced. The use of all-in aggregate should enable such reduction in cost, and even more so will be the widely available laterite, if this can be substituted for all-in aggregate in concrete. However a careful investigation needs to be carried out in order to access how feasible it would be to use laterite as all –in aggregate for the production of concrete; and that forms the objective of this study.

Methodology

The study considered laterite picked from Afetia near Adumasa in Kumasi and Okponglo in Accra to represent samples from both the forest and savannah belt. Four treatment levels were obtained with the laterite by progressively increasing the sand content from 0 – 30%, in stages of 10%. The range of 0 – 30% of sand was chosen because in a typical nominal mix of concrete the ratio of fine to coarse aggregate is usually 1:2. Thus, increasing the percentage of the sand more 30% would have meant producing concrete of more sand than coarse aggregate as specified. Again the sand was mixed with the laterite to reduce the percentage of silt and clay in laterite. This is because the presence of the clay in concrete adversely affects the setting or hardening of the cement. Also excessive silt and clay content may prevent proper bond development between the binder and aggregate and require the use of an excessive amount of mixing water leading to weakness and porosity in the hardened material. The specified prescribed concrete mixes used in the study were 1:3:6, 1:2:4 and 1:1:2 (batching by weight) corresponding to strength of 12N/mm^2 , 21N/mm^2 and 25N/mm^2 respectively. The strengths represent concrete of low, normal and high strengths respectively. The water/cement ratio was varied as the sand content in the laterite increased. This was because the proportions of fines in the laterite (clay and silt), which is responsible for increased requirement of water for mixing reduced as the fraction of pit sand increased requirements of water for mixing reduced as the fraction of pit sand increase. However, it was ensured that not too much water was added as this would reduce the strength and the mixture will be sticky and difficult to remove from the mould. Thus the minimum water/cement ratio used was 0.4. The specimen were tested using three properties of concrete; compressive strength, workability and density.

Experimental Procedure

Identification Test

Prior to the preparation of the concrete test cubes, preliminary tests were performed on the materials used; cement, sand, all – in aggregate and laterite gravel. The sand (from Aputuogya in Kumasi), all-in aggregate (from Kyerekrom in Kumasi) and laterite (from Afetia and Okponglo) were graded with sieve analysis in accordance to BS 882. The hygrometer test was performed on the laterite to determine the various proportion of particle size.

Preparation of Test Specimen

The experimental and laboratory procedures relating to the preparation, curing and testing of concrete containing lateritic gravel as all- in aggregate is similar to that for normal concrete. Therefore, standard published procedures, method of analysis and experimental design for the latter were followed in the preparation of the test cubes. Three prescribed mixes of each of the laterite samples and a control using naturally occurring all-in aggregate in a ratio of 1:9, 1:6 and 1:3 (cement :all in aggregate) were prepared ,cured and tested in accordance with the procedures in BS 1881 (1970). The mixing was done on a concrete platform with the use of a shovel. It involved the thorough mixing of the ingredients in the dry, followed by the addition of water and further mixing to achieve consistency. Specimen moulds of 100x100x100mm were used and three specimens each tested on their due dates of 7 days and 28 days for each mix. Identification marks were made on each of the fresh concrete cubes. The cubes were removed from the moulds after 24 hours and then cured under wet sacks. The procedure was repeated when portions of the laterite were replaced with the ordinary sand in proportions of 100:0, 90:10, 80:20 and 70:30. A total of 162 cubes were prepared as shown in 2.1. The cubes were sent to the laboratory for testing on the 7th and 28th day of casting. A sample calculation of the derivation of the proportions of materials for the prescribed mixes is given below.

Weight Batching for 12N/mm² (100% laterite)

For proportions 1:9 by volume (cement: laterite)

But 1 bag of cement equals 1 gauge box of 35dm³

Therefore Batch quantities = 1bag of cement (50kg): 35 x 9 dm³

$$= 50\text{kg} : 315 \times 1.8 \text{ (1.8 is density of laterite)}$$

$$= 50 : 576$$

$$= 1 : 11.52$$

Weight Batching for 12N/mm² (10% replacement of laterite with sand i.e 1:0.1:0.9)

Batch quantities = 1bag of cement (50kg): 35 x 0.9: 35 x 8.1 dm³

= 50kg : 31.5 x 1.6: 283.5 x 1.8 (1.6 is density of sand)

= 50 : 50.4:510.3

= **1 : 1.01: 10.21**

Table 1: Mix proportions (by weight) for prescribed mixes

Strength	Percentage proportion of sand: laterite	Cement(kg)	Sand(kg)	Laterite(kg)
C12	0:100	1	-	11.34
	10:90	1	1.01	10.21
	20:80	1	2.02	9.07
	30:70	1	3.02	7.94
C21	0:100	1	-	7.56
	10:90	1	0.67	6.80
	20:80	1	1.34	6.05
	30:70	1	3.62	4.93
C30	0:100	1	-	3.78
	10:90	1	0.34	3.40
	20:80	1	0.67	3.02
	30:70	1	1.01	2.65

Workability, Density and Compressive Strength

The slump test was used to measure the workability of the fresh concrete mix according to BS 1881 (1972). As much as possible it was ensured that not so much water was added as it would have made the mix sticky and difficult to work with because of the presence of silt and

clay in the laterite. However different water cement ratios were used as the percentages of silt and clay in the two different samples were different.

Prior to testing of the specimen at the specified dates (7th and 28th days), each cube was weighed using an electronic balance to determine the mass. The density of the specimen was determined from the expression

$$Density = \frac{mass}{volume}$$

The compressive strength of the test specimen was found according to the method described in BS 1881 Part 4 (1974). The compressive test was performed after the cubes had been weighed by the use of the compressive test machine. The average compressive strength results for the samples are shown in Tables 3.

Results, Analysis and Discussion of Test Results

Particle Size Distribution of Aggregates

Lateritic Gravel

The particle size distribution of the lateritic gravel from Okponglo and Afetia are shown in figure 1 and the mark up of the specimen, in terms of gravels, sand and fines sizes is shown in the Table 2.

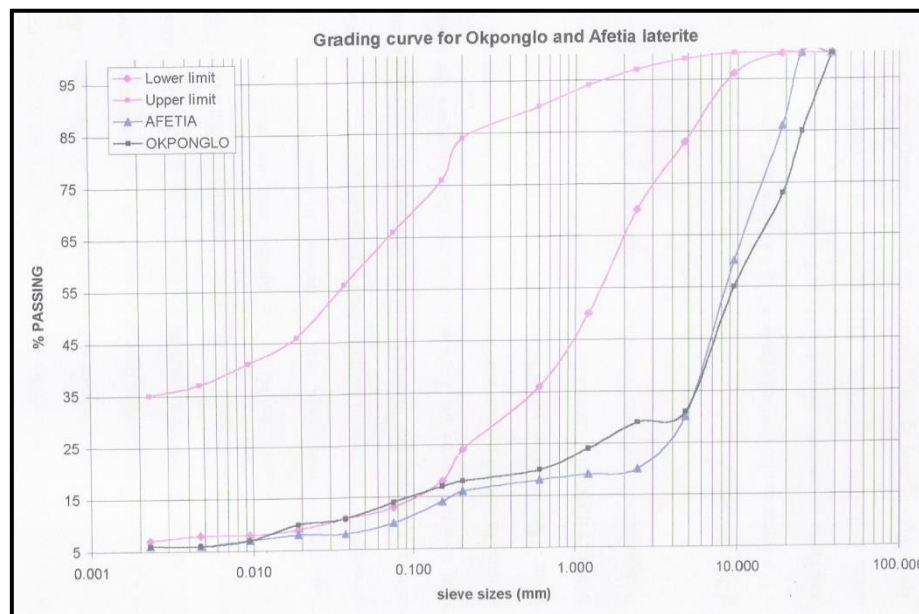


Figure 1: Grading Curve for Okponglo and Afetia Laterite

Table 2: Proportion of Particle Sizes in Laterite

ELEMENT	OKPONGLO %	AFETIA %
Clay	6	6
Silt	2	7
Sand	12	15
Gravel	80	72
Total	100	100

Laterite from both Okponglo and Afetia generally fall outside an 'envelope' determine by BRRI for soils that can be said to posses properties typical of laterite. The samples of the study tend to have higher coarse aggregate size and content than the typical laterite. However, in the sand and fines proportioned (<0.15mm), the laterite of this study fall on the lower borders of the 'envelope', It is therefore expected that the samples should possess some of the properties that are determined

by the influence of the fines fraction of typical laterite that is poor compressive strength if the laterite is not stabilized by an appropriate binder like lime and cement. Both Okponglo and Afetia have a combined clay and silt fraction of more than 6%; the Afetia specimen having more fine fraction (total of 13%). It has been noted in a study (Okyere, 1980) that though the classical rule suggest that a combined fines content of more than 4% in normal fine aggregate should give poor result when used to produce concrete, good concrete strength were obtained with a fine proportion of slightly more than 4%. It will be expected that the relatively high fines content in the laterite should result in relatively low strength concrete; Afetia laterite being more so. The expected low strength concrete comes about because of poor bonding of the cement paste to the coarse aggregates of the laterite because of the coating of the aggregates by the clay/silt. It is expected also that as the coarse aggregate content of the laterite increases, the concrete strengths will increase because of a reduction in fines content and larger area of coarse aggregates for cement/aggregate bonding. Thus Okponglo laterite, with higher coarse aggregate content and coarse aggregate size than Afetia laterite should be expected to give higher compressive strengths.

Pit Sand

The particle size distribution of pit sand from Aputuogya is shown in figure 2.



Figure 2: Grading of Pit Sand from Aputuogya.

It is observed that the sand falls wholly in zone 1 (according to BS 882). Fine aggregate within this zone are on the coarsest end. Therefore even though the pit

sand falls on the finer side of this band, it is expected that it improves on the coarseness of the laterite and lead to higher compressive strength when mixed with cement.

Workability of the Mixes

An indication of the workability of the various mixes is given by the slump values in Table 2. It is observed in the study that generally, the water cement ratio for a particular mix for both laterite, reduced with increase in sand content. This is attributed to the absorbent nature of the fine clay and the silt in the laterite. Sand is more granular than clay and silt, thus making the clay and silt have a higher surface area than the sand. The higher the surface area, the more water required for moistening. However, even with this decrease in water content, the slump values increased with increase in sand content for particular cement content. Also the slump decreased with increase in cement content. This property is expected as an increase in sand content reduces the fines in a mix and thus improves the workability. An increase in cement content also implies an increase in fines content and thus a lower slump if the water content is to remain the same. Pure laterite/cement mixes require relatively high water content for easier mixing. Thus an input of some amount of sand is recommended for better workability of laterite concrete mixes.

Table 2: Strength, Slump and Density of Okponglo and Afetia

Target Strength (N/mm ²)	Mix Proportions (by weight) C:S:L	Laterite from Okponglo					Laterite from Afetia				
		Slump (mm)	7 days		28 days		Slump (mm)	7 days		28 days	
			Average Density (kg/m ³)	Average Compressive Strength (N/m ²)	Average Density (kg/m ³)	Average Compressive Strength (N/m ²)		Average Density (kg/m ³)	Average Compressive Strength (N/m ²)	Average Density (kg/m ³)	Average Compressive Strength (N/m ²)
12	1:11.34	12	194	2.2	209	4.8	13	204	2.1	218	4.5
		14	3	6.1	9	7.4	11	4	5.5	1	5.5
	1:1.01	13	225	6.8	223	7.7	13	212	6.3	211	6.5
	:10.21	16	4	7.3	1	9.0	14	0	7.1	7	8.1
	1:2.02		207		207			230		212	
	:9.07		7		2			8		4	
21	1:3.02		214		191			209		226	
	:7.94		9		8			9		1	
	1:7.56	10	221	11.5	214	13.1	8	213	10.7	221	12.3
	1:0.67	13	3	12.5	2	16.1	10	6	11.9	2	13.9
	:6.80	14	217	13.1	222	17.1	12	221	12.9	203	16.3
	1:1.34	14	7	14	0	18.0	12	2	13.8	0	17.9
30	:6.05		221		225			219		211	
	1:3.62		3		1			7		5	
	:4.93		221		230			213		219	
			8		3			4		2	
	1:3.78	8	217	18.7	229	21.2	8	221	17.7	234	20.4
	1:0.34	10	7	19.5	5	22.5	8	5	18.6	6	21.7
30	:3.4	12	220	20.1	216	23.1	12	220	19.7	216	23.3
	1:0.67	15	8	20.7	3	24.6	12	3	20.3	4	24.2
	:3.02		221		227			222		224	
	1:1.01		9		6			6		5	
	:2.65		221		229			219		223	
			8		3			8		1	

Compressive Test

The compressive strengths of the mixes are shown in Tables 3. A general trend in compressive strength attainment is observed for both samples of laterite. The compressive strengths increase with increase cement content, duration of test and also within a prescribed mix, increased with increase in sand input in the aggregate content of the mix.

For mixes made towards the attainment of a strength of 12N/mm² at 28 days (1:3:6), the strength increased from an average of 2.2N/mm² with no sand input to 7.2N/mm² with 30% sand replacement in aggregate content at 7 days, and from 4.7N/mm² to 8.6N/mm² at 28 days; an increase of 230% and 83% respectively. Similar strength increases with sand input were 25% and 42% for 1:2:4 and 13% and 17% for 1:1:2. Thus increase in sand content leads to an increase in strength. This property is due to reduction of the adverse effect of clay/silt on the bonding of cement to coarse aggregate, as a result of the introduction of sand. It is however noted that the relative increase in compressive strength with increase in sand tend to be lower as the mixes become stronger (i.e. higher cement content). This can also be attributed to the fact that the percentage of sand supposed to be in a particular mix tends to reach its threshold earlier in the stronger mixes than the weaker mixes.

Within a particular mix for target strength, it is observed that the percentage increase in compressive strength as a result of increase in sand content of laterite reduces. This property could be ascribed to the fact that an increase in sand content leads to a replacement of not only fines content (which is desirable) but also gravel (which is not desirable). Thus bonding between cement paste and gravel is reduced and thus also a less than rapid increase in compressive strength.

The trends observed in the earlier explanations suggest that the addition of sand and its beneficial effects on compressive strength attainment has a threshold. However this study did not get to that threshold (optimum sand input). It is however estimated that it would be about 40%.

For no addition of sand, strength gain is at an almost constant rate up to 28 days for 1:3:6 mixtures. For 1:2:4 and 1:1:2 however there is faster rate of increase up to 7 days which is the normal trend for mixes with sand input. With low cement input (1:3:6), the cement content is not enough to substantially negate the effect of the fines content on the strength. The faster rate of attainment with higher cement content can be ascribed to the fact that there is a better negation of the effect of lateritic fines and thus a more complete hydration process is assured, leading to a faster attainment of strength in early days after casting.

The percentage achievement of target design strength for C12, C21 and C30 were 75%, 90% and 83% respectively. Though the target strengths could not be achieved, the strengths achieved would enable lateritic gravels be used for unreinforced concrete and for reinforced concrete of normal strength (21N/mm² to 25 N/mm²). It will mean that for reinforced concrete more cement will be needed than for that using granitic/quartzitic aggregate. However lateritic gravels are almost everywhere in the country and within economical haulage distances. The cost of weaning such aggregates will therefore be lower, thus compensating for the extra cost of cement.

The compressive strengths achieved in Okponglo were found to be higher than the compressive strengths from Afetia. This is ascribed to the higher gravel and low fines content (80%, 8%) in the Okponglo laterite as compared to the lower gravel and higher fines content (72%, 13%) in the Afetia laterite. The high percentage of fines reduced the bonding between the gravels and cement resulting in the lower compressive strength in Afetia concrete compared with the Okponglo concrete.

Density

The densities of the mixes (Table 3) show that using lateritic gravel as all-in aggregate in concrete resulted in about 5% increase in density over concrete made from normal all-in aggregates. However such an increase is not significant, as the level of compaction is also a factor in the level of densities. On average the density of all mixes is about 2200kg/m³.

Curing

The reduction in compressive strength was also as a result of the mode of curing adopted. The cubes were cured by covering them with moist sacks as ponding will disintegrate laterite specimen. This method did not allow for uniformity in the curing as water could not get into the cubes and the parts that lay on the ground.

Durability

It was not possible to determine the durability of lateritic concrete when used in construction due to time limitation and the limited scope of this study. However the density and compressive strength are indications of the durability.

Conclusion and Recommendations

Conclusion

The effect of using laterite gravel in place of all-in aggregate for concrete has been investigated in terms of workability, density and compressive strength. From the results test and analysis, the following conclusions can be drawn at this stage:

- (i) lateritic soil of high percentages of gravel (>70%) content may be used in place of all-in aggregate for concrete.

- (ii) the introduction of lateritic gravel in place of all-in aggregate produced a fairly stiff concrete. The use of 100% lateritic soil in the concrete required additional water than using the typical all-in aggregate. However, the slumps measured did suggest workability of the concrete mix
- (iii) the average density using the lateritic soil was higher than using the typical all-in aggregate
- (iv) addition of cement content generally increased the compressive strength for pure laterite, normal all-in aggregate and for laterite gravel with part replacement with sand. The attained strengths were about 78% of the designed strength. The lateritic gravel from Okponglo which contained a lower percentage of silt/clay of (8%) and higher percentage of gravel (80%) produced concrete of slightly higher compressive strength than the sample from Afetia which contained silt/clay of (13%) and gravel of (72%).
- (v) the compressive strength of the lateritic concrete increased as part of the laterite was replaced by the pit sand. However, the rate of increase decreased progressively with increase input of sand, suggestive of the existence of a threshold. This threshold is estimated at 40%.

Recommendation

It is recommended from the study and foregoing conclusions that:

- (i) lateritic gravel is a good substitute for all-in aggregate concrete. Soils of high proportions of sand and gravel and lower clay and silt content will produce high strength concretes. Concrete mixes containing lateritic soils would require more cement and water to achieve a workable mix and the target strength.
- (ii) the finish surface of lateritic concrete was smooth and may not require painting due to the reddish brown colour imparted by the laterite.
- (iii) further research into the behavior of reinforced structural elements made of concrete containing lateritic soil as all-in aggregate is necessary before it could be used by builders and engineers.
- (iv) the durability of such concrete is too early to predict and more research have to be conducted under different weather conditions before some predictions can be made in this direction.
- (v) the onus now lies with the concrete technologist to develop specifications and mixes for the utilization of lateritic soils in concrete production. Further investigation needs to be carried out in the following areas:
 - amount of water required for concrete mixes containing lateritic soils
 - the long term effect of environmental parameters on concrete containing lateritic soil

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THE THERMAL ANALYSIS OF RESIDENTIAL BUILDINGS IN KUMASI (GHANA)

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Abstract

The increase in energy consumption of buildings is receiving attention worldwide. Based on various studies and founded on the Kyoto Protocol, measures to reduce green house gas emissions and to address the sustainable use of resources are being implemented. A parametric study was conducted to analyse the thermal performance of three residential buildings in Kumasi, with the main objective of reducing overheating temperature (mean overheating) and increasing satisfaction of occupants. The selected buildings were modelled in a simulation application tool, based on a long term data acquisition period (10 months) which led to the calibration and the probing of design alternatives resulting in an improved performance. Combined improvement scenarios of high building mass, efficient lighting, enhanced windows and natural ventilation were found to have a synergistic effect on thermal comfort. Further, predicted mean vote (PMV) and predicted percentage of occupants dissatisfied (PPD) were calculated using the approach after Fanger. The combined improvement scenarios could reduce the mean overheating from 4.3 to 1.9 Kelvin. Additionally, the number of occupants who were dissatisfied could also be reduced from 92 % to 53 % depending on building type. For the purposes of occupants' satisfaction and thermal comfort, the use of fans in residential buildings is recommended.

Keywords: Thermal comfort; occupants; overheating; satisfaction; buildings.

Introduction

The negative effects of unsustainable use of resources can be experienced all over the world. Green house gas emissions have increased over the past decades, causing climate change. It is projected that the rising temperature and water levels of our oceans would submerge low lying islands. The Kyoto Protocol is a declaration of nations to combat the negative effects of climate change through sustainable measures, and regular conventions are held to monitor the progress made (UNFCCC, 2009).

The building sector could contribute to the sustainable process by reducing the amount of energy being consumed for thermal comfort reasons. Worldwide, energy consumption of buildings for cooling, heating and lighting is estimated to be 40 %

of energy produced. Additionally, 40 % of building energy consumption could be saved through building automation (Lauber, 2005 and Langthaler, 2009).

In Ghana, the extensive use of glazing in buildings can be seen in the metropolitan areas of Accra and Kumasi. Low-rise buildings are being renovated with sliding glasses and equipped with air-conditioners. In addition, most buildings lack consideration of sustainable design strategies. All these factors have led to the increase in energy consumption and the resultant electricity load shedding exercises. In this paper, a study on the thermal performance evaluation of 3 low-rise residential buildings in Kumasi over a 10 months period is presented. The main objective was to use sustainable means of thermal mass, improved windows, efficient lighting and natural ventilation to reduce heat build up in the spaces. Additionally, the predicted persons dissatisfied (PPD) are tabulated after the accepted method of Fanger (1973) on thermal comfort.

Methodology

Selection of Buildings

The 3 residential buildings selected for the study are located in different parts of Kumasi, capital of the Ashanti Region in Ghana. The buildings are representative of many existing low-rise residential blocks belonging to private persons. The cooling systems in operation were split air-conditioning units.

Monitored Environmental Data

Air temperature and relative humidity values were measured inside a number of living rooms and bedrooms, and outside the buildings. Data loggers were used to acquire 746,420 data points during the monitoring period from February 2010 to November 2010. The temperature was measured with hobo sensors in the range of -20 to 70 ± 0.4 °C, while the relative humidity was monitored with the same sensor type (hobos), ranging from 5 to 95 ± 3 %.

The measurements with the data loggers (outside the buildings) were necessary because hourly weather data from the Kumasi meteorological office were not available.

Calibration of the Simulation Tool

A weather file for Kumasi was generated using Meteotest (2008). Greenline software was used to launch and download the files from the data loggers. The downloaded temperature and relative humidity values were screened in Hoboware pro software and exported to an MS Excel file. In MS Excel, the text files were imported, screened and mean hourly values generated (also for psychrometric chart plots). The buildings were eventually modelled in a numeric simulation tool (EDSL, 2008) and calibrated by identifying segments of a synthetic weather file for Kumasi

(generated via Meteotest (2008)) that matched our own measurements of outdoor conditions. Indoor air temperatures were then simulated using the above mentioned weather file segments and compared with the measured indoor air temperatures.

Parametric Study

Thermal improvement scenarios (concerning glazing and shading, ventilation alternatives, thermal mass, efficient lighting) that could reduce overheating were carried out. Information regarding the various scenarios considered for the simulations is summarized in Table 1. Table 1 provides the base case scenarios for the three buildings (TAFO, KOKOBRA and FUMESUA).

Table 1. Overview of base case simulation scenarios

Code	Scenario	Description
BC1	Base case TAFO	$U_{\text{walls}} = 3.4 \text{ W.m}^{-2}\text{.K}^{-1}$; $U_{\text{window}} = 5.8 \text{ W.m}^{-2}\text{.K}^{-1}$; $g_{\text{window}} = 0.82$; day/night ACH = 1/0.5 h ⁻¹ ; lighting load = 5 W.m ⁻² ; occupants' load = 10 to 20 W.m ⁻² ; equipment load = 2 to 6 W.m ⁻² ; floors tiled
BC2	Base case KOKOBRA	Similar to BC1, but attic space with: $U_{\text{attic floor}} = 3.4 \text{ W.m}^{-2}\text{.K}^{-1}$; $U_{\text{window}} = 2.7 \text{ W.m}^{-2}\text{.K}^{-1}$; $g_{\text{window}} = 0.49$; floors carpeted
BC3	Base case FUMESUA	Similar to BC1, but: $U_{\text{window}} = 5.5 \text{ W.m}^{-2}\text{.K}^{-1}$; $g_{\text{window}} = 0.66$

Adaptive Comfort Scale

The neutral temperature (T_n) was used to calculate the reference temperature for the month. It is the temperature at which a person should feel neither too hot nor too cold, with the comfort zone being 2°C below and above the neutral temperature (Eqn. 1) (Hyde, 2000).

Eqn. (1) $T_n = 17.6 + 0.31 * T_{e.av}$

Where $T_{e.av}$ = the mean monthly outdoor temperature (°C).

Mean Overheating (OH_m)

Combined improvement (CI) scenarios (high mass [uncarpeted floors], efficient lighting [1 W.m⁻²], improved windows [$U_{\text{window}} = 1.8 \text{ W.m}^{-2}\text{.K}^{-1}$; $g_{\text{window}} = 0.29$] and natural ventilation [air change rate per hour during the day and night, ACH 10/10]) were simulated to create a comfortable indoor thermal environment. The main concern here was the mean overheating (OH_m) (see Eqn. 2).

Eqn. (2)

Where $\theta_{i,j}$ represents the mean indoor air temperature (°C) at hour j (averaged over all simulated zones in the floor), θ_r the reference indoor air temperature (neutral temperature for 90 % acceptability (Szokolay, 2004)) for overheating (°C), and n the total number of hours. The term $\theta_{i,j} - \theta_r$ was considered for those hours when $\theta_{i,j} > \theta_r$. The reference

$$OH_m = \sum_{j=1}^n \frac{\theta_{i,j} - \theta_r}{n}$$

indoor temperature (neutral temperature) for Kumasi was calculated to be - depending on the time of the year - between 25.4 °C (August) and 26.5 °C (February).

Predicted Mean Vote (PMV) and Predicted Percentage of Dissatisfied (PPD)

The indoor environmental parameters, in this case temperature and relative humidity values, were combined with the clothing values (*CLO* of 0.7), metabolic rates (*MET* of 1) and air speeds (*V* of 0.07 to 0.21 m.s⁻¹) to determine the predicted mean vote (PMV, see Table 2) and the predicted percentage of dissatisfied occupants (PPD), using the software application PMVcalc_V2 (Nilsson, n.d.). The ACHs were converted to air velocities based on research work on natural ventilation (Pröglhof, 2004), (Eqn. 3).

Eqn. (3)
$$V = (ACH + 3.43)/63.1$$

Where *V* is air velocity and *ACH* is the air change rate.

Table 2. PMV scale

Vote	Description
-3	Cold
-2	Cool
-1	Slightly cool
0	Neutral
1	Slightly warm
2	Warm
3	Hot

Source: Predicted mean vote scale after Fanger (1973)

Results

The results show the calibration outcome of the parametric study, the tabulated mean overheating and the PMV-PPD output for the studied buildings. The combined improvement scenarios could reduce the mean overheating to an appreciable level.

Calibration

Fig. 1 shows the comparison of our outdoor temperature measurements "DL" (averaged over the building locations) with an average temperature "MET" obtained as the mean of maximum and minimum temperatures recorded by the Kumasi weather station. The results suggest a good agreement between our measurements and the values from Kumasi's official weather station.

As mentioned earlier, simulation model calibration was performed using segments of a standard weather file with a good fit to our local measurements. Fig. 2 shows a sample of time intervals where the weather file data (WF) and our measurements at building sites (DL) showed a relatively good agreement. These weather file segments were subsequently used to predict indoor temperature values and compare those with the respective measured temperatures.

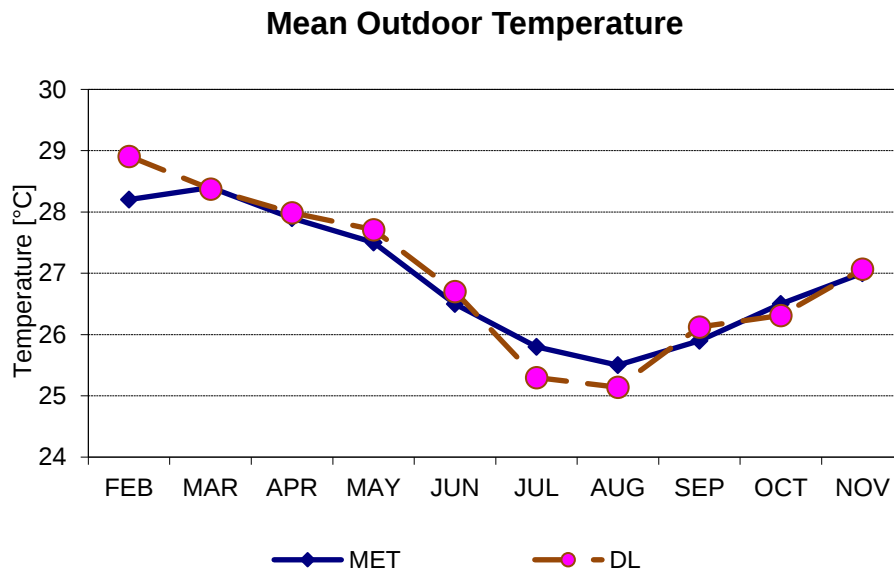


Fig. 1. Comparison of mean outdoor temperature measurements at building locations (DL) with Kumasi weather station data (MET)

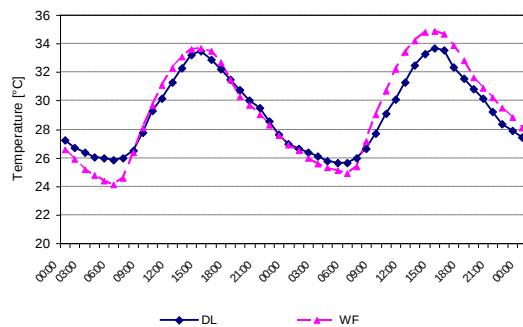


Fig. 2. Outdoor air temperature segments (WF) as against measurements (DL) at building location (TAFO)

Predictions of the calibrated simulation models compared well with the measured values. Fig. 3 provides an example of measured versus simulated indoor air temperatures in KOKOBRA. Moreover, Fig. 4 provides an overview of the relationship between measured and simulated indoor air temperature (in terms of regression lines).



Fig. 3. Measured versus simulation indoor air temperatures in KOKOBRA

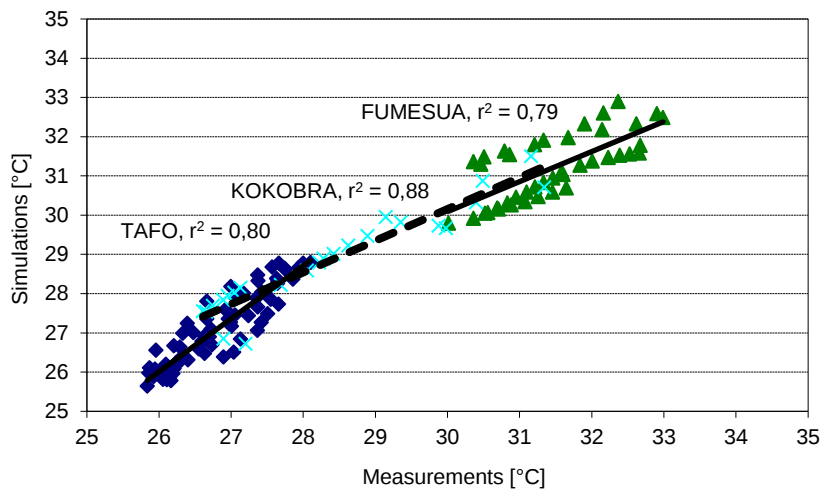


Fig. 4. Overview of the relationship between measured and simulated indoor air temperatures in the buildings

3.2 Parametric

In the passive building operation scenario (no air-conditioning), the "base case" with ACH (1/0.5) and the combined improvement (CI's, thus, high mass, improved windows, efficient lighting and ACH (10/10)) scenarios resulted in lower mean overheating values (OH_m) (Table 3).

Table 3. Simulated mean overheating (for all buildings) for the base case and combined improvement (CI) scenarios (K)

Building	BC	CI
	OH _m [K]	OH _m [K]
TAFO	4.1	1.9
KOKOBRA	4.3	2.1
FUMESUA	4.0	2.0

Predicted Mean Vote and Predicted Persons Dissatisfied (PMV and PPD)

Table 4 summarizes computed mean PMV and PPD results for BC and CI scenarios. The predicted percentage of dissatisfied occupants could be reduced from the mean base case level of 92 % to about 53 % through the combined improvement scenarios.

Table 4. PMV and PPD for all buildings

Building	BC		CI	
	PMV	PPD	PMV	PPD
TAFO	2.7	91.0	1.5	54.0
KOKOBRA	2.6	92.0	1.4	53.0
FUMESUA	2.8	90.5	1.6	58.0

Measured Indoor Conditions

The measured indoor environmental parameters (mean monthly relative humidity and temperature values) plotted on psychrometric charts show the majority of months represented outside the comfort zone (Fig. 5). The comfort zone recommendations (Szokolay, 2004) use the neutral temperature for 90 % acceptability which is based on the mean monthly outdoor temperatures. However, a general recommendation on humidity ratio is suggested (0.4 g.kg⁻¹ and 12 g.kg⁻¹ for the lower and upper boundaries).

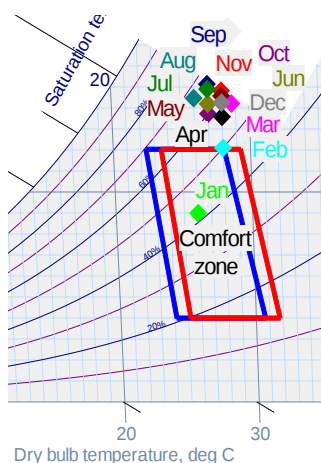


Fig. 5. Mean daily temperature and relative humidity values (averaged over all days in a month) in KOKOBRA building

Discussion

The evaluation of the results lead to a number of conclusions.

- The measured temperature and relative humidity values in the buildings point to deficient thermal comfort conditions (see, for example, Fig. 5). However, in interviews, occupants do not express a pronounced sense of discomfort. This could imply that the occupants' adaptation capability may be underestimated by the current thermal comfort scale recommendations.
- The better thermal insulation of the attic space/ceiling floors clearly improves the thermal performance, due to the reduction of conductive heat flows from these typically overheated spaces. Moreover, sustainable design principles of orientation, aspect ratio and building form are measures that could be used to reduce overheating in residential buildings. Also, the positive effects of plants (shading, filtering of air by reducing the dust content, provision of oxygen, positive psychological feeling, etc) in the landscape lead to a more comfortable environment, less energy usage for indoor comfort, reductions in greenhouse gas emissions and a filtering potential on pollutants (Salmon, 1999 and Wagner et al., 1980).
- Increased night-time natural ventilation improved the thermal performance of the buildings, albeit in a modest fashion. This is due to the rather small diurnal temperature range in Kumasi: night temperatures do not sink low enough to effectively cool the building mass. The combination of high thermal mass and increased night-time ventilation was only insignificantly better than natural ventilation alone. The result led to the use of a higher ventilation rate in the parametric study (ACH (10/10)) through the application of fans (see Hyde, 2000 and Ferstl, 2003). This result was commendable. In order to have energy efficient buildings, it is necessary to orientate the buildings in a direction where less energy would be spent in maintaining thermal comfort. In passive solar architecture, southward orientation is recommended over east-west, where energy losses of 30 % are to be expected (Wagner et al., 1980). Attention should also be given to wind direction and a higher window to wall ratio (Lechner, 2001).
- Certain combinations of selected modifications (such as better windows, natural ventilation, attic/ceiling floor insulation and efficient electrical lighting) appear to have a synergistic effect leading to a significant reduction of buildings' overheating temperature, as simulation results for combined measures (CI's, see Table 3 and 4) suggest.
- In comparison to the base case (BC), a passive cooling option (CI) could reduce mean overheating down to about 1.9 K through the use of efficient building

systems and natural ventilation (Table 3). Likewise, estimated PMV and PPD values show improvements by adapting the CI scenario (Table 4).

Conclusion

Given the climatic conditions in Ghana, cooling energy requirements represent an ecological and economical challenge. Yet only few studies have been conducted to explore methods and means of improving the energy performance and thermal conditions of buildings in Ghana. Generally, mechanical cooling uses six times the amount of energy required for e.g., heating and it is therefore essential to be energy conscious in the design of buildings in tropical countries. Thus, local measurements in (and calibrated simulation models of) three existing low-rise residential buildings were applied to parametrically explore and evaluate building features and operational options that could be beneficial energetically, environmentally, and economically. The results demonstrate that improvements in the building fabric and controls can lead to a better performance. Specifically, combinations of improvement measures (such as better windows, natural ventilation, attic/ceiling floor insulation and efficient electrical lighting) have the potential to significantly enhance the buildings' performance in the climatic context of Kumasi, Ghana. Therefore, to increase thermal comfort and satisfaction in residential buildings, the use of fans is recommended. Fans have been found to support evaporative cooling by providing a physiological cooling sensation of up to 3°C. This could result in an indoor sensation temperature of 26°C, which would be comfortable for most building occupants.

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AN ASSESSMENT OF THE INDUSTRIAL ATTACHMENT PROGRAMME IN KOFORIDUA POLYTECHNIC

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Abstract

Since its inception in 1997, Koforidua Polytechnic has been sending students on industrial attachment to enable them acquire practical training before completion of school. This practice is in line with the Polytechnic curriculum which demands that students undergo industrial attachment in their fields of study before completing their three-year courses of study. However, there has not been any research up to date to find out how effectively the programme is being carried out in the Polytechnic. This study therefore aims at filling the gap by assessing: the students' understanding of the industrial attachment programme and its effect on their study; its relevance to the students' future career; the internal measures put in place by the Polytechnic to ensure a positive impact of the programme on students; challenges inherent in the programme and efforts at addressing them. Quantitative and qualitative approaches were combined in data collection and analysis. Data were obtained from a survey of 884 Koforidua Polytechnic students and interviews were further conducted with 125 students and 35 staff members purposively selected. The results of the study indicate that to a large extent Koforidua Polytechnic is effectively organizing industrial attachment by providing opportunities for the application of classroom knowledge to real-world situations. Through the addition of the on-campus industrial attachment (VIRA), students' practical skill acquisition is on course. It is clear from the results that in spite of few challenges, students are confident they are acquiring practical skills that are aiding them to successfully integrate academic work with industrial experience.

Key Words: Polytechnic education, Industrial attachment programme, practical education, VIRA Programme, Koforidua Polytechnic

Introduction

Although numerous academic institutions provide qualifications and a grasp of the fundamentals in academics and research, preparation of the students for the job market receives minor consideration. Many students graduating with various certifications are unprepared to deal with the needs of the job-market. Qualifications are not all that there is to securing a job and performing well, since the job-market and society wants thinking and experienced contributors to development, not just qualification. Educational institutions, particularly higher education, attempt to address this deficiency by building industrial programs and

internships into their study programs. Most academic programs relating to technology require students to perform internship at specific stages of their academic programs. Such academic programs incorporate work experience as an integral part of a student core curriculum. It is line with this that Polytechnics have entrenched industrial attachment into their study programme as an accreditation requirement.

Current policy at the polytechnics in Ghana requires that students must undergo industrial attachment in their fields of study while at the polytechnic, at least once before completing their three year courses of study. In Koforidua Polytechnic, students normally enter at the end of their first and second year in school and are supervised by qualified, experienced personnel at the worksite as well as lecturers from the school. During such periods of industrial attachment, students get exposed to working life and experience, where they gain some hands-on skill. This opportunity leads to the future employability of some of the students on completion of their coursework. Lecturers and other certified individuals who wish to develop on-the –job experiences are also encouraged to take the initiative to secure placement to upgrade their skills and to be abreast with technology and industry. This practice, according to Lim Chong Lim (2002, Internet) enables the lecturer to make practical link during class lessons.

Practical skill acquisition has its attendant challenges, which include the reluctance of some industries to allow students to use their facilities for training. While securing placement is very competitive because of the limited number of industries, some students also fail to show any seriousness towards the programme by not looking for placement any seriously. Some of them fail to send application letters issued them by the Industrial Liaison Office to source for placement or hardly make any efforts to follow up for response from organizations they managed to apply to. Others also fail to avail themselves for t he opportunity offered even when industry in spite of the stiff competition for placement manages to squeeze one for them, thereby blocking the opportunity to others.

What is Industrial attachment? How is it organized in Koforidua Polytechnic?

Industrial attachment usually refers to the formal placement of trainees or students in the workplace for agreed periods of time to facilitate the achievement of specific and authentic learning outcomes. It involves the placing of students in the industrial environment where they are employed on seemingly fulltime basis, in a career-related job for durations agreed by the institutions.

According to Graduate Placement Services (Internet, 2011), industrial attachment is an accepted “value-added” mode of delivery that enables students to combine their classroom theory with on-the-job practical work. The main objective of this

industrial attachment scheme is to enable students to identify and gain practical knowledge, key skills including skills for learning, employment and life, workplace safety and professional expectations, legalities and ethics. Additionally the attaché acquires appropriate working attitudes required for the workplace through hands-on experience in an organization. An attaché is a student or a recent graduate undergoing supervised practical training.

The industrial attachment process is divided in Koforidua Polytechnic into three segments. These are: before attachment, during attachment and after attachment. Before the attachment, students are tasked to send application letters to industry and organizations appropriate to their courses of study in the polytechnic. This gives the student a feel of job-searching experiences including communication, coordination and follow up. The Industrial Liaison Officer augments this search on behalf of students, assisted by the Liaison Office Administrative Assistant, School and Departmental Liaison Coordinators to place students at various vacancies offered by industry. Between 2004 and 2010, attachment figures have risen from a low of 400, to 500, and steadily gone beyond 1,500 to over 2000. (Industrial Liaison Office, Koforidua Polytechnic, 2010).

The second stage is the time schedule for the programme. This differs according to the academic calendar of most organizations and ranges between two to six months. Koforidua Polytechnic for example allocates two months currently to industrial attachment, but the Auto Engineering students do four months of practical training in industry as a requirement. Due to the competitive nature of placement in industry in recent times, some industries are offering rotational attachment policies that only allows one month at a time.

The tasks assigned attaches are mainly decided by the host organization though students' application letters spell out some competencies students are expected to acquire by the end of the period. The student is accountable to and will obey the company rules throughout the duration of the attachment. Dress code, operating hours and any of the human resource requirement is determined by the company. Students' practical training is closely supervised by worksite supervisors assigned by the Human Resource Department of the host organization as well as lecturers from the polytechnic assigned to monitor and assess students. Students record their daily assignments into logbooks which assists them to give accurate reports of their attachment. Assessment forms are submitted to the worksite supervisors to assess students' skills and performance in various tasks assigned them for onward submission or postage to the polytechnic. This assessment from industry and lecturers' assessment forms part of the polytechnic's records for scoring students' attachment.

The third phase is what happens after the attachment. From the logbook recordings, students write comprehensive report that should give accurate account of their internship. It provides information on the organization, their experiences, knowledge gained and achievements. The report is first submitted to the worksite supervisors to be endorsed before they are submitted to their HODs for scoring purposes. Scores are however collated from each department by the Industrial Liaison Office for the totals to be computed together with the other two assessments (lecturers and industry) as students' attachment scores. Students are expected to do presentations in their department of these reports.

Apart from sending students out to industry for industrial attachment, Koforidua Polytechnic has with the help of Teaching and Learning Innovation Fund (TALIF) initiated an on-campus attachment named Virtual Industrial Attachment (VIRA), where seasoned resource persons are brought down from industry to simulate the work environment with the students. This initiative was a result of the keen competition that has characterized student placement on attachment. With all 10 polytechnics, private and public universities competing for placement in industry virtually at the same time, while National Service personnel are also at post, finding placement on attachment has become a grave situation that demands other initiatives if the practical component of polytechnic education is to be achieved.

The Objectives of the Industrial Attachment Programme

According to Rutherford (2005), the objectives of the industrial attachment programme are to provide opportunities for students to use their initiative to translate theories learnt in classrooms and perform assignments in an actual working environment. Additionally, it is to instill in students, the right kind of work attitudes and professionalism through interaction with people in the organization and the observation of their future roles in industry. This opportunity is to further prepare students for the job market and reduce the on-the-job training requirements so that they can become effective and productive in their respective organizations much sooner than is usual for fresh graduates.

As rightly pointed out by Naana Boakye Agyeman (2006), the aims and objectives of Polytechnic education show that it is career oriented and more practical in content, hence practical skills acquisition is paramount. This practical skill acquisition from the limited number of industries has its challenges, including the reluctance of some industries to allow students to use their facilities for training, coupled with the very keen competition for placement. The creation of the Industrial Liaison Offices in all the Polytechnics has however strengthened the activities of industrial attachment coordination and improved linkage with industry and technical experts from industry, to offer opportunities for practical skill acquisition in all Polytechnics.

The Importance of Industrial Attachment

Industrial attachment gives students a full and realistic view of workplace environment. Jide Awe (2009) argues that, it is not a storybook, fantasyland, feel-good activity. It reveals the workplace culture, the expectation and students need to ask questions like: Is it an environment in which I can thrive? Internship are a great way to 'try out' career possibilities. Availing one to participate in the programme lifts the veil by allowing the student to learn more about the specific industry, field, technology, product or judgment values that are not coloured by fantasy.

In their contribution, the Faculty of Science and Engineering in the City University of Hong Kong (Internet, 2010) perceives the importance of providing students with an essential exposure and a solid training scheme in a real industrial working environment. They add that industrial attachment among other things enhances students' awareness of the latest technologies in mass-production, and enables students to learn new techniques in a genuine working condition. It also familiarizes students with the operation of a manufacturing plant, including its organization structure, management style, and sources of raw materials, inventory control, marketing channels, and other logistic supports. Further, it provides students with a real-life environment to pick up the spirit of professionalism, and helps establish the necessary the working attitude and broaden students' exposure and experience and enhance employability while providing a rare opportunity to learn some of the secrets of business.

Students on internship have affirmed that experience through the internship has helped them to work independently, to make own judgments while providing an overview of the working environment where the customer comes first.

Preparing students for the job market through industrial attachment

Industrial attachment is to equip undergraduates with high level skill sets required by industry to enhance the talent pool of the nation. It is also to enhance the employability of fresh graduates in a competitive job market by having additional industry relevant training during the industrial attachment, since industry is now than ever emphasizing experience before employment is offered. In addition to the exposure to practices in industry, students have access to career information as well as work attitudes, and opportunity to analyze their skills and interests by examining their academic and career goals. According to Saint Mary's College (Internet, 2011) the attaché can decide on what kind of experience they want and re-examine what their education, career, and personal goals are. The student has the opportunity to decide if that is the kind of organization they are looking for or the type of work environment they prefer.

Besides preparing students with the right skills for the right jobs, the participating companies are given the priority to absorb the trainees upon graduation. This means, industry equally benefit from the training they offer undergraduates by gaining access to a ready pool of young talents. Industry again benefits from additional manpower at a 'free cost', young fresh initiatives and enables industry to send feedback to training institutions for national interest. The training institutions, in this case Koforidua Polytechnic thus receives feedback about their training curriculum as well as a better assessment of the capability of their students.

Understanding of the Industrial Attachment Programme by students

Students have participated in internships for years and have been considered as tried and true methods of mentoring and teaching students or workers a new trade or profession. In recent years, however, the number of college students participating in internship opportunities continues to grow as more and more schools offer structured programs and more and more employers expect graduates to have real world experience. It is important that students understand, and help their parents to understand, the importance of experiencing an internship while in school.

Indeed, not all jobs qualify as industrial attachment. Although they may take many forms, the purpose is to provide a meaningful learning experience for the student. It is possible that the work done may still be menial, but it should be meaningful in helping the student understand the job, profession, or field. An internship may take place during the academic year or during the long vacation. Some students may even apply for an internship after graduation. It may also be paid or unpaid, scored or not scored. The experience is intended to help the student close the gap between school and work. Internship is an important experience to complement the learning that students do in the classroom, but according to College Parents of America (Internet, June 2011), there are rather more concrete reasons why student should participate in industrial attachment and to add to their college experiences. A few of these reasons are:

1. According to a survey conducted by the National Association of Colleges and Employers (NACE), nearly 50% of employers would like to see an internship on a student's resume.
2. An internship can serve as a screening device for employers. Again, according to a NACE survey, nearly 36% of employers hired employees from their own internship program. According to Matthew Zinman of the Internship Institute, IBM may convert as much as 50% of their interns into full time employees.
3. An internship gives a student an opportunity to "audition" a job or a field *before* taking a permanent position.

4. Students who complete internships may discover gaps in their practical knowledge which may affect their course selection in subsequent semesters. They will have the opportunity to fill in gaps before they graduate.
5. Students who complete internships may receive higher salaries when they are hired.
6. Very simply, an internship may lead directly to a job offer.
7. Finally, many internships are fun – and great self-confidence builders.

It is however important that students understand that completing an internship is not a guarantee of a job. However, completing an industrial attachment experience, or multiple experiences, may have an advantage when it comes to job search. Employers recognize the advantage of an internship, but even more importantly, the experience and confidence student gain is very vital.

The Effect of Industrial Attachment on Students Understanding of their Courses

Max Weber is one of the earliest scholars to point the weakness of what he called bookish curricula. Polytechnic education was a reaction to what Max Weber called bookishness, a curriculum characterized by memorization and rote learning, reflecting the value of those in power. It is clear therefore that practical experience or internship or industrial attachment are central forms of teaching and learning. Checkland (1981, cited in Sibanda, Internet) add that practical skills are an important part of any curriculum, while Michael Young argues that nurses, doctors, lawyers, teachers, engineers and many other professionals have a component of internship or industrial attachment. This is seen as touching on all aspects of learning: cognitive, affective and psychomotor, in other words, the ability to think feel and do.

It is clear that there cannot be education without some form of training input and there cannot be effective training without some educational input. The productive individual must therefore be able to combine and utilize the outcomes from the two forms of learning - “know-how ability and do-how capability”.

Challenges of the Industrial Attachment Programme

Industrial attachment is pursued when an application for placement has been approved by the providing institution. There is however no guarantee of acceptance. Applying for an internship is like applying for a job where students may be competing with others of similar qualification.

A peculiar challenge pertaining to the Polytechnics is the public perception of Polytechnic education being inferior to University education which is even reflected in some organizations discriminating in granting offers to university and polytechnic

students. Another challenge which is not peculiar to Polytechnics is the provision of facilities for training- in whose absence the whole essence of curriculum delivery is defeated. In view of this, Robert Onsare (2010) assert that governments would be of great service to the industry if it catalyzes these linkages, given that industry is the major player in the private sector which constitute the engine of growth.

Others are - overpopulation in the workplaces as a result of the presence of National Service and Youth Employment personnel at the same period when the attaches are to go in for their practical training, thereby compounding the problem of stiff competition that has characterized internship as a result of the pressure from all polytechnics, universities, technical and vocational schools at the same time. Admissions to relevant places in students' chosen career have become difficult to achieve, since frustrations sometimes compel students to take any offer.

Significance of the Study

The requirement by industry for graduates with a number of years of working experience has revolutionized interest in industrial attachment. The study which seeks to assess the industrial attachment programme will afford the Polytechnic the opportunity to put necessary measures in place to improve upon its organization. It is not clear if students understand the purpose of industrial attachment. It is also not clear how students perceive their industrial attachment experiences in preparedness for the needs of the job-market. This study, when published will inform students about the importance of the industrial attachment programme to encourage maximum involvement. It will also make industry/organizations and government to pay more attention to industrial attachment placement policies, as well as pursue training and motivational policies that would come to enhance the future prospects of industrial attachment.

Methodology

The study was limited to Koforidua Polytechnic students who have undertaken practical training through industrial attachment. This means, only second and third year students formed the population of the study. The entire second and third year student population of about 2670 was divided into year groups (Year 2 and 3). The second and third year class each was randomly selected in 12 departments with an average class size of 40, summing up to 960 students as the sample size.

The study employed a mixed methodology research design where both qualitative and quantitative methods were used. Stratified random sampling method was then employed to select 960 students out of 2670 for data collection. These sampling techniques ensured representation from the entire population in the study and avoiding bias. To collect quantitative data, survey questionnaire were administered to 960 students covering all the departments in the Koforidua Polytechnic. Out of

that number, 884 usable responses were received representing approximately 92% response rate. In addition, a total of 170 members of the polytechnic, made up of 125 students (three separate student classes) 12 departmental industrial liaison coordinators, two school liaison coordinators and 23 supervisors were purposively selected for face-to-face interviews, to gain deeper insight into how they assess the industrial attachment programme. The interview questions were structured and bothered on the measures put in place to ensure the effectiveness of the programme, their views on worksite supervisors' grading of students' performance, and their own assessment of students from their workplace supervisors' comments. The qualitative data was analyzed manually with content analytic method. This was followed by a quantitative analysis of the survey data by the use of statistical techniques such as descriptive analysis.

Discussion of Findings

Analysis of item 1 of the students' questionnaire sought to find out if the students understand what industrial attachment is all about. The results as indicated in Table 1 show that a significant percentage (87.5%) of the students said they have an understanding of the programme. This was with particular reference to on- the- job- experience and practical skills they need to acquire during the attachment to prepare them for the job market. An open ended item in the questionnaire enabled the student respondents to provide additional information as proof of their understanding of the programme. A few of their responses were that, their ability to operate some machines in industry successfully for example has enhanced their confidence in engineering and for that matter their coursework.

Table 1: Students' understanding of the industrial attachment programme

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	728	82.4	87.5	87.5
	No	104	11.8	12.5	100.0
	Total	832	94.1	100.0	
Missing	System	52	5.9		
Total		884	100.0		

Qualitative input was further sought from 50 of the students who were randomly selected, and interviewed. All of them indicated that, adequate information is provided to them during the orientation programmes organized by the Industrial Liaison Office to help them understand the programme. Additionally, through the real contact with attachment experiences, they have really become aware of the gap that exists between the theories taught in class and the practice in the various companies. However, a small percentage (12.5%) of the students reveal that they do not have a clear understanding of the programme. Two of such students were also

interviewed and it became clear that some of them think they don't need to work for other people since they have 'solid' financial support from home.

The effect of industrial attachment on students understanding of their courses

Table 2, showing students' response to the question whether they think experiences during industrial attachment helps their understanding of some lessons better when they come back to school:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	663	75.0	77.3	77.3
	No	195	22.1	22.7	100.0
	Total	858	97.1	100.0	
Missing	System	26	2.9		
Total		884	100.0		

The findings with regards to the effect of industrial attachment on students understanding of their courses as shown in table 2 reveal that the large majority (77.3%) of the respondents said indeed they demonstrate understanding of their courses of study as a result of their practical experience during industrial attachment. This explains that the practical training they undergo enables them to gain better insight into their field of study and it helps them to understand the courses they study in the classrooms better. In response to a request to explain their response, they asserted that, the concepts learnt during internship and experiences gained are shared in class and it facilitates teaching and learning. They also added that they tend to contribute more during discussion in class especially if the topic being discussed is what pertained in the organization where they had the industrial attachment. The results also show that they usually write the final project work in relation to their attachment and choose the organizations as case studies.

Interviews with the lecturers also confirm the findings since 95% of the lecturers affirm that industrial attachment allows the students to meet technical and academic standards for performance. It can be inferred from the results that industrial attachments makes the students better prepared for both academic and real life work.

Table 3 : Relationship between what is learnt in the classroom and that of students' practical experiences during Industrial attachment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Related	663	75.0	77.3	77.3
	Un-related	195	22.1	22.7	100.0
	Total	858	97.1	100.0	
Missing	System	26	2.9		
Total		884	100.0		

The study further attempts to find out whether any relationship exists between what the students learn in the classroom and that of their practical experiences during Industrial attachment. Table 3 shows that 77.3% of the respondents said there is a relationship between what they learn in the class and that of the practical experiences gained during attachment. Though the minority 22.1% stated otherwise, obviously these either accepted any kind of placement due to stiff competition or met personnel who were insensitive to their training needs. It is however inferred that there is relationship between school learning and students' industrial experience in the majority of cases.

Table 4: The internal measures in place by the polytechnic to ensure a positive impact of the programme on students

Logistics support, funding for supervision and scoring of attachment are to ensure there is a positive impact on the students.		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	205	23.1	23.1	23.1
	Agree	504	57.1	57.1	80.2
	Disagree	175	19.8	19.8	100.0
	Seriously disagree	0.0	0.0	0.0	
Total		884	100.0	100.0	

Students were required to agree or disagree to the statement that logistics support, funding for supervision and scoring of attachment are to ensure there is a positive impact on the students. The study attempts to find out the measures in place by the polytechnic to ensure that students go through the attachment programme successfully.

Item 12 of lecturers questionnaires, who are either departmental coordinators or attachment supervisors was to find out how the polytechnic has ensured that students receive the needed practical training. The findings confirm that the creation of the full time Industrial Liaison Office with a qualified Industrial Liaison Officer and a vehicle to facilitate its work is a step towards achieving that task. Both staff and student respondents however added that the Polytechnic could do better by providing more vehicles and logistics.

Another very important internal measure is the introduction of the Virtual Industrial Attachment. In order to gain further insight into students and lecturers responses, a total of 170 respondents purposively selected to include those who had participated in VIRA and who had answered the questionnaire. Responses in Table 5 explain respondents' views on VIRA:

Table 5:

S/N	Item statement	Seriously Agree	Agree	Disagree	Seriously Disagree	Not Sure	Decision
1	There is inadequate provision of training materials and space during VIRA	85	10	65	0	0	Agree
2	The large class size during Virtual Attachment reduces the maximum effectiveness	78	32	60	0	0	Agree
3	More Resource Persons should be brought from industry to allow more students to participate in	85	50	25	0	10	Agree
4	VIRA can be made to be more effective with smaller student-to resource -person ratio.	105	58	17	0	0	Agree
5	VIRA should be stopped so that all students go to industry	0	0	20	150	0	Disagree
6	VIRA should be encouraged to be part of the polytechnic's industrial attachment programme More Resource Persons should be brought from industry to	160	10	0	0	0	Agree

It is clear from Table '5b' that the VIRA concept has been extensively embraced and steps should be taken to improve its delivery if it would continue to help solve industrial attachment placement problem while ensuring the right practical skills are passed on.

Table 7: Showing students' response to the question of whether they meet challenges during industrial attachment or not:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	595	67.3	67.3	67.3
	No	269	30.4	30.4	97.7
	Total	864	97.7	97.7	97.7
Missing	System	20	2.3	2.3	100
Total		884	100.0		

Table 7 explains students' claims about challenges they face during industrial attachment. Some call it 'frustrations' they encounter when they have to go on industrial attachment. A high majority of 67.3% of the respondents have issues that can be worrisome. The first and the most 'frustrating' challenge according to 340 (38.5%) in response to an open ended item is that of securing placement. Several organizations, private and public, they say, are simply not interested in taking attaches, partly because of mistrust, and fear of financial commitments. They complain severely of lack of office space, furniture and over congestion. This is one reason why students will choose to take part in the VIRA.

Other challenges include the lack of willingness on the part of some personnel to assist them to learn what is relevant to them thus making it difficult to learn all they need to. Some of the functions are also kept from them, for example, 20 of the student respondents complained of non-involvement in the preparation of the tender document while some particular jobs which the regular staff find difficult are often reserved for the attaches.

Others which affect their practical skill acquisition are the insistence of some host organizations not to allow them to use their computers, which are paramount to their training while some of the personnel are very unfriendly. Others include transportation problems, the need for some of them to fend for themselves and even get some menial work done to pay their fees when school reopens since a lot of them claim they are from poor homes and are self-sponsored.

Conclusion

This study attempts to find out the effectiveness of the organization of the industrial attachment programme in Koforidua Polytechnic. The results from the study show that to a large extent the students understand what the industrial attachment programme is about and its benefits. This knowledge of the students is evident in the great interest the students have in the attachment.

The findings also indicate that the industrial attachment has a positive effect on the students' understanding of their courses of study. Quite a number of measures have been put in place by the polytechnic to ensure a positive impact of industrial attachment on students. These measures include the setting up of industrial liaison office, appointment of departmental liaison coordinators, providing guidelines on industrial attachment, supervising and assessing students on attachments and the addition of the Virtual Industrial Attachment Programme. It can thus be said that the Polytechnic has really put in place mechanisms to ensure that there is a positive impact of the industrial attachment on students.

Further, the study reveals positive effects of industrial attachment on the students' preparedness for the job market, which includes the acquisition of practical skills, instilling in the students the right kind of work attitudes and observation of their future roles in industry. Evidence from the study also point out that to some extent facilities are available in the institutions to support the programme.

The effectiveness of the industrial attachment programme in the polytechnic is therefore seen in the extent to which the objectives of the attachment are achieved. Clearly, from the study the students are acquiring practical skills and integrating academic work with industrial experience.

It was further revealed the attachment experiences have equipped students to assess their basic preparedness for specific occupational requirements for specific occupations while it has really help them to develop themselves and definitely prepared them better for the job market.

The study concludes that Koforidua Polytechnic to a great extent is effectively carrying out its mandate of organizing industrial attachment for students. However, they could do better if the recommendations would be considered to improve on the programme.

Recommendations

The Polytechnic should put in place measures to as much as practicable, find places for all students to ease the frustration and stress students face in finding placement for them. Students should be given class level orientations to enable all students understand the industrial attachment programme better for their full benefit.

Furthermore, the cost element in VIRA should be well worked out to enable adequate number of seasoned resource persons to be engaged in the provision of relevant practical skills to student to achieve the objectives of the programme. Adequate logistics and human resource should be improved in the Industrial Liaison Department to help effectively improve upon the organization of the industrial attachment programme in the polytechnic.

The Government should consider the National Service Scheme side by side, the Industrial Attachment Policy and allow the two programmes to run without overlapping.

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**ORGANIZATIONAL CULTURE AND ITS RELATIONSHIP TO
ORGANISATION PERFORMANCE AT GHANA EDUCATION SERVICE
HEAD OFFICE – ACCRA**

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Abstract

The main objective of this research was to find out the organizational culture that exist at Ghana Education Service (GES) Head Office and to determine if this culture has any relationship with the organization's performance. The study was also targeted at getting feedback from respondents on the way forward for the organization in the area of study. This study looked at performance in eleven areas including the organization's mission, ethics and accountability, leadership and management, strategic planning, finance and technology. The research was centered on five divisions of the organization. The main tools for data collection were questionnaires and interview. The conclusions drawn in the study are that the existing culture does not mirror the preferred culture; culture and performance have a mutually reciprocating relationship. The study showed that the current level of performance could be improved if support systems in the area of finance, staff and technology are enhanced. Furthermore the organization should encourage shared leadership and give credit to others when they do the right things. Staff need to be trained in information technology so they can be current in the use of the technology.

Keywords: Organizational Culture, Organizational Performance, Power Culture, Role Culture, Achievement Culture

Introduction

No organization in the twenty-first century would boast about its constancy, sameness, or status quo standing compared to ten years ago. Stability is interpreted more often as stagnation than steadiness, and organizations that are not in the business of change and transition are generally viewed as unmanageable. The frightening uncertainty that traditionally accompanied major organizational change has been superseded by the frightening uncertainty that is now associated with staying the same. Change in organizations is pervasive because of the degree and rapidity of change in the external environment.

The purpose of this research was to assist in understanding the way in which culture could be diagnosed and changed in order to enhance organizational performance. Since culture is such a crucial factor in the long-term effectiveness of organizations, it is imperative that those charged with managing organizational culture be able to measure key dimensions of culture and to develop a strategy for changing it. Culture

enables people to see the goal alignment and motivates them to higher levels of performance, as shared values make people feel good about the organization and commit their capability and potential sincerely to the organization. Such strong culture acts like intrinsic motivator.

French and Bell (1984), state that Organisation Development (OD) is the applied behavioural science discipline that seeks to improve organisations through planned systematic, long-range efforts focused on the organisation culture and its human and social processes. They add that organisation development is a process of people managing the culture of an organisation, rather than being managed by it. The importance of studying organisational culture is that it helps profile the current state of organizational culture, a preferred culture for the future, and it outlines a process for moving from the current to the preferred state. It is therefore very important to study the culture of Ghana Education Service Head Office to find out the type of culture that prevails there and its relationship with the performance of the sector. The focus of most organization development change efforts is on changes in an organization's culture. This research is on the culture of the organization in the area of power, role, achievement and support as they relate with organizational performance at the Head Office of Ghana Education Service to see if there will be the need for change in the current culture of the organization.

In OD, performance improvement is the concept of organizational change in which the managers and governing body of an organization put into place and manage a programme. This programme measures the current level of performance of the organization and then generates ideas for modifying organizational behavior and infrastructure which are put in place in order to achieve a better level of output. The primary goals of organizational improvement are to improve organizational effectiveness and organizational efficiency in order to improve the ability of the organization to deliver its goods and/or services in the marketplaces in which the organization competes.

Culture can be understood as a pattern of learned assumptions about how to behave or in more colloquial language the way we do things around here. Organisations are much more complex than the formal aspects which can be easily seen above the water-line such as the organisational charts, job descriptions, the mission statements or strategic plans. The ways in which organisations perform are often more influenced by the informal things which occur 'below the water-line' such as the way people relate unofficially, the political manoeuvring, the personalities involved, and the ways decisions are made.

The analogy of an iceberg is often used to illustrate this reality. In more literary terms, Schein (1984) likens culture to lily pads:

“There you can see the lilies floating on top of the pond ... but you do not see the roots that may go down 10-15 feet, deeply bedded down in the mud that made the lily pad grow. If you do not get down into these roots and down into the mud, you do not understand the whole process. (Schein quoted in Info-line 1988:5)”.

Lusthaus et al (2000), state that organizational performance is made visible through the activities it conducts to achieve its mission. Outputs and their effects are the most observable aspects of an organization’s performance. They came out with some indicators of organizational performance which are effectiveness efficiency, relevance and financial viability.

This research looked at how the four pillars of culture that is power, role, achievement and support relate with the organizational performance in GES.

Problem Statement

Organizational culture conveys a sense of identity to employees, provides unwritten and, often, unspoken guidelines for how to get along in the organization, and enhances the stability of the social system that they experience. Unfortunately, people are unaware of their culture until it is challenged, until they experience a new culture, or until it is made overt and explicit through, for example, a framework or model. Such a framework or model has not been used to assess the culture of Ghana Education Service Head Office in Accra and its relationship with the organization’s performance. It is for this reason that this research was undertaken.

The main objective of this research was to assess the culture that exist at GES Head Office and to determine if this culture has any relationship with the organization’s performance. The study was also targeted at getting feedback from respondents on the effect of the organization’s culture on performance.

The significance of this study was to help in understanding the way in which culture could be diagnosed and changed in order to enhance organizational performance. This study will also make respondents and readers aware of how culture can or cannot influence the performance of the organization negatively or positively.

Methodology

The study used the descriptive survey design. This involved gathering data with the aid of survey instruments on which was based a description of the phenomenon under study, that is, whether there was any relationship between organizational culture and performance at GES Head Office in Accra.

The total population at the Head Office was Four Hundred and Fifteen (415). Data was collected purposively from five divisions out of ten main divisions. These were Basic Education, Curriculum Research Development Division (CRDD), Finance,

Human Resource Management and Development (HRMD) and Secondary Education. The reasons for purposively using these selected divisions was that they could offer more details and high degree of accuracy when answering the questionnaires and responding to the interviews. After selecting the five divisions each member of the division was selected using the simple random sampling technique using a table of random numbers. The sampling interval is one out of two (one person is selected out of any two people the researcher met). This was done to give everybody in the divisions an equal chance to be selected.

The data collected was analyzed and came out with the findings. These findings were then sent to some respondents to get their understanding and recommendation in the form of feedback which was later incorporated into the research work. In the end conclusion was drawn with recommendations

Results and Discussion

Table 1: Returned questionnaires from the five divisions on culture

Division	Number Given Out	Number Returned
Basic Education	24	22
CRDD	23	20
Finance	55	50
HRMD	87	75
Secondary Education	27	23
Total	216	190

Source: Fieldwork, 2010

In all 88% of the questionnaires were retrieved.

Having studied and analyzed the result on the Culture profiles of the five divisions the following came out, that the existing culture does not mirror the preferred culture.

A (Power Culture)

The Power figures in tables 2 and table 3 and figure 1 histogram below show the existing average power level as 144.4 and the preferred level at 43.4 giving the power level as higher in all the five divisions. This means that the existing power level is high and they will prefer a lower power level in the organization. Power is centralized in supervisors and leaders at high levels in the organization. The performance of certain routine administrative tasks still requires approval of managers and supervisors. Rules had been put in place and members of staff were expected to abide by the rules. There was no room for tolerance such that any little deviation on the part of Heads of Division especially attracted some form of sanctions.

Table 2: Distribution of the mean responses in each of the five divisions on the existing culture

Division	A (Power)	B (Role)	C (Achievement)	D (Support)
Basic Education	81	73	40	22
CRDD	72	68	34	20
Finance	188	144	92	50
HRMD	292	233	145	75
Secondary Education	89	72	43	23
Total	722	590	354	190
Mean	144.4	118	70.8	38

Source: Fieldwork, 2010

As much as the staff members liked the implementation of rules, they will prefer a system that tolerates human errors. The analysis also revealed that the system stifles initiative this is supported by the mean figures in the existing and preferred figures in tables 2 and 3. The research shows that the staff will prefer the diffusing of power where Heads of Division were allowed to make decisions limited to their level and this will percolate down to other staff members. This in a way will encourage initiative. This type of culture goes to confirm the comment by Handy (1993) that decisions in an organization that display a power culture are centralized around one key individual. That person likes control and the power behind it.

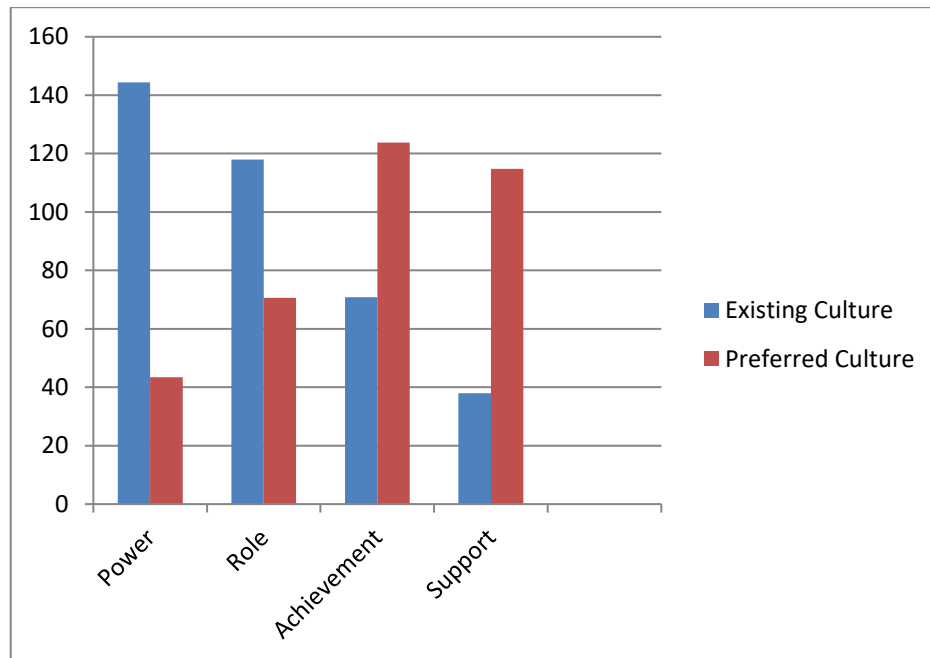
Table 3: Distribution of the mean responses in each of the five divisions on the preferred culture

Division	A (Power)	B (Role)	C (Achievement)	D (Support)
Basic Education	26	40	68	82
CRDD	22	38	85	72
Finance	58	92	160	190
HRMD	85	140	233	292
Secondary Education	26	43	73	88
Total	217	353	619	724
Mean	43.4	70.6	123.8	114.8

Source: Fieldwork, 2010

Below is the pictorial representation of the existing and preferred culture at GES Head Office.

Figure 1: Histogram on the existing and preferred culture of five divisions at GES Head Office



Source: Fieldwork, 2010

Table 4: The mean table for culture profile on the five divisions

Response	A(Power)	B(Role)	C (Achievement)	D (Support)
Existing	144.4	118	70.8	38
Preferred	43.4	70.6	123.8	114.8

Source: Fieldwork, 2010

The mean distribution table was used to generate the histogram above of the existing and preferred culture in the five divisions.

B (Role Culture)

According to the findings the role level existing in the divisions are 118 and they will prefer 70.6. Roles within the organization are well spelt out and staff members who did well tend to be those who play by the rules. Members in the divisions need to learn the formal rules and procedures and abide by the regulations in the organization and stay within the boundaries of their jobs. It was found out that the relationship between staff members in the divisions are characterized by indifferences towards each other. They help each other when they are directed by their superiors to do so. According to the findings, the system is typically a

bureaucratic type. Respondents will prefer the rules to be there but members should be allowed to take initiatives while performing their routine work (see Tables 2 and 3 and Figure 1).

C (Achievement Culture)

Contrary to power and role culture, the existing achievement levels in the five divisions are rather low at 70.8 and the preferred level was 123.8. This shows that staff members within these divisions are willing to take initiative to get things done to achieve the goals of the divisions and also healthily challenge their leaders or supervisors on issues necessary to attain the goals of the total system. A mean preferred responds of 123.8 show that staff member will wish all the resources needed to help them do their job effectively and efficiently be provided for a higher achievement culture in the divisions. This finding also supports the assertion of Handy (1993) that in a culture of achievement you notice people who are interested, energetic, committed, and co-operative and results focused. They are supported to do this through aligned systems, processes, structures and clear leadership. This is shown in the preferred mean achievement level of 123.8.

D (Support Culture)

Respondents indicated that supports from members that exist in the divisions are on the lower side making the desire to be accepted by others and working as a team is low. The bar indicated the support level at the existing level as 38 and the preferred as 114.8 (see Tables 3 and 4 and Figure 1).

Performance level in the organization

The analyses were basically descriptive in nature.

Mission: On the subject of the organization's mission 85% of the respondents agreed that Ghana Education Service Head Office has a clear mission and core values and it is understood by them. They also agreed that the mission addresses critical needs in the human market place. The rest stated that they do not know. 70% of the respondents disagreed with the fact that the organization periodically reviews the mission statement to assess whether the conditions it addresses still remain. The others stated that they do not know.

Ethics and Accountability: In the area of ongoing evaluation, peer reviews and performance reviews 90% of respondents stated that there are evaluation procedures in place. They also agreed that there are policies governing distribution of materials to the public. However 80% of the respondents stated their disagreement to the statements that the organization has processes in place to periodically assess compliance and that the organization conducts ethics audits or has ethics compliance programme.

External Environment: 75% of respondents agreed to the fact that the organization monitors the needs of the external environment. They also agreed that GES Head Office helps to plan or solve community challenges when needed. 80% said the organization is involved in expansive network of people, organizations and communities. They finally stated that GES Head Office forms alliance with other organization when appropriate. These finding confirms the facts of Mohrman et al. (1990) that an organization's performance is high when its character promotes effective exchanges with its environment and its internal-design features effectively fit together and reinforce one another. However, the rest of the respondents stated that they do not know.

Strategic Planning and Management: On the issue of strategic planning and management 95% of the respondents agreed that the organization has strategies that were developed as an outcome of a strategic planning process. They also agreed that the organization has a clear strategy that guides the programmes or activities in the context of the organization's vision and mission. The same number of respondents disagreed to the fact that the organization involves functional heads of the organization in the strategic planning process.

Organizational Structure: 85% of respondents stated that the structure of the organization supports and reflects the strategy and vision of the organization. They also stated that GES Head Office has clear lines of authority and responsibility. They went on to state that the organization has a supportive and knowledgeable council in place. However, they strongly disagreed that the organization has enough as well as the right kind of resources for example financial, staff, time and technology to achieve its goals. The others agreed to the statement.

Leadership and Management: 90% of respondents disagreed with the fact that individuals who lead the organization create a culture that enables and motivate the organization to fulfill its mission. They also disagreed to the fact that the organization has a systematic process that promotes effective leadership across the organization. In addition to these they disagreed to the fact that the organization has a strong council that relates dynamically with the staff and officers to provide a bridge to the larger community. This finding disagrees with Morgan (1986) that shared reality and meaning will be created or maintained only when leadership and management is symbolically consistent with some desired direction. In other words culture can be influenced by leadership and management.

Human Resources Management: 70% of respondents disagreed with the statement that the organization has a system or process to attract, reward, retain, value and develop talented staff including emerging leaders. They also stated that the organization has no formal programme for staff development. However others

agreed to this fact. 60% disagreed that employees are considered a valuable asset of the organization. The others therefore agreed to it.

Internal and External Communication: On the issue of communication 85% of the respondents agreed to the statements that stakeholders are informed about the plans of the organization, the organization routinely share information from external sources with staff affected by the information. They also agreed that the organization educates its management and staff to communicate effectively.

Financial Management: 50% representing half of 190 of respondents agreed that the organization is committed to the survival, growth and financial soundness of the organization. They also agreed to the fact that the organization has an ongoing capacity to attract sufficient financial resources. However, the other 50% stated that they do not know about the operations of the finance division.

Evaluation and Performance Management: 80% of respondents agreed to the statement that the organization's programmes, projects and activities have well defined outcomes that have real impact on society. The others stated that they do not know.

Information Technology: 85% of respondents agreed that the organization is involved in electronic networks. They also agreed that the organization uses information technology to enhance decision making. However they stated that the organization is not current in its use of information technology.

The research on organizational performance proves that there is an appreciable level of performance in the organization in all the eleven thematic areas assessed.

Conclusion

Feedbacks from respondents have shown that organizational culture does make a difference with respect to long-term performance. It was also revealed that the existing culture does not mirror the preferred culture. The research also revealed that there is a relationship between culture and performance in the sense that where power level is appreciably low, performance goes high through staff initiatives. Organization's leaders will have to build cultures that endure and adapt through multiple generations of leaders and preserve the core of the organizational culture as an anchor point in changing and uncertain times.

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DESIGN AND CONSTRUCTION OF FUFU POUNDING MACHINE

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Objective

To provide training for students understand the principles of machines design (i.e. Fufu machine) that solve society problems as our social responsibility.

Enhance vision of Koforidua Polytechnic in using competency based training approach for the training and provision of highly skilled graduates to help grow the economy of Ghana.

Introduction

Fufu is made from boiled plantain and cassava, yam or cocoyam. The plantains and cassava are peeled, washed, and boiled until softened. After the water is drained, they are pounded together to a smooth, consistent paste using pestle and mortar. When well mixed and soft, this paste is formed into round balls. This laborious pounding sometimes could take more than 60 minutes or 90minutes. Then the *fufu* ball is served in a bowl, with the steaming groundnut soup, light soup or palm-nut soup with any fish or meat on top of it.

Technique

The Fufu machine designed and produced by the Koforidua Polytechnic solves the problems described above. The machine is electric driven, and fits into any 13A household socket. An internal light is included for convenience. It takes only five-to-seven minutes (5-7) for the fufu to be ready without any sweat. When ready the morsel is taken from the Fufu bowl and is finished or smoothened in a mortar.

Methodology

CAD graphics, Structure Designing, Fabrication, Lathe and machine works, Welding, Drilling and many laboratory experimental works were used in the process.

Results / Benefits

Hygienic, Saves time and does not disturb

Fufu can be enjoyed anywhere and anytime

Jobs creation for those in the food and catering industry, etc.

Challenges

Reducing size of machine to microwave oven.
Design Fufu Machine for commercial purposes.
Possible hand-operated-fufu-pounding machine.
Research into pounding noise and its effect on appetite.

Conclusion

Like Kenkey, Banku or Ampesi, many Ghanaians who enjoy Fufu want to employ the five basic senses in eating. You hear and smell the food when it is cooking. You see and taste it while eating. But in order to bring in your fifth sense, you have to touch and feel it

PRODUCTION OF FIRED CLAY BALLS TO BE USED IN A “SOAK AWAY” IN ORDER TO PREVENT MOSQUITOES BREEDING IN THE ENVIRONMENT.

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Abstract

Each year, malaria which causes high fever and flu-like system, kills more than 1 million people, mostly children, with 350,500 million cases reported worldwide. Approximately, 90% of all cases of malaria are in Africa, where one (1) child in ten (10) dies before the age of five (5) (www.cartercentre.org/health/malaria). In Ghana, this preventable disease is one of the largest causes of death. Ghana is endowed with clay deposits and it appears this naturally occurring mineral is being under utilized. In the saw-mill or wood industry, sawdust as a waste product is also a challenge to the environment. In most cases, the sawdust is burnt, thereby polluting the air and the ozone layer. The objective of the study was therefore to find out whether clay, laterite and sawdust could be used to compose clay body to make fired clay balls that would be used to absorb stagnant water, so as to reduce the breeding of mosquitoes which causes malaria in the environment. The experimental research method was employed. Samples of materials were obtained from the Sekondi-Takoradi Metropolis. A mix ratio of 5:3:2 (5 parts of clay, 3 parts of laterite and 2 parts of sawdust) was used. Water was added to the mixture to make it mouldable or workable before making the clay balls. It was found out among others that compared with the use of stones as soakaway, the fired clay balls were more suitable in terms of ability to absorb stagnant water, very hygienic and had no or little stinks or offensive odour in areas where fired clay balls were used as soakaway. It was recommended, among others that clay and sawdust could be used to produce fired clay balls for making “soak away” and the need to educate environmentalists or health officers to know how fired clay balls could be used to absorb stagnant water. It could also serve as a source of income for the indigenous where clay abounds. This study would also improve the environment and reduce the harmful effect that affects environmental quality as the country prepares to engage in commercial production of oil.

Introduction

Soak away is a pit dug in permeable ground which receives the water discharged from the roof and paved area of a small building and is so constructed that the water collected percolate into the surrounding subsoil (Cludley 1999).

It is constructed by excavating a pit of the appropriate size and either filling the void with selected coarse granular material or alternatively lining the sides of the

excavation with brick work or precast concrete rings. Soakaway pits are recommended as alternative when absorption trench are impracticable, where the previous soil is deep or where impervious upper layer is not laid by a porous layer

Statement of the Problem

In Ghana, malaria is described as number one killer disease. It is caused by a mosquito bite. Mostly; stagnant water is the main breeding ground for mosquitoes. Generally, the Ministry of Health spends several millions of Ghana cedis in malaria control annually. However; the disease is still prevalent in Ghana.

Clay is a naturally occurring raw material that can be found in every part of the country. It has several uses but it seems Ghanaians are not fully utilizing the potentials of this raw materials.

Sawdust is also a by-product of forestry felled timber. In the sawmill industry, sawdust is a waste product and it is normally burnt, thereby ,polluting the air and the ozone layer as well as causing environmental degradation. It is against this backdrop that the researchers seek to compose clay bodies and produce fired clay balls which could be used to absorb stagnant water so as to help curb the breeding of mosquitoes, the causative agent of malaria.

Objectives of The Study

The objectives of the study are

- i. To compose clay bodies.
- ii. To produce fired clay bodies that would be used to absorb stagnant water.
- iii. To find whether cheap materials such as clay, laterite and sawdust(waste product) can be well-utilized.

Importance of the Study

- i. The results of the study will be very useful to environmental or health officers.
- ii. The study will help prevent the breeding of mosquitoes in stagnant water.

Hypothesis

Fired clay balls can be used as soakaway

Review of Related Literature

Definition of Clay

According to Speight (2003) “clay in its dry state , is a crumbly earth material that is soft and easily modeled (plastic) when wet, holds its shape when formed and dried, and then becomes a new, hard dense material when subjected to heat”. Atkin (2004) also explains clay as “a fine –grained earthly material, which in its natural state can be found almost everywhere in the world”.

From the above definitions, the researchers could define clay as fine earthly material which contains minerals and is plastic. Clay shrinks when dry and expands when wet, gains in strength with retention of shape. Clay occurs throughout the world.

Factors to consider when constructing a Soakaway

To function correctly and efficiently, a soakaway must be designed taking into account the following factors;

- i. Area to be drained.
- ii. Permeability or rate of dispersion of the subsoil
- iii. Depth of water table
- iv. Storage capacity required to accept sudden inflow such as that encountered during a storm
- v. Local authority requirements as to methods of construction and sitting in relation to building.

Positioning of a Soakaway

Soakaway should be sited away from buildings so that foundations are not affected by percolation of water from the soakaway. The minimum “safe” distance is often quoted as 5.0m but local authority advice should always be sought. The number of soakaways required can only be determined by having the facts concerning total drains, areas to be drained and the rate of percolations for any particular site.

Types of Soakaways

There are three types of soakaway. These are;

- i. Filled soakaway
- ii. Brick-lined soakaway
- iii. Septic tank soakaway

Filled soakaway – are usually employed for small capacities, since it is difficult to estimate the storage capacity and the life of the soakaway may be limited by the silting up of the voids between the filling materials.

Brick-filled soakaways – are generally more efficient, have a longer life and if access is provided can be inspected and maintained at regular levels

Septic tank – this type of soakaway is perhaps the oldest and most commonly constructed in Ghana. This is a dug hole through the impermeable clay overlying deeper strata that might be porous.

Clay Deposits in Ghana

Records available indicate that clay is found in all the regions of Ghana. The table below shows some clay deposits in Ghana

Table 1: Some clay deposits in Ghana

Regions	Clay deposits
Ashanti	Adankwame,Bekwai,Mankranso,Hwereso,Pekyerekye,Kubease
Brong Ahafo	Atebubu,Berekum,Goaso,Kenyasi,Wenchi,Yeji,Nkoranza,Dormaa Ahenkro
Central	Ankaful,Ayipty,Mankessim,Saltpong,Abomano,Moseaso
Eastern	Asubuo,Kwae,Oda,Nkawkaw,Bebuso,Apeguso
Northern	Gushiegu,Tamale,Walewale,Yapie
Upper East	Bongo,Zebilla,Gambibigo
Upper West	Nanbeng,Nadowli,Sandema
Western	Ayanfuri,Bibiani,Kofi Gyan,Okarakrom,Samahu,Darman
Volta	Ave Dakpa,Kuli,Adzagonokope,Wute,Soipe

Source: Journal of the BRRI (CSIR) Ghana. Vol.9. Jan-Dec., 2005.

Methodology

The researchers employed the experimental research method for this study. An experiment usually involves two groups of subjects; an experimental group and a control or a comparison group (Fraenkel & Wallen 2000). In this study, the fired clay balls used as soakaway was the experimental group while the use of stones as soakaway was the comparison group.

Tools, Equipment and Materials used

Tools and Equipment



a.. A shovel



b. A bucket



c. A basin for mixing raw materials



d. A Wooden board



e. A mattock



f. A head pan



g. A wheel barrow



h. Nails

Materials used



a. Clay



b. Sawdust



c. Laterite

Preparation of the clay body for the clay ball

The following materials were measured

- 5 parts of clay
- 3 parts of laterite
- 2 parts of sawdust

A basin was filled with the measured clay and laterite and then mixed with water. The mixture was then pounded into a homogenous consistency using a pestle and mortar. A leveled and firmed ground was prepared and the clay ball kneaded and mixed with the measured sawdust. The sawdust serves as combustion and porous forming agent. The process was repeated until enough clay balls were obtained. The molded clay stones (balls) were then punched with nails in order to leave more pores.



Plate 1: Kneading of raw materials into clay balls



Plate 2: Punching of holes

Drying of the clay balls

The prepared clay balls were then arranged and placed in the sun for them to dry. The clay balls were often placed upside-down to ensure uniform air circulation to achieve maximum drying before firing.



Plate 3: Drying of clay balls drying



Plate 4: Clay balls turned to ensure maximum drying

Firing of the clay balls

The dried clay balls were then conveyed to the firewood kiln for firing. The clay balls were pre-heated to ensure that all the moisture-content had evaporated from the clay balls.

Firing continued from a low temperature and then to full blast (high temperature). Thus the clay balls were fired at about 1000°C. At that point, the clay balls became vitrified and most pores sealed. If the clay balls were to be fired too low, it would cause them to soak in water. After firing, the kiln was left to cool overnight and the fired clay balls were removed from the kiln.

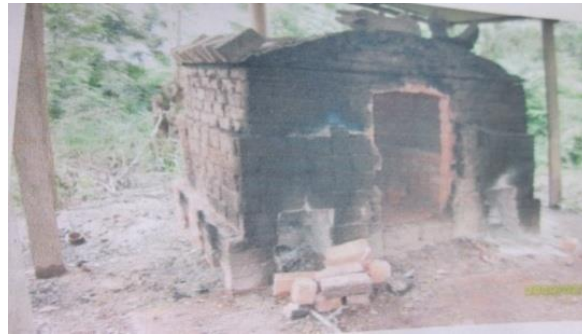


Plate 5 A firewood Kiln

Findings or Results

When the fired clay balls were used as soakaway to construct a urinal base and compared with the one with stones, it was found out that the fired clay balls were able to absorb water and urine, dried up quickly without any stagnant water. It meant that fired clay balls could absorb stagnant water that would serve as a breeding ground of mosquitoes which cause malaria in the environment.

It was also found out the fired clay balls soakaway pit had no stinks or offensive odour thereby making the urinal base very hygienic.

When the fired clay balls were also used to fill potholes with stagnant water, they were able to absorb the stagnant water. This could also mean that the fired clay balls had prevented the stagnant water from breeding mosquitoes.

Preparation of the Soakaway

The pit was then dug to about 3feet deep and the fired clay balls were laid in it .Pipe was connected to the pit so that inflow of water would go straight to the soakaway.The inlet was then fixed with a wire mesh and mortar. The plates below shows the stages of the finished soakaway



Plate 6: A dug pit balls



Plate 7: Laid fired clay



Plate 8: Connected pipe to the Soakaway



Plate 9: The finished soakaway containing the fired clay balls



Plate 10: Testing of the finished soakaway

Conclusions and Recommendations

In conclusion, it can be stated that if this technology is well adopted, there would be no or little room for stagnant water to serve as breeding ground of mosquitoes leading to the cause of malaria. As the saying goes “prevention is better than cure”, if the breeding grounds of mosquitoes are prevented, the demand for mosquito nets, sprays and coils will be reduced. The government would also not spend huge sums of money on campaign for malaria prevention but rather use that money to provide social amenities such as good drinking water, roads, electricity, hospitals, schools and libraries for the development of Ghana. The researchers were able to compose a clay body which was able to absorb stagnant water and had helped in curbing the breeding of mosquitoes.

Based on the findings and conclusions of the study, the researchers recommend as follows:

First, health officers or environmentalists and the researchers should collaborate and educate the general public using the mass media such as radio, television, and newspapers to promote this new technology. They could seek for sponsorship from

the Ministry of Environment, Science and Technology to educate the general public about this technology.

Second, in the construction industry of Ghana, building contractors should be encouraged to use fired clay balls to construct soakaway because they are more suitable in curbing the breed of mosquitoes.

Third, this technology could serve as a source of income for the indigenous people in areas where clay abounds. They could make these fired clay balls and sell them to building contractors who construct soakaways.

Fourth, in the communities where there is water stagnant, these fired clay balls could be used to fill these grounds to drain the water to prevent the breeding of mosquitoes.

Lastly, since the results of the study indicate that the fired clay balls used in constructing soakaway is hygienic, institutions such as schools especially in communities should adopt this new technology to construct public urinals in their schools.

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ENERGY REDUCTION STRATEGIES OF OFFICE BUILDINGS IN GHANA

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Abstract

The study presented in this paper seeks to address reductions in energy use, CO₂ emissions, and the potential in retrofitting buildings. Five low-rise buildings situated in Kumasi were chosen for the study. After a long term (12 months) monitoring period of the performance of the buildings, a simulation application tool was used to calibrate and calculate the cooling load of the buildings. The energy use resulting from the base case and combined improvement measures showed a saving potential of 20 to 35 %. Additionally, a mean value of 27 % CO₂ emissions (100 tons) could be saved. Analysis on retrofitting the buildings through improved windows, efficient lighting, insulation of the attic floors, and the use of natural ventilation showed a payback time of 3 to 12 years depending on building type.

Keywords: Emissions; carbon dioxide; energy; building performance

Introduction

Melting ice at the poles, landslides, heavy rain falls, severe draughts, rise in temperature and the fact that Mountain Kilimanjaro is expected to lose its entire ice by the end of the year 2010 (Taschwer, 2009) are all results of the negative effects of unsustainable use of resources.

The Intergovernmental Partnership on Climate Change (IPCC) and the United Nations Organisation (UNO) have through reports demonstrated that humans are the cause of climate change and that we can contribute positively to preventing drastic climate change. The Kyoto Protocol is a declaration of nations to combat the negative effects of climate change through sustainable measures. Regular conventions are held to monitor the progress made (UNFCCC, 2009).

The contribution of the construction industry towards energy efficiency, sustainable use of resources and improved technology cannot be overemphasised (Langthaler, 2009). In almost all Ghanaian cities, new and old buildings can be seen retrofitted with more glazing without thought of the energy demands of such designs. The fact that the country is producing oil should not be used as an excuse to waste energy. It should be a priority to adhere to efficient use of resources and sustainable design principles. According to the Energy Commission Ghana report (ECG, 2007), energy consumption of households increased from 26 % in 2000 to 37 % in 2005. Within

the same period, energy consumption of the commercial sector actually doubled, that is from 7 % to 14 %. In 1990, Ghana had a surplus of electricity of 3,545 GWh (Gigawatt hours) and in 2004; a deficit of 203 GWh was recorded. This trend of increasing demand for energy culminated in the load shedding exercise in the year 2006/2007. Nevertheless, it is noted that the increase in energy consumption in Ghana is partly due to such positive improvements as the new electric project, good economic environment, more location of foreign and local industries, etc.

In an effort to contribute to the process of saving the planet in which developing countries play a major role (with the financial and technological assistance from the industrialised nations), five low-rise office buildings in Kumasi are selected for the study.

The main objective is to use improved and efficient building systems (Koranteng, 2010) to reduce energy usage, CO₂ emissions and demonstrate the potential in retrofitting buildings.

Methodology

The demonstration of possible CO₂ emission reductions and the potential of retrofitting were based on precise and long term studies of the energy use of buildings. The energy use, specifically, cooling loads of the selected buildings in this study have been the subject of previous research (see Koranteng, 2010). Information regarding details of the buildings, locations, types, properties, internal loads, thermal controls, floor areas and functions has been addressed (Koranteng and Mahdavi, 2010). Further, data relating to monitored environmental conditions (Meteotest, 2008), accuracy of sensors used (OCR, 2008), calibration of the simulation tool (correlation coefficient of 0.53 to 0.87), parametric study of thermal improvement scenarios, measured external weather conditions and comparison of measurements and simulations were illustrated.

In brief, the five buildings chosen for the study are representatives of the majority of low-rise office buildings with different thermal controls (air-conditioned, naturally ventilated and mixed mode) in Kumasi, capital of the Ashanti Region in Ghana. The selected office buildings are the College of Architecture and Planning Administration Block (CAP), the Centre for Collaborative Research (KCR), the Angel Administration Centre (ANG), the Royal Plaza (ROY) and the Community Development Centre (DCD). A simulation application (EDSL, 2008) was used to explore measures that could improve the energy performance of the buildings. This software tool dynamically simulates the thermal performance of buildings and their systems. The application solves the sensible heat balance for a zone by setting up equations representing the individual energy balances for the air and each of the surrounding surfaces. These equations are then combined with further equations

representing the energy balances at the external surfaces, and the whole equation set is solved simultaneously to generate air temperatures, surface temperatures and room loads. Conduction in the fabric of the building is treated dynamically, using two methods for the analysis of wall heat flows. For state-representation, finite difference methods are applied, whereas conductive heat flows at the surfaces of walls and other building elements are calculated with a response factor method. Convection is treated by using a combination of empirical and theoretical relationships. Long-wave radiation exchange is modeled using the Stefan-Boltzmann law. Long-wave radiation from the sky and the ground is treated by using empirical relationships (EDSL, 2007). In the process, combined improvement scenarios (CI) of efficient lighting, windows, natural ventilation and attic floor insulation as against the base case scenarios (BC), could reduce the cooling loads of the buildings by 20 to 35 % (Koranteng and Mahdavi, 2010).

Energy Use

The cooling loads of the buildings were simulated and used with the price of electricity for the year 2007 (0.12 € per kWh, the average production cost of electricity as at 2011 is still 0.12 € per kWh (Quandzie, 2011), however, consumers pay 0.08 € per kWh (PURC, 2011) which represents a reduction of about 33%) to derive the respective energy usage. The paper uses the actual production cost for the calculation of the energy usage. The efficiency of the split unit air-condition systems (LGE, 2008) was factored into the calculation of the estimated annual energy usage. The base case (BC) and combined improvement (CI) scenarios (Koranteng, 2010) were also used for the computations.

2.2 CO₂ Emissions

The estimated CO₂ emissions resulted from the energy mix in Ghana (see Tables 1, 2 and 3). Further, the amount of carbon dioxide per kWh of generating plant based on climate reports ((Lightbucket 2008) and (Carbontrust 2008)) was used to derive the emission value for Ghana.

Table 1: Energy production and consumption as at 2006 in Ghana

Item	Amount [GWh]	Percentage [%]
Oil	2810	33.34
Hydro	5619	66.66
Residential	2080	31.91
Commercial	841	12.90

Source: IEA (2006)

Table 2: Amount of CO₂ in kg per kWh of electricity based on whole life cycle of generating plant

	Summary (av.) based on 1990 Technology	Recent values
Coal	0,914	0,52
Gas	0,444	0,194
Oil	0,679*	0,27
Hydro	0,018	0,009

**assumed value for oil resulting from the means between coal and gas emissions*

Source: ((Lightbucket 2008) and (Carbontrust 2008)

Table 3: Tabulated amount of CO₂ in kg per kWh of electricity based on whole life cycle of generating plant in Ghana

	Percentage production (%)	kgCO ₂ per kWh	Total kgCO ₂ per kWh
Hydro	66,66	0,018	0,012
Oil	33,34	0,679	0,226
Total			0,238

Retrofitting

Using the savings resulting from the combined improvement (CI) scenarios as against the base case (BC), a retrofitting analysis was conducted based on actual market prices. The main concern was the payback time.

An improved window was estimated to cost 500 € per 2.25 m², efficient lighting 10 € per bulb, natural ventilation 200 €, (fan and opening mechanism per window), and attic floor insulation 3 € per m² (see Tables 4 to 8).

Table 4: Estimated cost of retrofitting building CAP (795 m²)

Element	Quantity	Unit area (m ²)	Total area (m ²)	Unit cost (€.m ⁻²)	Total cost (€)
Window	60	2.25	135	222.22	29999.70
Efficient Lighting	44	36.14	795	0.28	445.24
Ventilation mechanism	60	2.25	135	88.88	11998.80
Insulation	1	265	265	3	795.00
Total					43238.74

Table 5: Estimated cost of retrofitting building KCR (1100 m²)

Element	Quantity	Unit area (m ²)	Total area (m ²)	Unit cost (€.m ⁻²)	Total cost (€)
Window	56	2.25	126	222.22	27999.72
Efficient Lighting	60	36.67	1100	0.28	616.06
Ventilation mechanism	56	2.25	126	88.88	11198.88
Insulation	1	550	550	3	1650.00
Total					41464.66

Table 6: Estimated cost of retrofitting building ANG (365 m²)

Element	Quantity	Unit area (m ²)	Total area (m ²)	Unit cost (€.m ⁻²)	Total cost (€)
Window	19	2.25	42.75	222.22	9499.91
Efficient Lighting	20	36.5	365	0.28	204.40
Ventilation mechanism	19	2.25	43	88.88	3799.62
Insulation	1	350	350	3	1050.00
Total					14553.93

Table 7: Estimated cost of retrofitting building ROY (1740 m²)

Element	Quantity	Unit area (m ²)	Total area (m ²)	Unit cost (€.m ⁻²)	Total cost (€)
Curtain wall	330	2.25	742.5	222.22	164998.35
Efficient Lighting	104	33.46	1740	0.28	974.36
Ventilation mechanism	330	2.25	743	88.88	65993.40
Insulation	1	580	580	3	1740.00
Total					233706.11

Table 8: Estimated cost of retrofitting building DCD (280 m²)

Element	Quantity	Unit area (m ²)	Total area (m ²)	Unit cost (€.m ⁻²)	Total cost (€)
Window	29	2.25	65.25	222.22	14499.86
Efficient Lighting	16	35	280	0.28	156.80
Ventilation mechanism	29	2.25	65	88.88	5799.42
Insulation	1	140	140	3	420.00
Total					20876.08

3. Results

The tabulated results are presented. Table 9 shows the estimated annual energy use of all buildings. Table 10 illustrates the estimated annual savings of energy as a result of the combined improvement (CI) as against the base case (BC) scenarios. Further, Table 11 shows the estimated amount of carbon dioxide saved due to the improved and efficient building systems. The payback time is demonstrated in Table 12.

Table 9: Estimated annual energy use for all buildings

Building	Floor area [m ²]	Cooling load (BC), [kWh.m ⁻² .a ⁻¹]	Cooling load (CI), [kWh.m ⁻² .a ⁻¹]	Efficiency of cooling system	Annual energy use(BC), [kWh]	Annual energy use (CI), [kWh]
CAP	795	149.00	117.00	2.60	307983.00	241839.00
KCR	1100	111.50	73.40	2.60	318890.00	209924.00
ANG	365	165.20	123.40	2.60	156774.80	117106.60
ROY	1740	126.20	89.70	2.60	570928.80	405802.80
DCD	280	166.20	133.40	2.60	120993.60	97115.20

Table 10: Estimated annual energy savings for all buildings

Building	Unit cost of electricity [€]	Annual energy cost (BC), [€]	Annual energy cost (CI), [€]	Annual energy savings, [€]	Annual energy savings, [kWh]
CAP	0.12	36957.96	29020.68	7937.28	66144.00
KCR	0.12	38266.80	25190.88	13075.92	108966.00

ANG	0.12	18812.98	14052.79	4760.18	39668.20
ROY	0.12	68511.46	48696.34	19815.12	165126.00
DCD	0.12	14519.23	11653.82	2865.41	23878.40
Total				48453.91	403782.60

Table 11: Estimated annual kgCO₂ savings for all buildings

Building	Annual energy use (BC), [kWh]	Annual energy use (CI), [kWh]	kgCO ₂ .kWh ⁻¹	Total CO ₂ (BC), [kg]	Total CO ₂ (CI), [kg]	Annual savings, [kgCO ₂]
CAP	307983.00	241839.00	0.238	73299.95	57557.68	15742.27
KCR	318890.00	209924.00	0.238	75895.82	49961.91	25933.91
ANG	156774.80	117106.60	0.238	37312.40	27871.37	9441.03
ROY	570928.80	405802.80	0.238	135881.05	96581.07	39299.99
DCD	120993.60	97115.20	0.238	28796.48	23113.42	5683.06
Total				351185.71	255085.45	96100.26

Table 12: Estimated payback time for all buildings

	CAP	KCR	ANG	ROY	DCD
Installation cost(€)	43238.74	41464.66	14553.93	233706.11	20876.08
Savings per year (€)	7937.28	13075.92	4760.18	19815.12	2865.41
Payback time (years)	5.45	3.17	3.06	11.79	7.29

Discussion

The results of the long term study through the calibration of the models, simulation of design alternatives as against the base case models, energy use, carbon dioxide reductions and the potential in retrofitting buildings lead to a number of observations.

- The improved and efficient building elements (the combined improvement scenarios) could significantly reduce the cooling loads and energy use of the buildings (20 to 35 %, Table 10).
- Carbon dioxide emissions could also be reduced (averagely 27 %) as a result of the efficient systems and its concomitant decrease in energy use.
- About 100 tons of CO₂ could be saved (Table 11) which has a value of about 1'700 € on the international market (CO₂ trading). With the European Union

initiative to raise the price per ton CO₂ to a sustainable level of about 120 € and the International Energy Agency proposing ca. 150 € (IEA 2009), a minimum but considerable estimated saving of about 12000 € could be achieved in the near future.

- Retrofitting the buildings would lead to a better performance and less energy use. Moreover, a payback time of 3 to 12 years (see Table 12) as against the life span of the structures makes it a lucrative investment opportunity for building owners

Conclusion

The parametric study has shown the potential in the use of calibrated models in probing design alternatives. In the building industry, simulation tools have potential towards the reduction of cooling loads in office buildings, especially curtain wall types. This calls for the use of efficient and improved building systems, the development of building energy codes and its implementation in Ghana.

The building industry in Ghana could contribute to reducing the devastating effects of climate change and energy use of buildings if attention is given to sustainable measures. However, investments and technological know-how are needed to face the challenges.

As much as 20 to 35 % of energy use and 27 % of carbon dioxide emissions could be saved. The savings through the improved systems and energy use of the buildings result in a short payback time (3 to 12 years).

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EVALUATION OF THE QUALITY OF SACHET WATER IN THE NEW JUABEN MUNICIPALITY

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Abstract

Access to good quality water has been a challenge to humans due to the pollution of the limited water resources around. According to Gadgil (1998), over one billion people do not have access to safe source of drinking water. This phenomenon is leading to the loss of children below the age five (5) on an hourly basis. This is largely due to the bacteriological contamination of these water sources. For water to be good for consumption, it should be colourless, odourless, tasteless and neutral to litmus. Further tests conducted on the water – chemical and biological – should prove the absence of harmful chemicals and germs (Shilkomanov, 2000). Some water-related diseases include cholera, typhoid fever, bacillary dysentery, etc. Institutions incur a lot of losses through the treatment of water-related diseases. With the rate at which sachet water producing companies are coming up, there is the need to check on the quality of the water being produced for sale to consumers. This research seeks to ascertain the quality of sachet water produced and vended in the Koforidua Municipality. Data was gathered through interviews and laboratory experiments. Membrane filtration method and 3TMPetrifilm tests were run in the laboratory to check the microbial quality. The results from the physico-chemical and bacteriological parameters of the samples indicated compliance with the Ghana standards on drinking water quality. The research recommends regular monitoring of the sachet water producing factories. Also the vendors and retailers should ensure proper hygiene to avoid contamination of the water.

Keywords – sachet water, drinking water, water-related, Standards, contamination

Introduction

Access to good quality water has become a challenge to both developing and developed countries. This problem is orchestrated by the wanton pollution of the limited water resources around us by the actions and inactions of humans. Boakye and Bentil (2010) quoted FORAW and Environmental Protection Agency (EPA) (2008) that rainfall would decrease on the average, 2.8% by 2020, 10.9% by 2050 and 18.6% by 2080 in all agro-ecological zones, except for the rainforest zone, where rainfall may increase.

According to Gadgil (1998), over one billion people do not have access to a safe source of drinking water. This phenomenon is leading to the demise of about four hundred (400) children below the age five (5) on an hourly basis. This is largely due to the bacteriological contamination of these water sources.

Most public sector water production plants are unable to meet the demands of their clients. A number of reasons could be assigned for this gap. This may include the

- high cost of treatment of water
- high cost of maintenance of plants and equipment
- water losses during distribution
- increasing population and water demand
- non-payment of water bills and others

In 2000, the United Nations Declaration was adopted by about 180 member states. This led to the promulgation of the Millennium Development Goals (MDG). The MDG Goals are to serve as the guidelines for the world to accelerate development and measure progress, contain a set of time-bound measurable goals and targets for combating poverty, hunger, disease, illiteracy, environmental degradation and discrimination against women. The MDG Goal Seven (7) seeks to ensure environmental sustainability.

According to the United Nations Mid-term Assessment Report (UNICEF and WHO, 2004), 80% of the world's population used an improved drinking water source in 2004, up from 71% in 1990. Although these numbers indicate the world is on track to meet the goal, there will be challenges as populations increase.

The introduction of the sachet water into the market was to provide an alternative source of good quality water for consumption. The sachet water was supposed to be safe, hygienic, affordable and an instant source of water for consumers. With the flooding of the market with sachet water and vendors embarking on the best methods to sell their wares, it is incumbent that the quality of water being offered for sale is ascertained. As one seeks to satisfy a natural requirement of the human body (drinking water when thirsty), the person needs to be able to make an informed choice on the type of water to be assimilated.

Aim and Objectives

The aim of this study is to investigate the quality of sachet water produced and sold in the New Juaben Municipality.

The objectives of the study are as follows:

- 1) Identify sachet water brands in the New Juaben Municipality.
- 2) To identify the sources of water used for treatment and the treatment methods adopted by these companies.
- 3) To ascertain the level of microbes in sampled sachet water.
- 4) Recommend strategies for improving sachet water quality.

Microbial Quality of Sachet Water in Ghana

Water pollution occurs when the water supply system is contaminated with faecal matter and pathogens which are shed in human or animal faecal matter. Some of the most dangerous pathogens include *E. coli*, *Salmonella sp.*, *Shigella sp.*, *Vibrio cholerae*, etc. These pathogens are noted for being the causative organism of most water-related diseases such as typhoid fever, dysentery and cholera.

A World Health Organization accepted method for calculating the losses incurred as a result of injuries and diseases (DALY) shows that, institutions such as the Koforidua Polytechnic should put its best to safeguard its employees against injuries and diseases. DALY is an acronym representing Disability Adjusted Life Years. It is defined as the sum of the present value of the future years of lifetime lost through premature mortality and the present value of the future years of lifetime adjusted for the average severity of any mental or physical disablement caused by injuries of diseases (Fox-Rushby and Hanson, 2001).

The microbial quality of sachet water was investigated by some researchers in four locations in Ghana. Figure 1 shows the map of Ghana. These are locations are:

- i. Cape Coast in the Central Region
- ii. Kumasi in the Ashanti Region
- iii. Teshie in the Greater Accra Region
- iv. Tamale in the Northern Region

Regions and Major Cities of Ghana

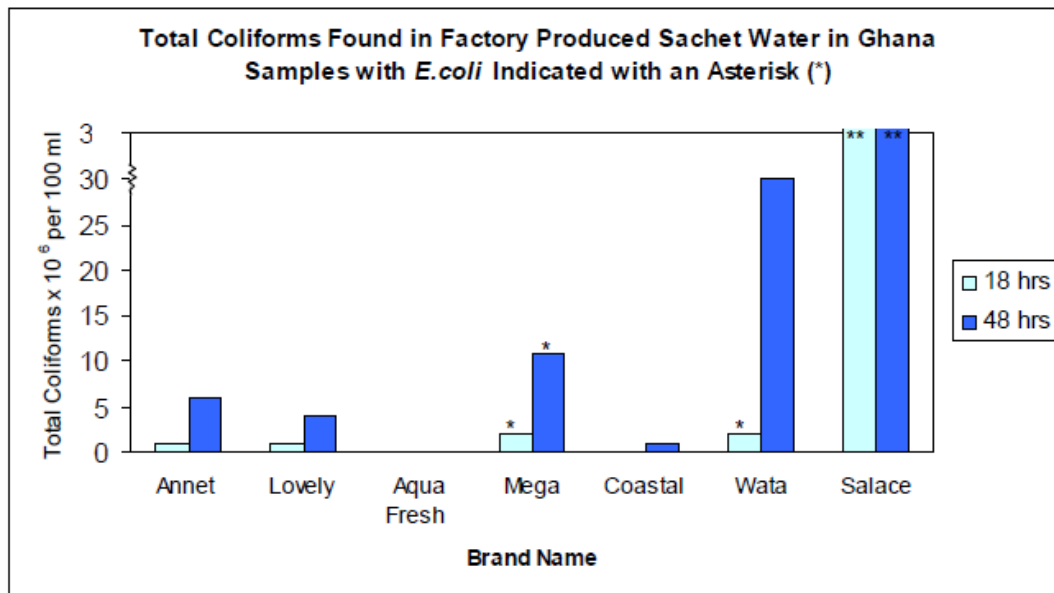


Figure 1: Regions and major cities of Ghana (VanCalcar, 2006)

Dodooet *al* (2006) investigated the quality of sachet water (factory-produced water) in the Cape Coast Municipality. The samples were exposed to three different environmental conditions i.e. the sun, room and laboratory. The water quality tests

were carried out using the membrane filtration method with lauryl broth or alga medium, and/or by the multiple tube fermentation method.

The results from the water quality tests indicated that 45% of the brands of sachet water contained total coliform bacteria in at least one test. The total coliform counts ranged from zero (0) colony forming units (CFU)/100ml to 98 million CFU/100ml. Three out of seven brands (Mega, Wata and Salace) returned positive results for *E.coli* in their analysis (as indicated with a single asterisk (*) in Figure 2). Figure 2 shows the maximum number of total coliform colonies counted for sachet water stored at a temperature of 40°C (sun exposure), that simulates the environmental conditions sachet water may be exposed to when sold in open air markets or on streets by roadside vendors.



* *E.coli* Present

**Too Numerous to Count (TNTC)

Figure 2: Total coliforms found in factory-produced sachet-water. (Source - Dodoo et al (2006))

The tests were run once per week over five weeks. Two counts, at 18 hours and 48 hours of incubation at 37°C, are shown. Only one brand out of the seven (Aqua Fresh) was free of total coliforms for tests run under the specified conditions. Two brands, Mega and Wata, incubated for 18 hours and 48 hours, showed the presence of *E.coli* as represented by an asterisk.

Obiri-Danso et al (2003) assessed the quality of hand-tied sachet water, bottled water and factory –produced sachet water sold in the streets of Kumasi. The water samples they considered included eight (8) samples of bottled water, 88 factory-produced sachet-water samples and 40 hand-tied sachet-water samples.

Their results showed that the bottled water had no presence of total coliforms (0 CFU/100ml). The factory produced sachet water had about 4.5% of the samples showing total coliform counts (counts ranged from 10 CFU/100ml to 13 CFU/100ml for positive results) and 2.3% had faecal coliforms (2 samples both 10 CFU/100ml). For the hand-tied sachet water, 43% (17 samples) were positive for total coliforms (range from 10 CFU/100ml to 67 CFU/100ml). Twenty three per cent (23%) (9 samples) showed presence of faecal coliforms (range from 10 CFU/100ml to 20 CFU/100ml). Figure 3 shows the percentage of positive *E.coli* and total coliform results from the samples tested.

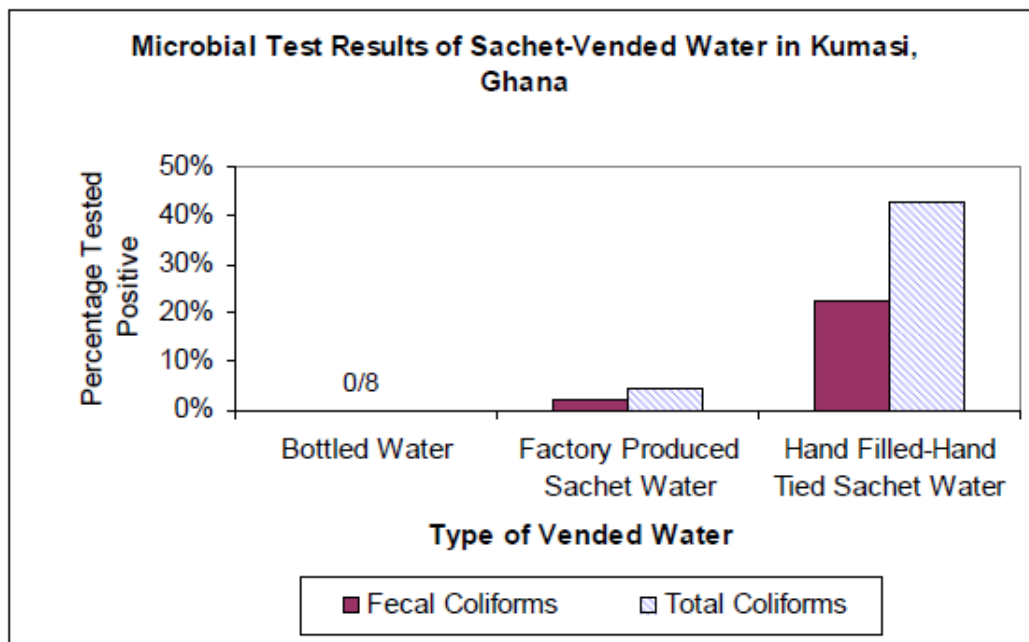


Figure 3: Results from microbial tests of vended water in Kumasi, Ghana (Source: Obiri-Danso et al (2003))

In 1993, SEI investigated the quality of **iced-water** sold on the street of Accra. The target of the investigation was to obtain the numbers of total coliforms, faecal coliforms and faecal streptococci in samples. The results of the research are shown in the table 2.1 below:

Table 2.0.1: Bacteria Concentration of Drinking Water from 'Ice-Water' vendors (SEI, 1993)

Counts/ 100ml	Total Coliform		Faecal Coliform		Faecal Streptococci	
	No.	%	No.	%	No.	%
0	0	0	42	100	0	0
1 – 10	5	22	0	0	0	0
11 – 100	18	78	0	0	14	33
101 – 1000	0	0	0	0	28	67
Total	23	100	42	100	42	100

Addoet *al* (2009) researched into the quality of sachet water produced and sold in Teshie-Nungua suburbs of Accra, Ghana. They concluded that some of the sachet water being sold in Teshie and Nungua in Accra, Ghana and in the other suburbs of the city may be safe as far as bacteriological quality is concerned but a lot more of these products are unsafe for drinking.

Okioga (2005) researched into the water quality and business aspects of sachet-vended water in Tamale. The research considered both hand-tied water and factory-produced water. The results showed that Ninety three per cent of the hand-tied sachet water and 20% of factory-produced sachet water had turbidities greater than the limit set by the GSB (1998) of 5 NTU. The maximum turbidity limit that the Ghana Water Company aims to achieve for water treated at the Dalun Water Treatment Plant is 0-2 NTU, while the average actually achieved is 3 NTU.

Also all samples of hand-tied sachet water had either *E.coli*, total coliform, or both in at least one test. Forty seven per cent of the factory-produced sachet water had total coliforms that ranged from 1 CFU/100ml to 115 CFU/100ml. With the 3M™ Petrifilm™ test, all samples of the factory-produced sachet-water had no *E.coli* and only one sample had total coliforms with 100 CFU/100ml. The hand-tied sachet-water sample with 49 *E.coli* CFU/100ml in the MF test had 100 CFU/100ml with the 3M™ Petrifilm™ test. Forty seven per cent of the hand-tied sachet-water samples had total coliform that ranged from 100 CFU/100ml to 2300 CFU/100ml.

Study Area and Research Methodology

Study Area

The New Juaben Municipality was used as the study area. Koforidua serves as the administrative seat of both the Eastern Region of Ghana and the New Juaben Municipality. According to Census 2000 conducted by the Ghana Statistical Services, the population of the Metropolis is around 87315. Some suburbs of Koforidua Metropolis include Srodæ, Adweso, Effiduase, Densuagya, Betom, etc.

The occupations of the economically active population in the Metropolis include Agriculture and its related activities, Sales and Promotions, Professional and Technical works, Transportation, etc. With the levels of activity, there is the need for water to quench thirst and keep activities going on. Some institutions within the Metropolis include the Ghana Standards Board, the Department of Urban Roads, Ghana Water Company Limited, Community Water and Sanitation, Koforidua Polytechnic, All Nations University College, etc.

Research Method

To achieve the aim and objectives of the research, the research team used the following research methods. Literatures on research works done on water quality and sachet water were reviewed. A market survey was conducted across the municipality to ascertain the brands being used and to aid sampling.

Thirty-eight brands were encountered but twenty (20) brands of sachet water were sampled from vendors using ice-packs and cooler bags. The samples were transported to the laboratory for testing. Three packs were taken for each brand making a total of sixty (60) samples.

The brands samples are shown in the table 3.1 below

Table 0.1: List of Brands Sampled for Laboratory Analysis

Brand Name	Brand Name	Brand Name	Brand Name
Coolpac	Mineral Cool	VidiAquam	Clear
Mount Zion	Sparrow	Waves	Gift
Golden Souvenir	Standard	Casante	Mobile Water
SirCool	Adom	Aqua-in	Sayko-Fresh
Besta	Ice Pak	Better Choice	S. Global

The sampled water was tested for physico-chemical and bacteriological quality parameters such as turbidity, total suspended solids, pH, levels of microbes (*E.coli*, *Enteroviruses*, *thermo-tolerant organisms*) within each sample, at the Ghana Water Company Limited Laboratory at Koforidua. Membrane filtration method (MF) was used. The membrane filter has a pore size of 0.45 microns. These pores are small enough to filter out bacteria. The filter paper is then transferred to a Petri dish which contains a pad saturated with a medium. For this study, mColiBlue24® broth (ready-to-use broth sold in plastic ampules) was the media for coliform growth.

Data obtained from the field and the laboratory were analysed. This gave a basis for conclusions and recommendations drawn.

Results and Discussion

During the market surveys conducted within the New Juaben Municipality, it came to light that the hand-tied sachet water has almost faded out of the market and almost all the people interviewed prefer the factory-produced sachet water. Therefore the research concentrated on the factory-produced sachet water.

Three major sources of water were identified as being used in the production of sachet water. These are:

- Water from the Ghana Water Company Limited
- Hand-dug wells: Water found in the unsaturated zones of the groundwater systems.
- Mechanical boreholes. These have their source deeper into the saturated zones of the water table.

The sachet water production plants visited filtered the water and chlorinated it before bagging. Also the water is passed through ultra-violet rays to remove pathogenic organisms and ensure the safety of the consumers. The samples taken had the Ghana Standard Board (GSB) logo and Food and Drugs Board (FDB) numbers embossed on them.

Seventeen water quality parameters were assessed in the laboratory. The parameters are grouped into physico-chemical and bacteriological.

Physico-Chemical Parameters Analysed

Appearance: all the samples tested were clear in their appearance.

Taste and Odour: all the samples tested were of unobjectionable taste and odour.

Temperature: The temperatures of the samples were between 24.6 and 26.6⁰C. Since there are no guiding values, the temperature range was considered good for consumption.

Colour: thirty-five per cent of the samples tested had their colour ranging from 1.00 to 3.00 Pt.Co while sixty-five per cent had their colour within the range of 6.00 to 9.00 Pt.Co. The Ghana Standard for drinking water posits that the colour of drinking water should be between 0.00 to 15.00 Pt.Co. Therefore, the samples tested are of good quality as far as colour is involved.

The results are summarised in table 4.1 below:

Table 0.1: Colour of Samples

Number of Samples	Range of Values (Pt.Co)	Percentage (%)
7	1.00 - 3.00	35
13	6.00 - 9.00	65

Turbidity: the turbidity of eighty per cent of the samples tested was within the range of 0.45 to 0.96 NTU while twenty per cent were within the range of 1.00 to 1.22 NTU. The Ghana Standards put the turbidity of drinking water within a range

of 0.00 to 2.00 NTU. This indicates that the turbidity of the samples tested were within the approved range and therefore the samples were good for drinking as far as turbidity was related.

The results from the turbidity test on samples are shown in table 4.2 below:

Table 0.2: Turbidity of Samples

Number of Samples	Range of Values (NTU)	Percentage (%)
16	0.46 – 0.96	80
4	1.00 – 1.22	20

pH: all the samples were within the pH range of 6.50 to 7.30. The Ghana standard for drinking water stipulates that, the pH of drinking water should be between 6.5 and 8.5. This shows compliance with the set standards.

Conductivity: forty-five per cent of the samples gave conductivity range of 65.80-99.20 μ S/cm. Fifty-five per cent of the samples gave conductivities ranging between 102.5 and 121.00 μ S/cm. The Ghana standard for conductivity of drinking water is 1000.0 μ S/cm. This implies that the samples tested were good in relation to conductivity.

Total Suspended Solids: all the samples tested showed the absence of suspended solids. Even though the standard gave no guideline value as requirement, the samples recorded 0.00mg/l. Therefore the samples were good for drinking as far as total suspended solids are concerned.

Total Dissolved Solids: ten per cent of the samples gave values of total dissolved solids were within the ranges of 31.5 to 40.0 mg/l. The presence of total dissolved solids in fifty-five per cent of the samples was within a range of 44.5 to 49.0 mg/l. Twenty-five per cent of the samples had their total dissolved solids within a range of 53.0 to 58.8 mg/l while ten per cent gave values between 90.0 and 95.0. These values are below the Ghana standard value of 1000.0mg/l and therefore the samples are safe for use.

The results are summarised in table 4.3 below:

Table 0.3: Total Dissolved Solids of Samples

Number of Samples	Range of Values (mg/l)	Percentage (%)
2	31.50 – 40.00	10
11	44.60 – 48.90	55
5	53.00 – 58.80	25
2	90.00 – 95.00	10

Total Alkalinity (CaCO₃): thirty-five per cent of the samples gave alkalinity values within a range of 5.00 to 10.00mg/l while fifty-five per cent of the samples gave alkalinity values within a range of 10.00 to 15.00mg/l. However, ten per cent of the samples gave alkalinity values within a range of 15.00 to 20.00mg/l. The Ghana standards do not give a guideline value for the total alkalinity of drinking water but considering the range of values, the samples can be said to be safe for drinking. The results are summarised in table 4.4 below:

Table 0.4: Total Alkalinity of Samples

Number of Samples	Range of Values (mg/l)	Percentage (%)
7	5.00 – 10.00	35
11	10.00 – 15.00	55
2	15.00 – 20.00	10

Total hardness: the total hardness of the samples tested gave three ranges of results. These are shown in table 4.5 below:

Table 0.5: Total Hardness of Samples

Number of Samples	Range of Values	Percentage (%)
5	10.00 - 13.00	25
11	14.00 - 16.00	55
4	17.00 - 22.00	20

The Ghana standard for total hardness of drinking water ranges between 0-500mg/l. Therefore the samples were within the approved ranges and hence good for consumption considering their total hardness.

Manganese: the samples tested gave values between 0.00 – 0.20mg/l. The details are indicated in table 3.6 below:

Table 0.6: Manganese Content of Samples

Serial Number	Values	Percentage (%)
9	0.00	45
3	0.01	15
7	0.02	35
1	0.20	5

From table 5.8 above, 95% of the samples gave values between 0.00 to 0.02mg/l while 5% gave an extreme value of 0.20mg/l. The Ghana standard for the presence of manganese in drinking water is between 0.00 to 0.10mg/l. This indicates that the 5% of samples that gave values of 0.20mg/l are not safe for consumption.

Total iron: all the samples tested showed the presence of irons. The values were within a range of 0.00 to 0.05mg/l. The Ghana standard for the presence of irons in drinking water is 0.0 to 0.30mg/l. Therefore the samples are good for consumption.

Sulphate: the presence of sulphate in drinking water, according to the Ghana standard, should be 0 to 200mg/l. The results from the tests conducted on the samples are shown in table 4.7 below:

Table 0.7 Sulphate test on samples

Number of Samples	Values	Percentage (%)
4	0.00	20
3	0.01	15
11	0.02	55
2	0.20	10

From the results above, the sulphate content of samples were within the approved range and hence the samples are good for consumption.

Ammonium Nitrogen(NH₄-N): All the samples tested gave values within the range of 0.00 to 0.50mg/l. These values are within the Ghana standards for the presence of Ammonium Nitrogen(NH₄-N) in drinking water. The Ghana standard has 0.50mg/l to be the maximum value.

Nitrate Nitrogen (NO₃-N): the samples indicated the presence of Nitrate Nitrogen(NO₃-N). The range of values obtained was 0.00 to 0.50mg/l. The Ghana standard for the presence of Nitrate Nitrogen(NO₃-N) in drinking water is given as 0.00 to 50mg/l. This shows that the samples were within the allowable range of values and hence making them good for consumption.

Nitrite Nitrogen (NO₂-N): All the samples tested gave values within the range of 0.00 to 0.50mg/l. According to the Ghana standards for drinking water, the allowable range for the presence of Nitrite Nitrogen(NO₂-N) in drinking water is 0.00 – 3.00mg/l. Based on the results from the test on the presence of Nitrite Nitrogen(NO₂-N) and the guidelines used, the samples tested are good for consumption.

Bacteriological Parameters

Total Coliform Bacteria and Faecal Coliforms: all the samples tested showed the absence of total coliform bacteria and faecal coliforms. The Ghana standard recommends that there should be no coliform bacteria and faecal coliforms in water being used for drinking.

***E.coli* (thermo-tolerant coliforms):** all the samples indicated the absence of *E.coli* (thermo-tolerant coliforms) in them. This conforms to the Ghana standard for

drinking water, which stipulates that *E.coli* (thermo-tolerant coliforms) should be absent from drinking water.

Total heterotrophic bacteria: the results from the test on total heterotrophic bacteria are shown in table 4.8 below:

Table 0.8 Total Heterotrophic Bacteria

Number of Samples	Values(CFU/100ml)	Percentage (%)
12	0.00	60
3	1.00	15
4	2.00	20
1	4.00	5

The Ghana standards recommend that the total heterotrophic bacteria in drinking water should below 3.00CFU/100ml. This indicates that 5% of the samples are not safe for consumption.

Conclusion and Recommendation

Conclusion

Based on the results and discussions above, the following are the conclusions of the research team.

- 1) Factory-produced sachet water is a very essential component of the water distribution system of the municipality. This is explained by the fact that the research team encountered more than thirty different brands at various sections of the municipality.
- 2) The samples taken to the laboratory were operating within the Ghana standards for physico-chemical and bacteriological guidelines for drinking water.
- 3) All the brands encountered during the research had the GSB mark and FDB numbers embossed on them.

Recommendation

The following are the recommendations of the research team to ensure that safe water is consumed by all.

- 1) Regular monitoring of factory-produced sachet water on the market by the appropriate regulatory bodies is necessary to maintain the quality of bagged water and to protect the health of consumers.
- 2) Factory-produced water should be stored away from direct sunlight and in very hygienic conditions.
- 3) Sachet water vendors should ensure proper personal hygiene so that there is no contamination during the handling processes.
- 4) There is the need for regulatory and law enforcement agencies to enforce the laws that govern the operations of sachet water producing outfits.

- 5) It is necessary to educate consumers on the need to purchase water from manufacturers that have been licensed to produce water by the appropriate regulatory authorities.
- 6) Further research should be conducted on the contamination of the sachet water wrappers.

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ASSESSMENT OF THE GROUNDWATER POTENTIAL OF KOFORIDUA POLYTECHNIC CAMPUS

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Abstract

Water is a basic requirement of humans as well as animals. The major sources of water in our planet are the atmosphere, the ocean and within fractured rocks in the earth crust. Though about 70% of the earth's surface is covered with water, less than 3% account for the freshwater resources of the earth. About 97% of the earth's water is saline. The freshwater resources of the earth are locked up in icecaps, glaciers, icebergs, etc. in the arctic regions. Others can be found in the aquifers and rock fissures below the ground surface. This leaves about 0.4% of the earth's freshwater resources as the most easily accessible. The pollution of surface water bodies through human activities continues to deprive the earth of easily accessible water for the basic needs of humans and other animals. With groundwater being another water resource potential, it is expedient that a research be conducted into the means of harnessing of it. This research assessed the groundwater potential of Koforidua Polytechnic campus, located some points of expected high yields and made recommendations on best ways to exploit the groundwater resource available. The recommendations would help the Polytechnic to be self-sufficient in its water supply.

Keywords – groundwater, aquifer, fissures, saline water, freshwater.

Introduction

The major sources of water in our planet are the atmosphere, the ocean, within fractured rocks in the earth's crust, on land and within the soil. Movement of water molecules from one location to another is driven by the solar energy. Through the Hydrologic cycle, water is conserved – water is neither created nor destroyed. The rivers, streams and other sources of water, discharge into the sea.

Water covers about seventy percent (70%) of the earth's surface while the remainder is covered by land. Out of the rich water resources of the earth, about ninety-eight percent is saline water found in oceans, leaving the remainder as the only source of freshwater for the basic needs of humans (Kharagpur, 2008).

Though the ocean is the largest reservoir of water, its salinity renders the water within it not readily available for usage. This requires some level of treatment and purification before the saline water becomes accessible for human usage. Thus the

freshwater available for human (and animal) usage is a fraction of the total water available on the earth's surface.

Aim and Objectives

The aim of this project is to assess the groundwater potential of the Koforidua Polytechnic Campus. To achieve the set aim for this project, the following objectives have been outlined:

- 1) To determine the geological formations of the Koforidua Polytechnic Campus.
- 2) To ascertain the water table levels of the Koforidua Polytechnic Campus.
- 3) To determine the groundwater yields of the Koforidua Polytechnic Campus.
- 4) Make recommendations for harnessing the groundwater resources of the Koforidua Polytechnic Campus.

Problem Statement and Justification

The natural availability of freshwater is limited to about two percent (2%). Out of the two percent, about 74% is found in icecaps, icebergs and glaciers. About 25% of earth's freshwater resources are found in rock fractures below the ground surface (groundwater) leaving less than one percent for rivers, lakes, streams, soil moisture etc (Kharagpur, 2008).

Some human activities such as construction, farming, quarrying, sand winning, logging and the like have threatened the sources of major rivers and streams. Most of these water sources are exposed to the elements of the weather leading to drying in the dry season. Some major water bodies have been found out to dry up during the dry seasons (Inconvenient Truth, 2006).

Water in the subsurface occurs as part of the water profile, a section through the ground from the land surface to the rocks forming the geological basement (Figure 1). Water below the ground may be considered **subsurface water**, **interstitial water** or **vadose water** (SCCG, 2006).

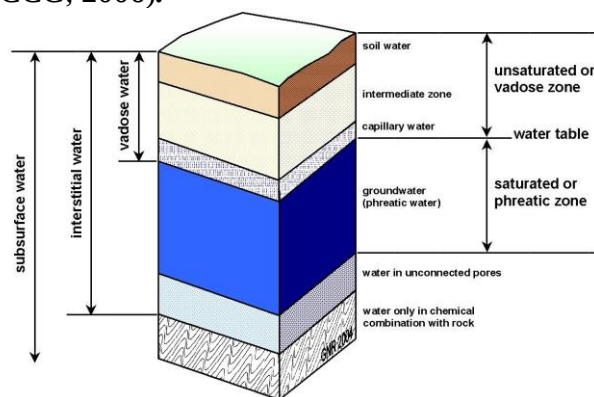


Figure 1: The water profile (modified from: Driscoll 1986, Domenico and Schwartz 1990)

Study Area and Research Methodology

Study Area

The student population of Koforidua Polytechnic as at the end of September, 2009 was around four thousand one hundred and fifty (4150) (Student Records) with the staff population being around four hundred and seventy (470). This makes the total population of the Koforidua Polytechnic stand around four thousand six hundred and twenty.

The Koforidua Polytechnic Campus covers a land area of about seventy-eight acres (78 acres). The campus is made up of the bungalows; accommodation facilities for some staff members, the GETFUND Hostel, the Administration Block and the Lecture theatres. The Polytechnic has three main schools. These are:

- ❖ School of Applied Sciences and Technology
- ❖ School of Business Management Studies and
- ❖ School of Engineering.

Research Method

To achieve the aim and objectives of this research, literature on works done by other researchers in the area groundwater studies were reviewed. This helped to ascertain the physical and groundwater conditions of Koforidua Polytechnic Campus. A visit was conducted round the Koforidua Polytechnic Campus with the aim of achieving the following:

- Identifying potential areas for groundwater exploitation
- Assessing the vegetation, soils and physiographical nature of the campus.
- Determine the predominant lineament directions.
- Identify suitable traverse orientations for geophysical investigations and thus selecting areas of preference.
- Noting waste dump sites, latrine sites, sacred areas, etc. and other potential groundwater pollution sources.
- Choosing appropriate geophysical investigation method to be used.

The Campus was demarcated into four zones to enhance the geophysical investigations. Geophysical investigations were done using Electrical Resistivity Profiling and the Vertical Electrical Sounding Methods.

Data obtained from the above methods were analysed. Conclusions and recommendations were outlined to help in harnessing the groundwater resources of Koforidua Polytechnic Campus.

Results and Discussion

The Hydrogeology of Koforidua Polytechnic Campus

Literatures reviewed indicated that the Koforidua Polytechnic Campus is mainly underlain by mainly the Pre-Cambrian formation. This formation involves the Akwapim-Togo Series. The Akwapim-Togo series consists of partly metamorphic and folded arenaceous, argillaceous sedimentary rocks made up of shale, phyllites, schists and quartzites.

A modified geological map of Ghana shown in figure 2 illustrates the hydrogeology of Koforidua and hence the Koforidua Polytechnic Campus.

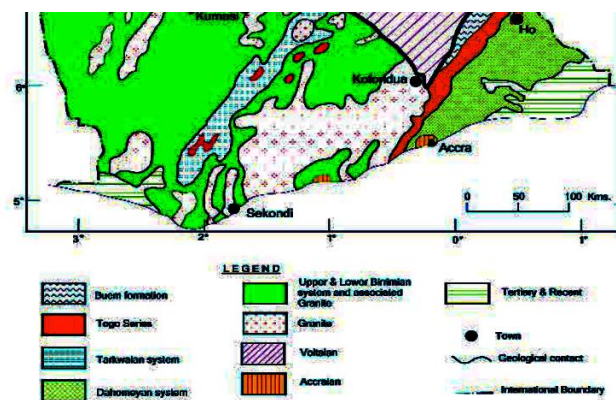


Figure 2: Modified Geological Map of Ghana

Groundwater Level of the Study Area

Seven profiling lines were run on three demarcated areas – Administration, Staff Bungalows and GETFUND. These lines were label A to G. Lines A and B were 250m long, Line C was 200m long, Line D was 160m long while Lines E, F and G were 200m long.

Line A showed two anomalies at 10m and 138m along the profile line. Line B had anomaly at 90m along the line while Line C had two anomalies at 40m and 80m along its lines. Lines D, E, F and G had anomalies at 40m, 70m, 150m and 180m respectively.

The range of resistivity of the various profile lines are illustrated in table 1 below –

Table 1: Resistivity of Profile Lines

LINE	20m Depth		40m Depth	
	Range (Ωm)	Average (Ωm)	Range (Ωm)	Average (Ωm)
A	95.20 – 265.20	180.20	337.59 – 988.02	662.81
B	57.80 – 285.60	171.70	167.81 – 746.96	457.39
C	31.37 – 275.40	153.57	53.96 – 856.35	455.16
D	82.73 – 262.93	172.83	111.87 – 971.16	541.52
E	60.07 – 214.20	137.14	120.29 – 589.75	355.02
F	14.47 – 607.46	360.97	342.54 – 1143.45	743.00
G	39.67 – 301.47	170.57	142.07 – 649.44	395.76

The resistivity figures above help in determining the anomaly points and the potential fracture zones.

The Dipole-Dipole method was used for the nine observed anomalies – A(10), A(140), B(90), C(40), C(80), D(40), E(70), F(150) and G(180). These identified anomalies were sounded.

To ensure data reliability, the results of Vertical Electric Sounding(VES) testing were plotted on the field. Values that appeared unrealistic were rejected and the sounding repeated at the same spot several times to achieve conformity with findings. The results from the VES show that the study area is underlain by diverse layer structure.

The anomalies selected for VES profiling as shown in table 2 below.

Table2: Anomaly points for VES profiling

PROFILE	ANOMALIES (m)
A	10, 140
B	90
C	40, 80
D	40
E	70
F	150
G	180

The fracture zones in the VES profiling are shown in table 3. Figures 3 and 4 show potential aquifer depth and depths for harnessing groundwater.

Table 3: Fracture Zones Resulting from VES

VES	FRACTURE ZONES (metres deep)
A10	20 – 30, 45, 70
A138	25 – 35, 40
B90	30,50
C42	20 – 45, 60
C82	20 – 35
D40	20 – 35, 50 – 70
E70	15 – 30, 35, 50 – 70
F150	15 – 25, 40 – 50
G180	16 – 25, 35, 50 – 70

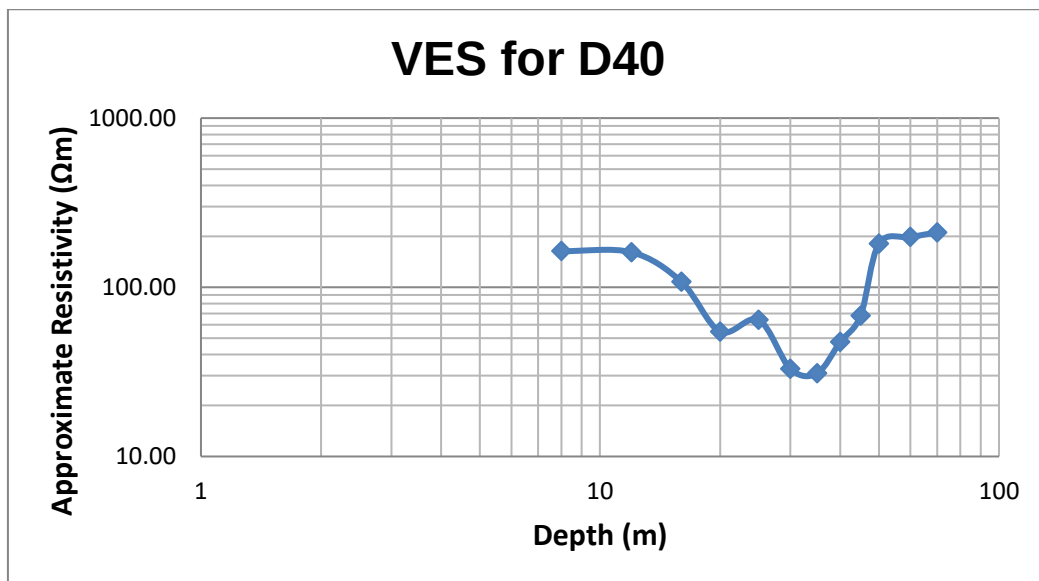


Figure 3: Potential Fracture Zones for D40

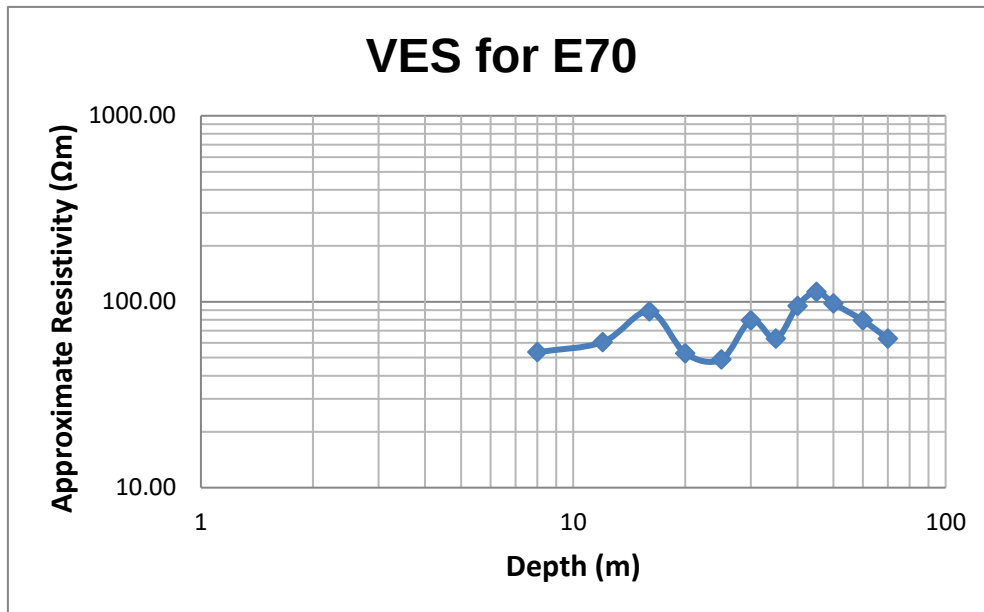


Figure 4: Potential Fracture Zones for E70

Groundwater Yields

Based on the results of the VES profiles above and the findings of Agyekum (2002) and WRI (2001), the study area has a good groundwater potential and the yields is estimated to be 0.7 – 24 M³/Hour.

Conclusions and Recommendations

Conclusions

From the results and discussions the following are the conclusions for the research:

1. The Koforidua Polytechnic Campus is underlain by Pre-Cambrian formation comprising mainly of the Akwapim-Togo Series. The Akwapim-Togo series consists of partly metamorphic and folded arenaceous, argillaceous sedimentary rocks made up of shale, phyllite, schist and quartzite.
2. The groundwater level of the study area ranges between 20m and 70m below the subsurface. The above range is based on a confidence level of ninety percent (90%).
3. The study area is part of a geological formation whose groundwater yield is potentially high and may range between 0.7 and 24m³/hour.

Recommendations

To ensure the harnessing of the groundwater potential of Koforidua Polytechnic Campus, the following are recommended:

1. The drilling of boreholes, testing of water quality and pumping rate. The recommended borehole drilling ranking is shown in table 4 below

Table 4: Ranking of Borehole Drilling Points

VES POINT	DRILL DEPTH (m)		GRID REFERENCE	RANK
	MIN	MAX		
A10	20	70	N06°03'49.5'' W000° 15'50.4''	9 TH
A138	25	70	N06°03'45.9'' W000° 15'45.9''	7 TH
B90	30	70	N06°03'45.3'' W000° 15'46.7''	6 TH
C42	20	70	N06°03'38.3'' W000° 15'50.9''	3 RD
C82	20	70	N06°03'38.0'' W000° 15'49.8''	5 TH
D40	20	70	N06°03'38.5'' W000° 15'49.5''	2 ND
E70	15	70	N06°03'41.5'' W000° 15'49.5''	1 ST
F150	15	70	N06°03'49.0'' W000° 15'57.3''	8 TH
G180	16	70	N06°03'49.5'' W000° 15'52.0''	4 TH

2. There is the need to design a comprehensive groundwater resource utilization system for the polytechnic.
3. The groundwater quality and level must be monitored.

Acknowledgement

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EXAMINING THE RESIT EXAMS PROCESS AS A QUALITY CONTROL MEASURE IN POLYTECHNIC EDUCATION IN GHANA: A CASE STUDY OF KOFORIDUA POLYTECHNIC

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Abstract

A fundamental process of quality assurance regarding the knowledge and skill levels in higher education is examinations, and resit examinations are an avenue for students who failed a course to demonstrate that they have attained the required capabilities. Thus, it is expected that the Polytechnics will pay attention to the process leading up to resit examinations as a way ensuring that acceptable standards of knowledge, skills, education and scholarship, are being met, maintained, and enhanced - quality control. The study is designed to examine how the resit examination processes empower students with improved knowledge and determine what significant difference lecturers and resit students themselves feel about their knowledge levels between main semester and resit exams. Key informant interviews with the relevant administrators, and separate sets of questionnaires administered to samples of lecturers, and resit students at the Koforidua Polytechnic were the means of data collection. The paper concludes that the current processes of preparing students and conducting resit examinations do not provide opportunity to the students to acquire the requisite knowledge in the courses they failed. However, the study reveals that while students perceive significant difference in knowledge levels between time of main exams sitting and resitting, the lecturers perceive otherwise. The study recommends a new approach to resit exams that recognizes individual differences in learning and a process of preparation, facilitation, counseling, and management of the resit process that enhances the quality of knowledge gained by participants.

Introduction

Background Information

Tertiary education plays a critical capacity building and professional training role in socio-economic and political development in Sub-Sahara African countries. Indeed, research findings show that expanding tertiary education may promote faster technological advancement and improve a country's ability to maximize its economic output (Bloom, Canning, and Chan 2006). In view of the significance of tertiary education, it is important to focus attention on quality assurance as a critical factor to ensuring its relevance to the country's development needs. There are many reasons why the issue of quality assurance in higher education is gaining grounds in Sub-Saharan African countries including Ghana. These include the growth in

enrolment rates amidst declining budgets, the proliferation of private provision of higher education, and pressure from a rapidly transforming labour market (Materu, 2007).

Examinations, as tools of assessment of knowledge, are quality assurance measures to ensure that knowledge acquired in taking a prescribed course of study over a specific period is standardized. Examinations are a phenomenon in many higher education institutions in Africa and Ghana. Incidentally, when examinations are used to measure the knowledge level of students, some students are known to fall short of the standard measure. How these students are prepared to upgrade their knowledge and fall in line with the standard requirements must be considered an essential quality issue in education.

One factor about examinations worth considering, which even has implication for examination malpractices but largely ignored because it affects minority of students is the conduct of re-sit examinations for students who happen to fail on the first attempt. It may be clear that what happens to a student due for examinations re-sit has implications for the whole examinations process and quality of students finally produced because, the feeling of inferiority complex to which a student that fails examinations is subjected to in the school, at home and in society at large would make the student to go any length to pass the examinations (www.socyberty.com/education/exam-malpractices-in-educational-institutions-in-nigerian-implication-for-the-counselor accessed 24/05/10).

Examinations serve the very important functions of testing, assessing, evaluation, and certification, and the desire to pass at all cost may abate if students are aware of credible opportunities that exist that help them achieve their educational objectives even after failing the main examinations. Meanwhile, examinations resit which gives opportunity for students who have failed their courses to make amends continue to present education with dilemma. The number of students involved is generally a small percentage of the total, but it is precisely these students that institutions bear a heavy responsibility to ensure they reach sufficiently high standards of performance and are accurately assessed. These students must be given the opportunity to reach the appropriate standards thereby ensuring overall quality education and protecting the public from incompetent graduates.

This creates a delicate balance for institutions since resits present additional financial and logistical burden. Even universities in developed countries including Durham, Oxford and Cambridge seem to have problems with organizing resits and the Edinburgh University Vice President in charge of learning and teaching, Simon Van Heyden stated that he is in favour of decreasing the number of resits or abolishing them completely because ‘we don’t give those students who fail their

courses much additional guidance with their resits over the summer and it is incredibly difficult to do so but these are the students who are most in need' (www.guardian.co.uk/education accessed on 29/3/11). In the same discussion, Ruth Cameron, the president of the Edinburgh University Student's Association sums it up when she states that 'this issue's been bubbling for quite sometime. Our worry is that resits aren't just there for people who fail for the first time, but for others who have been ill or had family problems and haven't been able to sit them'.

In Ghana, the emergence of polytechnics on the landscape of the higher educational sector is due to a deliberate public policy to create higher learning institutions that focus on skills development (Polytechnics Act, ACT 745, 2007) which calls for competence-based curricular, structure, and systems in pursuit of creating a hands-on corps of human resources for industry and society. However, it is not enough to create systems and structures to provide higher education to a mass of people, but it is equally important that the process creates high quality products in terms of knowledge, values, and skills. It is also important to produce individuals ready to ensure high performance wherever and whenever they are called upon. Thus, examination is a main criterion for progression from one level to the other and for certification. Even as official documents made reference to resits (Koforidua Polytechnic, Students' Examination Guide, 2009), they do not spell out the resit procedure to ensure that the desired standards of knowledge are obtained and aptly tested.

The study is designed to examine whether there exist any significant interventions in the the resit examination processes that empower students with improved knowledge as a quality control measure.

Statement of Problem

Polytechnic education is for skills development. This implies that students should grasp basic knowledge and ideas well and apply them in real life situations as required. Thus, failure in examinations is an indication that the necessary knowledge and skills have not been attained. Resit examinations are an avenue for students to demonstrate that they have attained the required capabilities. The resit process is thus a quality control measure in Polytechnic education. Thus, it is expected that the Polytechnics will pay attention to the processes to include significant interventions leading up to resit examinations and administering such examinations as a way of ensuring that acceptable standards of knowledge, skills, education and scholarship, are being met, maintained, and enhanced - quality control.

It has however been observed that the resit processes in Ghanaian Polytechnics are not well structured and short of appropriate interventions, and therefore do not necessarily give the students' opportunity to acquire and display an improved level

of knowledge. It appears students also take the resit examinations for granted and expect to pass irrespective of any knowledge deficiencies. This situation may detract from the quality of graduates produced by the Polytechnic and lead to ill-prepared graduates being passed onto the labour market.

This study uses the Koforidua Polytechnic as a case to investigate the process and management of the resit examinations with regards to its true worth as an instrument of ensuring that acceptable standards of knowledge, skills, education and scholarship, are being met, maintained, and enhanced.

Objectives

To assess the extent to which the systems and processes for preparing the students and administering resit examinations serve as quality control measure in the Koforidua Polytechnic.

To examine lecturers' and resit students' perceptions about the resit examinations as a quality control measure.

Operational Definition of Terms

- In the context of this paper, resit exams as a quality control measure is the extent to which acceptable standards of knowledge, skills, education and scholarship, are being met, maintained, and enhanced by resit exams.
- The lecturers and students perceptions were measured in terms of:
 - a) adequacy of preparations for resit students (including interventions like counseling, special tuition, timely information, proper scheduling of exams)
 - b) adequacy of processes of resit exams
 - c) resit students levels of knowledge in courses at the time of writing the main examination and at the time of writing the resit examinations.

Literature Review

Examinations as a Factor in Quality Assurance in Education

The Oxford Advanced Learner's Dictionary of current English (2000) defines quality as the degree of excellence and degree of conformity with standards. According to experts, a broad range of factors affect the quality of tertiary education, including their vision and goals, talent and expertise of teaching staff, admission standards, assessment standards, teaching and learning environment, employability of its graduates(relevance to the labor market), the quality of library and laboratories, management effectiveness, governance and leadership (Materu, 2007). The three main approaches to quality assurance in higher education are accreditation, assessment, and audit, where both accreditation and assessment

monitor the quality of teaching and learning, while audit focuses on internal procedures adopted by higher education institutions in order to achieve objectives (Kis, 2005).

The Concept of Examinations

The Oxford Advanced Learner's Dictionary (1995) defines examination as a formal test of somebody's knowledge or ability in a particular subject, especially by means of written questions or practical exercises. This means that an examination is a process of obtaining measurable information about knowledge, skills and aptitude of an individual.

Administration of Examinations

For quality purposes, how examinations are administered and conducted determines how accurate the levels of knowledge, skills, and aptitudes are measured for corrective actions to be taken when needed. The integrity of academic program and examination process is central to quality. A thorough procedure of course development and examination must be ensured. There is the need for a rigorously controlled examination system with clear published procedures within a context of impartiality and confidentiality. It is known that the administration of examinations is an exercise which requires logistics, personnel, and financial outlay. Regarding the processes involved in the actual measurement of knowledge, Ibara (2008) outlines a model used at the National Open University of Nigeria which includes the following successive stages: test development, test administration, post-test administration/award or resit procedures. This model suffices for the conduct and administration of examinations in most higher education institutions in Sub-Sahara Africa.

Resit examinations

In the knowledge acquisition process, there is enough literature to indicate that there are differences in the intellectual capabilities of individuals and this is expressed in the differences in scores obtained by different individuals when results are released. Ormrod, (2008) attributes some of these factors to the fact that some students have average or above average IQ but some have specific deficiencies, may have difficulty sustaining attention, have poor reading skills, have ineffective learning/memory strategies, have difficulty with tasks involving abstract reasoning, have low motivation/poor self-concept, have poor motor skills (not always), have poor social skills (not always). According to Ormrod (2008) there are many limitations to intelligence tests which include the fact that different kinds of intelligence tests may yield different scores, students' performance is affected by many *temporary* factors (such as general health, mood, fatigue, etc), test items typically reflect skills valued in mainstream Western culture, unfamiliarity with the

content or types of tasks in particular test items may yield poor performance, students with limited English proficiency are at a disadvantage, some students may not be motivated to perform at their best and so may obtain scores that underestimate their abilities. According to Vickers (2010):

Scan an undergraduate lecture hall at any U.S. college or university, and odds are that two out of every 100 students there will have Attention Deficit Disorder (ADD), Attention Deficit Hyperactivity Disorder (ADHD), or another learning disability such as dyslexia. These students are entitled to ask for special academic treatment under federal disability law. Such "accommodation" can include extra time to take exams, alternative exam formats such as oral or take-home, and classroom assistance such as the help of a note taker.

Even in the Ghanaian environment, it may be possible for college students to suffer these learning disabilities which remain largely undiagnosed. Some students may also suffer from limitations of intelligence and knowledge testing. Some students may suffer from limited proficiency in the English language among others and as a result, some students largely a minority of students, actually fail to obtain the required scores to pass the exams. This indicates a deficit of required knowledge.

The focus of this study is the level of attention given to these students and its effect on the overall quality of knowledge obtained by the respective students as qualified graduates. A lot more attention may be devoted to these students in preparing them through extra tuition, counseling, support, activities to encourage a healthy understanding of the course to enable them pass. Indeed several strategies exists for accommodating students' differing abilities and disabilities within educational context. These include but not limited to obtaining as much information as possible about each student, individualizing instruction for nondisabled students as well as for those with disabilities, being flexible in approaches to instruction, holding the same expectations for students with disabilities as for other students, identifying and teaching important prerequisite skills, consulting and collaborating with specialists, including students in planning and decision making, promoting interaction between all students, being alert to identify students who may qualify for special services (Ormrod, 2008). This may suggest that for quality assurance of its products, the Polytechnics may have to begin making provisions for students with certain disabilities.

Methodology

The mixed-method approach was used for the study i.e. both qualitative and quantitative data were obtained and analyzed. The work is a descriptive cross-sectional study conducted using mainly the survey design that allowed for questioning of a large number of elements that fall into the respective populations. Also, documentary analysis was used to validate data collected from the survey

sources. At the broad level the population of the study comprises all staff (teaching and administrative involved in resit examinations) and students (who have ever written resit examinations) of Koforidua Polytechnics. Specifically, the study had a heterogeneous population consisting of: All students currently in school who have ever taken resit examinations, All teaching staff, All academic deans and heads of departments, All administrative staff in the academic and examinations sections. In view of the heterogeneous nature of the population, and the different information needs relating to the different objectives of the study, different samples were drawn from the different groups in the population. The purposive and convenience sampling methods were used in selecting samples for the groups. The samples were drawn from the various sub-groups in the populations as follows: Using convenience sampling, a sample size of 100 was drawn from resit student's population to be surveyed with an appropriate questionnaire. A sample size of 50 was drawn from the total population of 147 teaching staff to be surveyed with an appropriate set of questionnaire. Out of the 100 questionnaires given out to the students only 88 were retrieved from the students and 47 out of the 50 given to the lecturers were retrieved. The analysis is therefore based on the retrieved questionnaires. Another sample of 10 was drawn from the total population of 20 academic deans and heads of department to be surveyed with an interview schedule relating to the management processes of the resit examinations. The purposive sampling method was however, used to select a sample of 2 from the administrative class as key informants on the processes and systems of the conduct of resit examinations i.e. The head of the examinations department and the deputy registrar: academic. Data was gathered from primary and secondary sources. Relevant secondary data on resit examinations were obtained and examined. Administrative Records, Student Records, Examinations records were examined to determine the proportion of resit students to total student population in the Koforidua Polytechnic over a three year period of 2007 to 2010 academic years. The Koforidua Polytechnic Students Examination Guide, NABPTEX Students Guide were also used as a data source. For the primary data, different sets of questionnaires were used to gather relevant data from the resit students and lecturers. Both open and close ended question were used. The questionnaires were self-administered to the groups because the respondents could read and write and are knowledgeable of the subject matter and could answer the questions unaided. An interview schedule was used to gather relevant data from deans and heads of department because in-depth data was required about the resit management process. An interview schedule was also used to collect in-depth data from head of the examinations department and the Deputy Registrar in charge of Academic Division. Both qualitative and quantitative data was obtained for the study. Data obtained from the in-depth interviews was analysed using the content analysis and logical analysis. Data obtained from the questionnaires were edited, coded and presented in appropriate tables.

Results and Discussion

Systems and Processes of Preparing Resit Students and Administering Resit Examinations as Quality Control Measure

Objectives for resit exams in Koforidua Polytechnic

To assess the resit systems and processes, it was necessary to determine the objectives for the conduct of resit examinations. Data obtained in interviews with the Deputy Registrar /Academic, the Head of Examination, the Deans, and Heads of Department at the Koforidua Polytechnic regarding the objectives for the conduct of the resit examinations is summarized below:

- To give the opportunity to students who trailed in the main semester examinations to redeem themselves before they can be certificated.
- To give students the opportunity to pass subjects they failed
- To ensure that academic records of the students are updated as and when resit results are due.

The data suggest that the resit is essentially an opportunity for the students to obtain the necessary passes for certification. The Oxford Advanced Learner's Dictionary (1995) defines examination as a formal test of somebody's knowledge or ability in a particular subject, especially by means of written questions or practical exercises. The issue about knowledge with regards to the resit objectives for the Koforidua Polytechnic, though implied, does not come out explicitly clear. For the resit exams to be seen as an opportunity for students to redeem themselves and get certificated without regard to the value of resit process as a knowledge enhancement process has implications for how the resit exams are administered in terms of what preparation goes into boosting the knowledge levels of the students. This analysis is important especially because from the survey of students and lecturers, it was clear that certain factors which detracted from knowledge acquisition were responsible for the failures. These include:

- Inadequate preparation(not regular in class, not enough studies, learning strategies)
- Lecturer factors(not regular in class, did not teach to understanding)
- Course factors(difficult, don't understand, weak course background, inability to obtain course handout)
- Examination factors(deviated, tension)
- Personal problems (loss of relatives, financial, health, pressure of combining other duties with education, family stress)

Systems of Conducting Resit Examinations

Between 2007- 2010, there have been changes in the system of conducting resit depending on whether the Koforidua Polytechnic or the NABPTEX examination handbook is of effect as follows:

- Before 2008/09 academic year, the National Board for Professional and Technician Examinations (NABTEX) handbook, Student Guide to HND Examinations in Ghana (2006) was in use and provides that **there shall be one resit at the end of every academic year and for a student to qualify for a resit examination, he/she should have taken the main semester examination during the academic year.** The NAPTEX handbook further provides that a student who trails more than four (4) courses after taking the resit examinations at the end of the academic year shall repeat the whole academic year. This regulation was operationalised as follows: a student obtains main semester exams results for 1st and 2nd Semesters, the next academic year resumes, affected students are informed of resit dates, students register, students prepare, and students resit. Within this process, students sometimes have to forego normal lectures to attend to resit exams.
- For the 2008/09 and 2009/10 academic year, the Koforidua Polytechnic Students' Examinations Guide(2009) came into effect, and states that there shall be no resit examinations and any student who fails/trails in a particular course shall register for that course for that semester the following year and sit for all exams associated with it, including continuous assessment. This regulation was operationalised as follows: students obtains results for 1st and 2nd Semesters, next academic year resumes , students attend normal lectures and lectures for papers trailed, Students take quizzes, class test, and midsem exams for normal courses as well as resit courses, students register normal courses and resit courses for end of semester examinations, student writes normal courses and resit courses at the main semester examinations. When clashes in timetable occur, students are quarantined to write one in the morning and the other in the afternoon.

The implication is that a resit student, apart from the normal lectures, had to participate in the lectures of the course he/she had failed and in most cases the time table was not synchronized to allow the resit students to join the lectures of courses trailed. A student who was weak enough to fail papers for one semester now doubles the workload in subsequent semesters.

- After 2009/10 academic year, the NABPTEX handbook came back into use and the system operates as it was before 2008/09 i.e student obtains main semester exams for 1st and 2nd Semesters, next academic year resumes, affected students are informed of resit dates, students register, students prepares, students resit, student receives resit exams results.

These changes and counter changes may be explained by the fact that it is because there is no laid down processes backed by law for the conduct of resit. The

institution does not know what to do with resit students and this manifests itself in how the resit exams are administered. The provisions as outlined in the systems of managing resit in the Koforidua Polytechnic may appear to be inadequate in preparing students to acquire more knowledge before the examinations.

Both systems run the resit process concurrently with ongoing semester. Some students have to miss lectures so as to be able to write the resit papers. Even when the resit are written separately from the main exams, the scheduling of the time table is such that some students have to write more than one paper to write at a time and so such students are quarantined to write one paper in the morning and another in the afternoon.

Administration of the resit exams

The administrators indicated the following about the administration of resit exams in the Koforidua Polytechnic:

- Objectives for the conduct of the resit examinations are hardly achieved because the exams ambience is not the same as the main end of semester exams.
- Much seriousness is not attached to the conduct of resit exams.
- It is always difficult to retrieve questions from lecturers and academic departments do not present resit exam results to the academic board for consideration.
- Resit exams questions do not also go for moderation.
- In addition, deadline for the submission of resit exams is not on the academic calendar and according to the administrators this might be an oversight.
- The administrators indicated that resit exams questions are not sent for moderation because it is not a NABPTEX requirement.
- They administrators indicated further that although for the main exams, lecturers are sanctioned for late submission of questions and marked scripts, it is not the case in resit examinations
- In addition, marked scripts of resit exams are not vetted as it is in the main examination.

Resit Records

The study sought to find out the proportion of resit students to total student populations per semester for the period 2007-2010 academic years but these records were not collated and compiled and therefore not readily available at the

- Polytechnic level ,
- School or Faculty level, and
- Departmental level.

As part of post-examination activities, it is necessary to compile statistical reports regarding examination trends, e.g. pass rates, failure rates, and malpractice rates

among others, as feedback mechanism for management decision regarding academic activities.

Processes of preparing resit students for their resit

All the lecturers, students and the administrators said there are no officially structured processes in place for preparing the students. Specifically:

- According to the administrators, this is so because the Academic Board is yet to establish any process and that, it is not a directive from NABPTEx yet.
- When the students were asked how the Polytechnic helped them in preparing for the resit examinations to improve their knowledge before the resit examinations, all the respondents (100%) indicated they received no help from the Polytechnic in preparing for the examinations.
- To another question as to how they prepared for the resit examinations, the students stated such issues as (i) their own self-determination through efforts to attend lectures of courses they had failed (ii) support from friends, and (iii) the benevolence of some lecturers.
- Specifically, when the students were asked if after they failed their main examinations, they were given any special tuition by Polytechnic, or counseling by the Polytechnic, in each case, all respondents (100%) indicated that the Polytechnic did not offer special tuition nor counseling related to the trials, although majority of the lecturers (83%) of the lecturers had the opinion that the students needed special attention in the form of extra teaching (tuition) for the resit exams, counseling, and user friendly course handouts (modules). However a minority of lecturers (17%) are of the opinion that any special attention to the resit students will amount to encouraging students to fail.
- As to whether the resit students receive clear instructions on how to go about the resit, the table below presents the responses:

Table 1: Clear instructions to resit students

Response	Frequency	Percentage
Yes	34	39
No	54	61
Total	88	100

Source: survey data 2010

Majority of students (61%) stated that they do not even receive clear instructions on how to proceed with the resit process.

- Regarding how lecturers prepare students for resit, while 11% either did not give a response or indicated they do not have a hand in preparing students, (79%) indicated that they prepare students by giving them 'areas', asking

students to read their notes well or join ongoing classes. One lecturer, constituting (2%) indicated that on his own, he/she organizes short lectures for the students.

- It can be adduced from the above that, there are no significant interventions from the lecturers nor administrators to enable the students acquire additional knowledge in the courses they trailed. Since majority of the lecturers give the resit students the critical “areas” to study for the exams, it may be that the students passed the exams not due to improved understanding of the course failed but due to selective learning just to redeem themselves and get certificated.

It can therefore be concluded that the current the process of preparing resit students and manner of conduct of the resit exams from the period of the release of the main semester results to the time of writing the resit exams in no way will ensure acceptable standards of knowledge, skills, education and scholarship, are being met, maintained, and enhanced.. It is clear that both systems and processes do not make provisions for appropriate interventions like counseling, special tuition, special attention. The administration of resit exams also does not follow the stringent measures of of the main exams that could affect the quality of the exams.

Resit Exams as Quality Control Measure: Students’ Perception

A critical factor in the quality of education delivered by the Polytechnics is the amount of knowledge and skills acquired by its students and graduates to enable them make necessary contributions in the relevant fields of study. A key objective of this study is to determine whether by the acts of commission or omission in the management of the resit process, the required knowledge levels are acquired by the resit students as perceived by the resit students and their lecturers.

It must be noted that the actual examination scores at the main examinations and resit examinations are the current existing indicator as to whether a student has acquired the needed level of knowledge. Within this reasoning, once a student passed at the resits, then the student is taken as having acquired the needed level of knowledge by virtue of the increased scores. But this study was designed to go beyond what is already known and to explore how the actors themselves perceive knowledge in the subject regarding the main examinations and resit examinations because other factors including the processes of managing the exams which have already discussed as not adequate can affect the use of examination scores as a true measure of knowledge.

With the following hypothesis to guide the researchers,

H_0 : There is no significant difference in the students' perception of their level of knowledge at main exams to that of the resit exams.

H_a : There is a significant difference in the students' perception of their level of knowledge at main exams to that of the resit exams.

To examine whether there is any significant difference between students' perception about their level of knowledge in the course they failed at the time of writing the main examination and at the time of writing the resit examinations, resit students were given a scale of 1 (Very Low) to 10 (Very High) to rate their perceived knowledge level at each point.

It was possible to classify the rated data into categories of students who rated perceptions of level of knowledge by resit examinations time as improved, same, or even lower. The table below summarizes the categories:

Table 2: Categories of Ratings of perception of level of knowledge at main and resit exams

Category/Perception	Frequency	Relative Frequency
1.Improved level of knowledge	56	63.7
2. Same level of knowledge	11	12.5
3. Lower level of knowledge	12	13.6
4. Non- response	9	10.2
Total	88	100

Source: survey data 2010

Clearly, a majority of students (63%) perceived an improved level of knowledge between main and resit exams. This is an indication that the resit process, if well administered can improve knowledge.

The fundamental question for this study is 'Is there a significant difference between perceived levels of knowledge in course at the time of main exams and resit exams?'

The student's **t-test** was used for analysis as shown below:

Table 3: Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	During main exams	5.59	79	1.871	.210
	During resit exams	6.67	79	2.043	.230

Source: survey data 2010

Table 7 shows that the mean of the perception level of students during main exams is 5.59 whilst that of during resit is 6.67.

Table 4: Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	During main exams & During resit exams	79	.505	.000

Source: survey data 2010

Table 8 which shows the correlation between the perception at main exams and at resit exams report that there is a fair positive relation between the two exams. The researchers therefore wanted to find out whether this fair positive correlation or relationship between the two exams is significant. The result is presented below.

Table 5: Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	During main exams - During resit exams	-1.076	1.953	.220	-1.513	-.638	-4.896	78	.001

Source: survey data 2010

The above was used to test whether there have been significant difference in the perception of students of level of knowledge at main exams and at resit exams.

Table 9 reports a p – value of 0.001. Since the p – value of $0.001 < 0.05$ we reject the null hypothesis which states that there is no significant difference in the perception of the level of knowledge at main exams to that of the resit exams and conclude that indeed there is a significant difference in the perception level of knowledge of the students at main exams to that of the resit exams.

Resit Exams as Quality Control Measure: Lecturers Perceptions

This finding is interesting if viewed against the lecturers' perspective on whether the resit exams are a source of significant knowledge improvements to the resit students. To the question as to whether the resit students display higher level of requisite knowledge compared to the main exams, the table below presents the summary of responses:

Table 6: Display of Higher Level of Knowledge at Resits Compared To the Main Exams

Response	Frequency	Percentage
Yes	7	15
No	33	70
sometimes	7	15
	47	100

Source: survey data 2010

These responses clearly indicate that as many as 85% of lecturers may not agree that the resit students have gained improvements in knowledge by the resit process. This position seems to contradict what the students believe. This discrepancy is very significant for the quality of students the Polytechnics produce. Lecturers are significant stakeholders in Polytechnic education and especially in academic matters. Lecturers play major roles regarding issues about test development, test administration and post-test administration activities. The resit exams are a major post-test activity which revolve around the lecturers (set and mark questions) and resit students.

Directly, when the lecturers were asked “Does the resit opportunity equip students with the necessary improved knowledge?” The response was an emphatic “No” as indicated in the table below:

Table 7: Lecturer responses on whether resit exams equipping students with the requisite improved knowledge

Response	Frequency	Percentage
Yes	11	23
no	36	77
	47	100

Source: survey data 2010

These responses confirm the fact that 77% of lecturers do not think that the current resit process equips students with the necessary improved knowledge. Indeed, 60% of lecturers do not think that resit students even take the resit exams seriously when the lecturers were asked ‘Do you think students take the resit exams seriously?’. Clearly, the lecturers believe the students do not even take the resit examinations seriously. And when asked the key question as to whether in their view, students pass the resit examinations as a result of improved knowledge, an emphatic 78% do

not think students have improved knowledge in the subjects by the resit exams. As many as 64% lecturers believed the resit students receive assistance in the form of “areas” and other special dispensations to pass the resit. It is thus possible, some resit students pass exams on “humanitarian grounds”.

To the question as to whether the resit exams questions are significantly different from the main exams questions. The table below summarizes the responses.

Table 8: Lecturer’s responses as to whether Significant Difference between Main Exams Questions and the Resit Exams Questions

Response	Frequency	Percentage
Yes	7	15
No	39	83
Non response	1	3
	47	100

Source: survey data 2010

Conclusions

- Resit objectives are unclear and not explicit about knowledge acquisition leading to less emphasis on upgrading knowledge of students and administering resit exams as a quality control measure.
- It can be adduced from the above that, there are no significant interventions from the lecturers nor administrators to enable the students acquire additional knowledge in the courses they trailed acceptable standards of knowledge, skills, education and scholarship, are being met, maintained, and enhanced. That is the process of preparing resit students and manner of conduct of the resit exams in no way will ensure acceptable standards of knowledge, skills, education and scholarship, are being met, maintained, and enhanced.
- The fact that students perceived improvements in knowledge levels at resit indicates that resit exams if given the necessary attentions and appropriate interventions can be an avenue for improving knowledge of students. This could stop students from getting desperate to pass exams and may reduce exams malpractices.
- Lecturers help students to pass resit exams by maintaining similar questions as the main exams and giving “areas” and may be softer in marking. Clearly some students pass resit exams on humanitarian grounds which compromises quality of graduates.

- Resit exams have not served as effective quality control measures in the Koforidua Polytechnic in terms of resit exams equipping students with improved

Recommendations

Based on the findings made and conclusions drawn, the following recommendations are made on the basis that the Polytechnics have a mandate which is slightly different in focus from the traditional universities and they must develop unique solutions to carry out the mandate of providing tertiary education geared at skill development. Resit examinations must be considered as a critical factor in quality of education offered by the Polytechnics and any acts of commission or omission which sends unprepared graduates to the labour market may cause damage to Polytechnic education. Accordingly, the following specific recommendations are to be considered in relation to the data presented and analysed:

- The objectives for the conduct of resit examinations in the Koforidua Polytechnic needs to be refined and explicitly linked to improvements in knowledge and skills of students who failed courses at the main exams. All stakeholders should be updated on the objectives for organising resit examinations, which should be to help the weaker students improve and perhaps catch up with their colleagues. With this focus, special lectures, and counselling sessions should be organised for the resit students to help them move up. Enough information and instructions should be passed on to students in this regard.
- There should be some seriousness towards the conduct of resit examinations by the Polytechnic in areas such as time-table preparation, recruitment of invigilators and training, notification/advertisement of exam dates, supply of materials, discussion of resit results at the Academic Board Meeting among others. Resit writing should be organised in a serious mode just as in the main examinations. Additionally, students and in fact all those involved should be made aware that the resit is not just a formality. The Polytechnic should develop standard guidelines for administering resit exams.
- It will be helpful for the Polytechnics to keep records at all levels and over the periods of all examination related activities to perform trend studies for appropriate management decisions.
- Resit examinations should be scheduled and conducted in the long vacation to enable students find time to revise their course materials.

- Referred students must be tactfully handled and not treated as block headed since factors contributing to failing in exams are many. There should be an identification of students' area of weakness or the possible underlying reason accounting for the failure. This can best be done during counselling sessions for them. The Polytechnic may consider identifying students with learning disabilities for special assistance.
- A special fee paying 'classes' should be organised for the affected and the examination should be conducted as early as possible preferably during the long vacation or at the beginning of the semester. Part of the proceeds from the fees paid should be used to adequately remunerate those who offer counselling to resit students; those who offer tuition and set resit questions and mark. Results of written examinations should also be published early so that students will know their fate and adequately prepare for resit exams. Resit results too should also be published.
- There is the need for better coordination and communication among the exams administrators, lecturers and the students. Course lecturers for instance should be informed about the resit students and their details. Students should be well informed of the resit exams period preferably on the Academic Calendar), venue and times for the exams,
- Also, the polytechnic must put in place a policy of the maximum load of students in a semester and this should be considered when a student is registering for resits because if the load becomes too much, the 'already weak' student is overly burdened and his/her problems are compounded rather than reduced.

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BIOGAS, A COMPLEMENT TO FOSSIL FUELS (COMPARATIVE ANALYSIS OF VARIOUS BIOMASSES IN BIOGAS PRODUCTION)

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Abstract

Biogas is a renewable energy, derived from biomass, which complements and reduces the demand for fossil fuels. This research is a comparative study on the effect of various test-biomass materials including cow dung, human excreta, fowl dropping, brewer's malt waste, and banana fruit, which are common in the Ghanaian community, on biogas production. Each of these materials were tested individually and also in various combinations within a two-week period, using laboratory techniques in anaerobic fermentation, culturing, microscopy and serological methods. Varied levels of microbial load and comparative quantum of biogas were realized for each of the test-materials, per unit time. Isolated microbes included *Aspergillus niger*, *E. coli*, and species of *Enterobacter*, *Clostridium*, *Pseudomonas*, and *Bacillus*. Generally the latter three microbial species were found to be greatest, quantitatively, ranging from 150-600 / ml; whilst the load for *E. coli* was the least, only up to 25 / ml. These microbes were more pronounced in cow dung, poultry dropping, and human waste, where biogas production levels were also greatest. A combination of the various test-biomass materials, especially the cow dung / poultry droppings and human excreta/poultry droppings, gave better biogas yields of 20 cm-diameter gas balloons; compared to the individual cow dung, human excreta, poultry droppings, which recorded maximum values of 12 cm, 11 cm, and 9.5 cm-diameter gas balloons, respectively. This is a first phase of an on-going project and the results provide knowledge on the relationship between biomass and biogas production, which will help guide biogas-producers to making appropriate choices on material for biogas production.

Key Words: Biogas, renewable, biomass, fossil, microbial load.

Introduction

Biomass is organic material that is used purposely for the generation of energy, mostly biogas, when it is anaerobically fermented. Biogas production helps convert seemingly undesirable organic matter into usable fuel. Biogas is mostly methane and carbon dioxide and rarely contains any useful portion of hydrogen, and used as a fuel for cooking as well as for the provision of heat and light. However when refined and the methane content raises to about 90 % it can be conveniently used as a vehicle gas. In this way it complements and reduces the pressure on fossil fuel. The

gas is highly flammable and great care is needed to prevent any leakage during the production stages or its handling during transportation and usage. Biogas production is highly technical and needs a biotechnological approach. The proper choice for fermentable material, types of equipment, conditions for production, and the living mass (microbes) is vital for a successful biogas project.

This work, therefore aims at showing how various biomass materials generally affect biogas production. The work also identified the microbial types in the fermented biomass, since they played a vital role for the gas production. Subsequent phases of the work will research into the effects of temperature, pH, and types of fermenters to biogas production.

Literature Review

Biomass materials used to provide energy include organic waste from crops, forests, municipalities and aquatic plants, such as like algae, and dropping from animal and birds. Biomass, like wind, solar, geothermic energy and hydro-power are renewable energy sources (Gallagher, 2003). Biogas technology offers a low cost alternative for energy requirements – firewood, kerosene, electricity, LPG, charcoal – for heating purposes, power production and a source of transportation fuel when refined (www.tutornext.com, 2011). A combine heat and power plant is more efficient way of rationally using biomass. Being highly explosive and dangerous the biogas disaster should be away from flame and placed at well ventilated area as some elements and molecules present in biogas can cause suffocation (www.claverton-energy.com, 2009; Andriana, 2005). Bioconversion not only turn biomass into alternatives fuel source, but will help dispose off troublesome accumulation of solid waste. This in effect helps reduce odour, pathogenic contamination and levels of green house gases (Jay, 2001; Lai, 2006; Roger, 2005). Heaped biomass or landfills can however pollute the air, though not as much as fossil fuels, when the biogas they produce is not collected but allowed to escape into the air and this can affect global climate change. Biogas production is aided by anaerobic fermentable microbes (Hashimoto, 2005; Uzodinma *et. al*, 2007; www.ruralcostarica.com/biogas, 2011). These microbes are sensitive to pH, with optimum range being 6.6 - 6.7 and a maximum of 8.5. It is revealed that pH 5 exhibited reduction of methanogenic activity during biogas production (Energy Commission, 2008; Biogas Train, 2005). Other important factors are temperature, feeding stock types, organic loading rate and hydraulic retention time. Microbes needs carbon and nitrogen for the fermentation process but consumes carbon roughly 30 times faster than nitrogen (30:1 ratio) – Debryn *et al*, 2005. Biomass material rich in nitrogen has its biogas production improved by addition of vegetable matter (Sayer, 1997). Complete anaerobic digestion of cow manure takes about 8 weeks at warm temperature and one-third (1/3) of the total biogas is produced in the first week, one-quarter (1/4) in the next and the remainder spread over the remaining 6 weeks. Within the

fermentation period changes in conditions do occur, resulting in creating a form of microbial succession in the biogas digesters, with changes of microbial types: from hydrolytic to acetogens and finally to methanogens (Boris *et al*, 2007; Cantrell *et al*, 2008). Hydrolytic microbial fermentation products, such as succinate, lactate and ethanol are further fermented by the acetogens to form acetate, H₂ and CO₂. The later two products are substrate for methanogenic bacteria. Some of the CO₂ is reduced to a more terminal product CH₄ (methane). Thus hydrogen producing-microbes are in syntrophy with methanogenic bacteria which consumes the hydrogen as soon as it is produced. Extreme thermophilic microbes like *Bacillus* are of higher hydrogen production efficiency compared to mesophilic bacteria such as *Salmonella* (Uzodinma, 2007). In nature these biogas-producing organisms exist in complex anaerobic community. Through gene-sequencing methods microbiologists are able to understand these microbial communities better. It has been detected that individual isolates from these communities are hard to grow (www.tutornext.com, 2011). Animal manure, especially those from ruminant, are easier to hydrolyze and some authors attribute this to microorganisms that live in their rumen, carrying out anaerobic digestion, as compared to plant waste materials (Chawla *et. al*, 2005). Other common sources of biomass include various sludges, soybean cake waste, powered rice husk, as well as potential energy crops – sugar cane, sorghum, napier grass. Reports indicates that subjecting them to anaerobic digestion for 25 days the slurry produce greatest amounts of biogas and this was even greater when blended with soybean cake waste or pig dung (Lai, 2006). Shredding of the biomass material increases its surface area making it easy for microbial digestion, with consequential great heat generation which aids in speeding up the fermentation process.

Methane production is said to be inhibited when animal waste biomass from the animals treated with antibiotics are used. The antibiotics inhibit bacteria which help convert undesirable nutrients into methane gas at the expense of producing meat and milk. These antibiotics in the dung continue to persist and inhibit methane production from the waste (Adeniran *et. al*, 2003). Unlike biogas, fossil fuels are obtained from coal, oil and natural gas, formed many hundreds of years ago, mined out of the ground, using various methods (Jay, 2000). Biofuels, including biodiesels from vegetable oils, fats, greases, and ethanol have relative low emission of pollutants and are usually blended with petroleum fuels (gasoline and diesel fuel) to help reduce pollution of air; but the former can also be used on their own (Oniouka, 2005, Uzodinma *et. al*, 2007). Currently the number of projects using biomass energy is relatively much less compared to those from sun, water, electricity or wind. Nuclear energy, derived from the fission and fusion of nucleus of an atom is capital intensive to produce, and is the less form of energy used in developing countries (Lema *et al*, 2007).

Various species of *Bacillus*, *Pseudomonas*, *Clostridium*, *Enterobacter*, *Salmonella*, *Aerobacter*, *Proteus*, *Methanobacterium*, *Methanococcus*, *Desulforibrio* and *E. coli* are common bacteria in fermented biomass. Fungi population and types are relatively low. However *Aspergillus niger* and *Aspergillus fumigates*, which are thermophilic, are usually present in biomass material; especially animal and bird dropping (Cray and Briddlestone, 1999; Rhode and Hartman, 2002; Ofoefule *et al*, 2010). Presence of pathogenic-microbes, especially during the acetogenic stages, poses health problems for biogas researchers and workers if proper health care measures are not taken.

A typical biogas contain 50-70 % methane, 25-50 % CO₂, 0-10 % N₂, 0-1 % H₂, 0-3 % H₂S and 0-2 % O₂ (Energy Info book, 2006; Faisalbaig *et. al*, 2008). Treatment of the raw biogas can bring the methane levels to 90-95 % and this can be used as vehicle fuel complementing natural gas (Roger, 1996). Fruit pulp and brewers grains have biogas yields ranging from 50-180 m³ / t; raw material such as grains, fresh grasses, molasses and root crop leaves are reported to have high biogas yield ranging from 400-560 m³ / t as compared to droppings from cattle, pig, chicken; however the later release the biogas faster and earlier than the former biomass types (Cunaseelan, 1988).

A biogas production requires an airtight anaerobic digestion to be fed with a water / biomass ratio of 1:5, a pH range of 6.8 - 8.0 and a temperature range of 29 - 60 ° C with a optimum of 32 - 35 ° C. Agitation or stirring biomass slurry help prevent it settling and also prevent fermentation of hard scum on the surface which prevent release of the produced biogas. The biogas is usually collected in inverted drum with a non-return valve to prevent air being drawn into the digestion (Hajarnis, 1992).

Gas production is accelerated and made more constant by continues feeding the digestion with small amount of waste fluid forms, daily. This also provides fresh active microbes for effective biogas production. A double digester is preferable with continuous feeding, consuming the waste in two stages; with the first stage producing a greater part of the biogas and the second stage producing about 20 % of total biogas (Saylor, 1997). With batch feeding solid vegetable waste are recommended, where a single batch digester is used; and this is opened for old slurry to be replaced by new ones. Here the gas production starts 2 - 4 weeks, slowly increasing production then drops after 3 - 4 months. Equal weight of vegetable matter produces about 8 times of much biogas as animal manure; though the production rate is low. A mixture of dung and vegetable matter is ideal. With fresh cow manure the equivalent dilution is roughly an equal quantity of water (Hilborn, 2006). High protein levels in manure such as those of poultry and swine contain sufficient amounts of nitrogen (N₂) and sulphur (S) which upon mineralization, to

ammonia and sulphide, and together with possible heavy metals can cause inhibitory effects (Wilkie, 2010).

Methodology

Materials

The materials used were in the category of equipment, glassware, reagents and test-items, including: microscopes, flasks, Latex balloons, PVC pipes, thread, duct tape, rubber bands, measuring rule, agar media, cow dung, human excreta, poultry droppings, banana fruits, malt grains, distilled water.

Methods

Anaerobic fermentation method was used to assess levels of biogas produced by various biomass materials; culturing, microscopy and serological methods were used to identify and assess their microbial loads in suspensions of various fermented biomass materials.

Procedure

(a) Preparation of Biomass

50 kg of each of the following biomass materials was mixed with 300 mls of distilled water, in special conical flasks, which had balloons fixed to them to collection the produced gas.

Set 1: cow dung; human excreta; malt waste; banana fruit, pig dung; fowl dropping; distilled water (control).

Set 2: cow dung + poultry droppings; human excreta + poultry droppings; cow dung + human excreta; cow dung + malt waste; human excreta + malt waste; cow dung + banana fruit; human excreta + banana; distilled water (control); each mixture was 40 g + 10 g, the main biomass (cow dung and human excreta) and additive material, respectively.

(b) Measuring of Biogas

The set up was placed at room temperature, monitored for two weeks and measurement of the diameters of each of the balloons taken each other day. The values from each set up was contrasted with the control, comparative analysis done and conclusion drawn.

(c) Identifying the Types and Estimating the Quantities of Fermentable Microbes

10 g of each set of one-week fermented biomass was prepared into 1:10, 1:100 and 1:1000 dilution suspensions. A drop (1ml) of each was inoculated on labeled Petri plates with nutrient agar;

after which fungal microbes were sub-cultured on potato dextrose agar and those of the bacterial types were sub-cultured on pseudomonas agar base (PSA), livine eosin methylene blue (L – EMB) agar, and perfringes agar, after physiological examination, and incubated at 30 ° C for 48 hours. The colonies and mycelia were then observed, counted and identified, using culturing, microscopy and serological techniques.

Results and Analysis

The results included findings of the identified microbes and their microbial load, comparative estimates of biogas collected from various combinations of biomass materials, as expressed in tables 1 to 4.

Table 1: Identification of Isolated Microorganisms

Test Reagent or characteristic	Microbial Isolates						
	A	B	C	D	E	F	Control
Nature/type of microbe	Bacteria	Bacteria	Bacteria	Bacteria	Bacteria	Fungi	NA
Growth characteristic	Yellowish, Slimy colonies	Yellowish, Slimy colonies	Blue-green, Slimy colonies	Yellow-green, Slimy colonies	Greenish, Slimy colonies	Black, cotton-like, Black conidia	NA
Microscopic features	Rod-like	Rod-like	Rod-like with endospores	Rod-like	Rod-like with endospores	Semi-septate, bi-serate, short chain phialides conver vesicle, unbranched conidiophores.	NA
Spore Motility				-			NA
Urea	-	-		+			NA
Cat	+	+	+	-	+		NA
Oxi	+	-	+	+	-	+	NA
SIC	-	+	-	+	-	-	NA
LIM	+	-	-	-	+	NA	NA
Coagul	+	-	-	-	-	NA	NA
Ind	+-+	+++	-	+	-	NA	NA

Lac	-	-	-	-	-	NA	NA
TSI	-	+	-	-	-	NA	NA
Gram's	+	+	-	-	+	NA	NA
H ₂ S	-	-	-	-	-	NA	
O ₂ needs	-	-	-	-	-	NA	
	-	-	+	Facultat	+	NA	NA
	Faculta	Faculta	+	ive	+	NA	
Interpreta	tive	tive	Anaero	Anaero	Anaero	NA	
tion	anaero	anaero	be	be	be	Aerobe	
	<i>Entero</i>	<i>E. coli</i>	<i>Clostri</i>	<i>Pseudo</i>	<i>Bacillu</i>	<i>Aspergillu</i>	
	<i>- bacter</i>		<i>-dium</i>	<i>mo-nas</i>	<i>s spp</i>	<i>s niger</i>	
	<i>spp</i>		<i>spp</i>	<i>spp</i>			

Key

Urea – urease; Cat – catalase; Oxi – oxidase; SIC – Simon's citrate; LIM – lysine indole motility;

Coagul – coagulase; Ind – indole; Lac – lactose; TSI – triple sugar iron; H₂ S – hydrogen sulphate;

O₂ – oxygen; + - positive test; - - negative test; NA – not applicable

Table 1, above, shows the various tests used to identify the various isolated microorganisms from the fermented biomasses. The fungi were studied and identified using culturing techniques and direct microscopy. Apart from these methods, biochemical or serological reactions, using various reagents were used to identify the bacterial organisms. The microbes identified included *E. coli* and species of *Enterobacter*, *Clostridium*, *Pseudomonas* and *Bacillus* – all bacteria, and a fungal organism – *Aspergillus niger*. The control (distil water) showed no reaction with the reagents and without any identified microorganism.

Table 2: Microbial Load in Various Biomass Samples after a Week's Fermentation

<u>MICROBES</u>	<u>BIOMAS SAMPLES</u>						
	Cow dung	Pig dung	Fowl dropping	Human waste (excreta)	Malt waste	Banana fruit	Control (water)
<i>Aspergillus niger</i>	200	44	165	180	20	100	0
<i>E.coli</i>	15	20	25	25	0	0	0
<i>Clostridium spp.</i>	*600	*350	*500	*550	20	250	0
<i>Pseudomonas spp.</i>	*400	*450	*350	*500	20	200	0
<i>Enterobacter spp.</i>	*300	180	265	100	30	250	0
<i>Bacillus spp.</i>	*500	*400	*480	250	40	150	0

*A dilution of 1:10 was used and total count calculated: Total count = dilution factor x colony count.

Species of *Clostridium*, *Bacillus* and *Pseudomonas* were more prominent, recording about 150-600 / ml of suspension of the biomass materials. That of the *E. coli* was seen to be relatively low in all the biomass samples, with maximum levels of 25 / ml. The cow dung, fowl dropping and human excreta gave relatively higher microbial load. The control (distil water) showed neither evidence of gas production nor any recorded microbe, while the malt waste sample recorded the least microbial load, 20 - 40 / ml, among the test-samples.

Table 3: Comparative Estimates of Gas Collected from Various Biomass Fermentation, within 2 weeks.

<u>Days</u>		<u>Diameter of Balloons with Gas (cm)</u>					
	<u>Cow dung</u>	<u>Human waste (excreta)</u>	<u>Malt waste</u>	<u>Pig dung</u>	<u>Poultry dropping</u>	<u>Banana fruit</u>	<u>Control</u>
1	1	1	0	1	1	0	0
2	2	2	0	3	2	1	0
4	4	4	0.5	5	4	2	0
6	7	8	1	5	6	3	0
8	9	9.5	3	6.5	7	5	0
10	10	10.5	5	7	8	7	0
12	10.5	11	7	7.5	9	9	0
14	12	11	7.5	8	9.5	9.5	0

Generally the balloons increased in their sizes from day one (1) to the 14th day. The rate of increase was greatest within the first eight (8) days and slowed down to the 14th day. On the 14th day the balloons had their diameter values ranged from 7.5 - 12 cm, except for the “control” (distil water) which recorded zero centimeters. The cow dung and the human excreta samples exhibited greatest gas collection, with their affixed balloon recording diameters of 12 cm and 11 cm, respectively; followed by poultry dropping and banana fruit samples – 9.5 cm; before pig dung and malt waste samples, 8 cm and 7.5 cm, respectively. The malt waste and banana fruit samples were seen to have the rate of their gas production greatest within the period of day 6 - 12; while the dropping from the animals and birds were from 2nd - 6th day.

Table 4: Comparative Estimates of Biogas Collected from Various Combinations of Biomass

Material, within a 2-Week Fermentation Period

	<u>Diameter of Balloons with Gas (cm)</u>							
<u>Days</u>	<u>1</u>	<u>2</u>	<u>4</u>	<u>6</u>	<u>8</u>	<u>10</u>	<u>12</u>	<u>14</u>
Cow/poultry dropping	2	6	8	13	15	17	19	20
Human excreta/poultry dropping	2	6	9	14	16	17	19	20
Cow/Human excreta	1	4	7	9	11	13	15	16
Cow dung/malt waste	1	3	6	8	10.5	11	12	13
Human excreta/malt waste	1	3	6	9	11	11	11.5	13
Cow dung/ banana fruit	2	5	7	10	12	14	16	17
Human excreta/banana fruit	2	5	6	10	11	13	15	16
Control (distil water)	0	0	0	0	0	0	0	0

A combination of biomass materials (table 4) gave better results generally, compare to using individual biomasses (Table 3). In all cases the control (distil water) did not show any sign of gas production. After the 14th day the various test-balloon samples expanded to a diameter range from 13 - 20 cm. The cow dung / poultry droppings and human excreta/poultry dropping gave better results. The rate of increase is seen to be greatest within the period of 2nd - 6th day.

Conclusion

Biomass is a renewable energy derived from biomass and has the capability of complementing and reducing the demand for fossil fuel as well as being an effective means of waste management and pollution control. The gas production rate for droppings from animals and birds is greatest from day 2 to day 6 whilst those from the direct plant source (malt waste and banana fruits) were found to be relatively later – from day 6 to day 12. Cow dung and Human waste are good source of material for biogas production; however some additives like poultry droppings and banana gave even better results. Species of *Clostridium*, *Bacillus* and *Pseudomonas*,

found to be relatively great in their numbers in the fermented test-samples, are known to be good fermenters for biogas production; however literature recommends thorough studies in the interrelationship among the fermentable microbes and other conditions needed in their anaerobic communities, for better biogas production. The findings of this work will, no doubt, help biogas producers to reflect on the need to make better choices on biomass materials for better output in biogas production.

Recommendation

Biogas production should be encouraged, especially in institutions or communities where the raw materials are readily available. This will help not only to produce fuel and reduce pressures on fossil fuels, but also as a means to help address environmental issues. The production plant must be leakage-free to prevent various hazards as the gas is highly flammable. Treatment and refining plants for the biogas could be installed to raise the methane component, mostly from 50 - 75 % to 90 - 95 %, to enable it to be used as vehicle fuel, when production develops to commercial quantities.

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**THE ECONOMIC OPPORTUNITIES EVOLVING FOR SMALL SCALE INDUSTRIES IN SEKONDI- TAKORADI METROPOLICES, DUE TO THE OIL AND GAS DISCOVERY IN THE WESTERN REGION.
[A case study of the Art and Craft industry in Sekondi- Takoradi.]**

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Abstract

It is anticipated that Ghana's status as an oil producing country will in the next few years have tremendous effect on a lot of industries that do not have direct involvement in the oil extraction industries but provide other services to the envisaged influx of expatriate staff of the oil industries. One of such industries is the art and hand crafted sector of the economy. This research would explore the effects of the flux of foreigners from Europe and America who may be expatriate staff and their families or other experts and consultants who come for a short stay. Critical examination of Western cultural attitude towards art and craft indicate there would be an increase patronage, especially in hand crafted art works. The research would also analyze the present situation of the art and craft industry in the Sekondi-Takoradi area, specific location within the city and their working conditions, production levels, design and aesthetic considerations and technicalities, and how to increase capacity to meet the increase demand that would emerge. The paper would also look at how the government through its agencies like National Commission on Culture, Ghana Export Promotion Council and others, as well as the Commercial Art Departments of various polytechnics, can help craftsmen to improve on their production capacities, and to run short courses for craftsmen to improve their design respectively. Finally, the research would also give insight into how other organizations can get involved in art and craft business; these would include NGO and other financial institutions.

Introduction

Although Ghana is an agriculture based economy with cocoa as the main export product, other industries play a major role in the economic development of the country. One of such industries is the small scale art and craft sector, which provides employment for lot of people in various cities and towns. The main customers of the art and craft industries are tourists from Europe and America and a few local elite who buy art works as gift or for decoration in their homes. So the art market is centered in main tourist centers like Accra, Kumasi, cape coast, Sekondi/Takoradi, Aburi, etc.

The exploration of oil in Ghana and in particular the western region will bring an influx of expatriate staff and their families to Sekondi- Takoradi. By the nature of most Western cultures, the use of art and craft works as decoration in their environment and homes is a cultural requirement or practice used to satisfy their aesthetic desires.

Art is described online at www.brainyquote.com as:

Art is the product or process of deliberately arranging items (often with symbolic significance) in a way that influences and affects one or more of the senses, emotions, and intellect. It encompasses a diverse range of human activities, creations, and modes of expression, including music, literature, film, photography, sculpture, and paintings.

While art is a process that involves a deliberate attempt to create something, craft on the other hand is described online at www.brainyquote.com as:

A craft is a branch of profession that requires some particular kind of skilled work. In historical sense, particularly as pertinent to the Medieval history and earlier, the term is usually applied towards people occupied in small-scale production of goods. There have been serious attempts to differentiate between art and craft in terms of definition but this has always led to the same thing that is producing aesthetic objects with ones hands. What is important is that it provides an income activity for a lot of Ghanaians.

The Sekondi- Takoradi area already has an existing art and craft market which was developed due the presences of the Takoradi seaport. Most the art and craft shops are therefore located near the port area consisting of craftsmen, retailers and exporters. The types of products vary from antique furniture to different types of artifacts which are classified in terms of the processes used in making them such as carving, painting, casting, drawing, welding, weaving, dyeing, printing etc. Items produced from these processes include mask, stools, textiles, wall hangings, paintings and other functional and decorative pieces.

Statement of the Problem

The art and craft industries in Sekondi-Takoradi in their present situation have not positioned their activities in readiness to take advantage of an increase in the market that would evolve due to the expected increase of foreigners in Ghana for oil exploration activities.

Objectives

- (1) To present the situation of the art and craft industries in Sekondi- Takoradi in terms of low production levels and other technical challenges that affect the industry.
- (2) To analyze the market and demand trends of the art and craft products and factors that affects the industry.
- (3) To examine other possible roles of the polytechnic in terms developing the manpower needs and provision of technical support through research activities.

Historic Background of Art and Craft Industry

The history of acquiring an African artifact when ever Europeans visit the continent dates far back as the colonial era. Initially traditional African art and craft were not considered as art work but as ethnocentric object. This ideology is justified by Stokstad 2007,

Since the first Europeans explored Africa, quantities of Africa artworks have been shipped back to western museums of natural history or ethnography, where the works were first exhibited as curious of ''Primitive '' cultures.

These ideas of African artworks as 'primitive' persisted for a long time because the early Europeans did not understand the cultural background and what influenced Africans to work that way. Miller (2006), also has the following description of African art, *The black arts Africa have been describe as shocking, sublime, bold, severe, dynamic, restrained and expression by connoisseurs in the west.*

The early Europeans' reaction to art of Africa was as a result of the great difference between their arts and that of African. Whiles Traditional African art was symbolic and functional base on traditional and religious concepts. This is explained further by Taylor (2003),

As in other parts of the world, arts were practiced predominately in religious and political context, which include kingship ritual, ancestor cult and related didactic purpose designed to perpetuate ancient traditions as well as to satisfy a need for symbolic wealth and power.

European art was at its highest level in the representation of realism and was more concerned with achieving aesthetic satisfaction, so when they came in contact with African art, they did not understand and therefore branded it as 'childish' and collected them for the purpose of using them to explain how 'uncivilized' and 'backward' African art was. So this became a tradition for all visiting westerns to buy and send an African artifact home to show other people. This perception changed during the nineteen century as stated by Stokstad (2007).

Toward the end of 19th century, however profound changes in western thinking about art gradually led move and more people to appreciate the inherent aesthetic qualities of these objects and at last to embrace them fully as art.

The change in the attitude of Europeans towards African art was as the results of an art revolution that started round 1900s, in which European art begun searching for new direction and inspiration for their art. This is explained further by Taylor (2003) as:

But in their search for directness and immediacy of instinctual response, artists increasing turned away from civilized ‘fine art’ in favour of the supposed primitive, especially “Negro art” sculpture.

By this time African sculptures had now become source of inspiration and influence on European art. This resulted in the creation of modern trends and radical non representational forms like cubism, surrealism, Dadaism etc. well known artists like Pablo Picasso and Braque have created master pieces due to the influence of African sculptures. Taylor (2003) continues,

By 1915 African sculptures was being claimed as among the greatest ever created. As Braque, an artist, confessed: ‘Negro mask also opened a new horizon for me, they permitted me to make contact with instinctive things, direct manifestation that ran counter to a false traditionalism which I abhorred’.

Due to these major influences of African artifacts on European contemporary art, people visiting Africa make it a trend to buy an art piece. This led to the creation of businesses which included art collectors who buy from local artisans and export them for sale in shops and museums in Europe and America. There are also local art producers who produced for sale in their own shops which are mostly located at vantage points especially where tourist mostly visit.

Art and craft situation in Sekondi/Takoradi:

The Twin-City of Sekondi-Takoradi is the third biggest city of Ghana. It is also the first seaport city and a capital of the Western Region of Ghana, where most of the nation’s natural resources are obtained. It is a cosmopolitan city that draws many peoples of all works of life together into a business hub that make the city very attractive and strategic to the economic prospects of Ghana.

One of the main occupations of the city is art/craft which over the past years has been sustained by the presence of the seaport bringing in a great number of seamen and expatriates who buy the crafts away mostly as souvenirs and decorative pieces. Thus, a number of businessmen have set up curio shops at strategic places within the city serving as middlemen between the craftsmen and the collectors. Those craftsmen who despise the hard handedness and deceitful nature of these middlemen

have set up showrooms next to their workshops to work as well as deal directly with collectors.

Over the years, art/craft workshops have proliferated in the city due partly to the booming of the business, and then the number of trainees and apprentices who have graduated as masters and set up their own shops. However, the city authorities have always been up in arms against them for their wanton use of space that tends to disrupt the orderliness and serenity of the cityscape. Thus, most of them have been pushed to a tight corner of the industrial area of the city near the seaport jostling for space and convenience.

Types of work:

Most of the crafts practiced in the city are mainly traditional wood carving, rattan works and batik/Tie-dye among others. Due to the briskness of the business other crafts that are not traditionally associated with the city are also brought in to take advantage of the marketing opportunities. Such items include leather works, 'Kente' cloth, 'smock', and others.

As traditional crafts, designs of most of the products are repetitive and mostly copied from templates that have existed for many years most of which are transferred or copied from a master during apprenticeship. This makes it easy to mass produce. Few new designs are occasionally brought forth by the creative among them but soon also get copied by others in that cycle. Again, many other ideas especially that of the rattan is developed or copied from foreign catalogues.

- i. Traditional wood carving: Items produced under this craft generally include traditional masks, ash trays, elephant pieces, figurines and other ornamental and decorative objects. However, the city which is coastal, has no forest area and therefore wood, the major material, is obtained from as far as Sefwi, Enchi, Ataike all in the Western Region. Carvings such as masks are often combined with other materials as beads, raffia etc, and others painted with water based paints all to give them traditional semblance and sometimes inspire awe and fear.
- ii. Rattan works: This is another lucrative area with very great prospects. Some of the items produced are baskets, hats, wig stands, and furniture. Cane, the main material, is obtained mostly from Dabose which is not far from the city.

SURVEY OF ARTISANS IN SECONDI- TAKORADI

TABLE 1 TYPES AND NUMBER OF SHOPS

Types of Shops	Number
Wooden Structure	11
Metal Container	5
Uncompleted Building	17
Garages	3

Analysis

The shops in which the artisans operate depend on their level of financial position and their production capacities. Majority of them that is 17 works in uncompleted buildings belonging to private individuals or abandoned government projects because they cannot afford to build their own structures. Such artisans are always faced with ejection orders from either the building owners or city authorities. Lot of the artisans who work in such conditions are mostly the cane weaves and carpenters, the reason may also be attributed to the large sizes of their products, so they display wares by the road side during day time and park them into uncompleted buildings in the night. Other group of artisans (11) operate in wooden structures because is little affordable in terms of the cost of construction as compared to the metal containers which are expensive so only few artisans (5) can afford.

The last group of artisans (3) works in garages of buildings by the road side, their number is low due the fact that there are only few buildings which have garages by the road sides and for other building, the owners would not want to let artisans operate in their garages.

TABLE 2 Master Craftsmen

AREA OF SPECILISATION	NUMBER	AGE RANGE	NUMBER OF APPRENTICES PER MASTER
Carvers	15	28 to 44	3
Cane weavers	17	28 to 59	2
Carpenters	7	28 to 51	2
Painters	7	28 to 40	2
Finishers	3	20 to 38	0
Dealers	6	25 to 48	0
Helping hands	3	18 to 25	0

Analysis

A critical observation of the workforce in the art and craft industry reveals the following trends. The ages of the artisans ranged between 20 years and 59 years and majority of them are either cane weavers or wood carvers, this because they are the original group who started operating in the area. The other artisans only joined them later. There are only 7 painters in the research area this due to the fact that painting is more of a contemporary art form and it is mostly learnt in formal institutions. Also buyers prefer to buy from well known practicing artist than a roadside painter. There also a few dealers (7) in number because by the nature of their work only people who have the finances to buy from the artisans can become dealers. The dealers also have shops where they retail or export their purchases. The final groups are made of finishers and helping hands who are also few because they work on contract bases for other artisans. Their numbers increase when the main artisans get more orders especially for export. They then recruit more of the finishers and helping hands to assist them.

TABLE 3 Market Trends

Types of Work	Products	Market Share (%)
Carving	Mask, figures, furniture, doors, Lamps holders, animal forms.	35
Cane weaving	Furniture, Lamps holders, basket etc.	30
Painting	Landscape, creative, abstract and realism painting.	20
Carpentry	Chairs, tables, TV. Stands, beds, doors	10
Batik	Fabrics, clothing, etc.	5

Analysis

A critical review of table 3 shows market trend which is very predictable, in terms of the market share obtained by each art and craft specialties. The art market in Ghana, and as in lot of African countries, has tourists and foreigners as the main buyers. These buyers prefer traditional wood carvings which they know portray a true African identity and culture. That is why the market share of wood carvings in Sekondi/Takoradi is the highest (36%). This market share is still low; this is as a result of international concern on the negative effects of the use of wood on the environmental, a lot of European and American buyers would like to know the sources of the wood used, whether it is from a sustainable forest or forest reserves before they buy such products.

The second biggest market share is taken by the cane weavers (30%) this sector's products are more for the local consumption and usage. A few foreigners buy cane

furniture for local use and not as products they send back home when they are living Ghana.

Apart from wood carving and rattan products painting also has significant market share, although they are not the favorite items demanded by tourist and foreigners, people buy for interior decoration in Ghana and also some tourist buy them because they are easy to ship back home and there are relatively cheap to buy them in Ghana as compared to their home countries.

Carpentry commands a (10%) market share, this a local based market because they produce bulky items which are purchased mostly for local use but not as a products for export. There are more carpenters in Sekondi- Takoradi but this market share is about a few carpenters who work with wood carvers to produce unique products.

The last market share of (5) is batik products, this not the total market share, there are a lot other batik producers and sellers who are not captured by the survey because they operate outside art and craft area.

Problems

Problems affecting the art and craft industries in Sekondi/Takoradi are numerous, these include the following,

1, Assess to raw materials especially wood and rattan, has become a major problem this is due to governmental policies on issues of environmental concerns and the preservation of our forest reserves; it has become very difficult to obtain them. Also the uncontrolled harvesting of forest resources without replanting has led to near extinction of certain species of timber. So most the raw materials like wood used now are illegal because they are harvested by chainsaw operators whose activities have been banned by government.

2. The location of the art and craft industries in Sekondi/Takoradi also presents another problem. Most of them are sited on unapproved lands which either belong to government or private individuals, unlike Accra and Kumasi which have centers for national culture where a lot of the artisans have established their workshops. This is not the same in Sekondi/Takoradi where the artisans face a Constance threat of ejection and harassment from city authorities.

3. The artisans in Sekondi/Takoradi also face a lot of technical challenges which would make it difficult for them to benefit from the business that the oil find would bring Sekondi/Takoradi. Some of these challenges are as follows,

- Most artisans reproduce things they see in foreign catalogs, books or magazines, so a few of them have the ability to design new things for the market. Buyers have little option in terms of products selection because a lot of the artisans produce the same products. A few of them are able to design

and produce new things for the market but are not able to reproduce them because they may too complicate for mass production.

- The production capacities of the artisans are very low. This is due to the use absolute tools and equipment which does not help in mass production.
- Another problem is finishing, these are the final things done on an art work before it is offered for sale. The finishing standards of some these artifacts are very poor or inappropriate, which means that the finishing does not suit the work in terms of the colour or the way the work have been polished.

4, Poor business practices and bad work ethics also affects the art industries immensely, the artisans have no planned system of operation, some do not keep records of their work and they also have weak financial practices.

5, Marketing of products is another major problem, although the number of foreigners in Sekondi/Takoradi has increased, it has not affected the sale of art works. This may be due to the problems of the poor products and poor marketing styles.

Conclusion

Generally, in terms of the products produced and skills of the artisans the standards are okay but they have a lot of problems that would not make them benefit from the market boom that the oil find is envisaged to bring. There is the need to find solutions to the numerous problems through various interventions. These interventions can come in the form of training, financial support and technical assistance by institutions like the polytechnics, governmental bodies and non – governmental associations.

Possible interventions by Takoradi Polytechnic

The vision of the Takoradi Polytechnic is to achieve excellence in manpower training and action research in order to provide support to industry and commerce in the areas of human resource development. One of the goals of the Polytechnic is also to offer selected essential technician and craft programmes to students to ensure good balance in the supply of middle and operative level performance on the labour market. Thus, any programme in the Polytechnic setting that reflects the above considerations does not only seek to push the dreams of the Polytechnic forward but be in keeping with the government's desire to reduce the burden of unemployment in the Ghanaian economy.

However, one major duty the polytechnic should perform to make its goals fully accomplished is to institute programmes that will encourage people of the Sekondi-Takoradi community, within which the institution is situated, to fully avail themselves to polytechnic education. One of such programmes will be to organize short courses for craftsmen within the Sekondi-Takoradi community. To this end,

craftsmen in the metropolis will acquire enough artistic skills as well as the requisite technical knowhow aimed at increasing their capacity in the art/craft business.

This will not only open up and augment the art/craft business and make Sekondi-Takoradi the art/craft hub of Ghana, but will also attract the youth to take up that business which will go a long way to reduce the unemployment rate, occupy them, and stem the increasing crime and drug pushing in the Metropolis. By so doing, the Takoradi Polytechnic will be more meaningful to the Twin-City.

Possible interventions by governmental Bodies

The government through the National Commission on Culture in Sekondi/ Takoradi can assist the artisans to improve on their activities by the following interventions,

- The government should assist the National commission on Culture to complete their office complex, so that they can also provide workshop space for the artisans to solve the problem of finding working space. This would also bring all the artisans to one location as it is in Accra and Kumasi.
- The government through the National Board for Small Scale Industries should provide assistance in the form training and technical support services especially business training so that the artisans can improve on their activities.
- The government through district assembly's poverty alleviation fund can provide direct financial support in the form of grants or loans to the artisans for their operations.
- The Ghana Export Promotion Council is another governmental organization that can assist the artisans to improve on their activities so they can export to other countries.

Possible interventions by non- governmental associations

There are a few non- governmental associations which also provide some form of assistances to artisans by providing technical training, supplying tools / equipment and financial aid. An example is Aid to Artisans Ghana which has over the years helped lots of artisans to improve on their activities.

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**COMMUNITY – BASED WASTE MANAGEMENT FOR
ENVIRONMENTAL MANAGEMENT AND INCOME GENERATION IN
LOW – INCOME COMMUNITIES IN THE NEW JUABEN MUNICIPALITY**

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Abstract

Inability to manage waste properly, especially in Urban Communities, has been a major public health concern in Ghana. An innovative and an alternative means of waste management being advocated worldwide among Urban Communities is the re-use of urban refuse. It is environmentally friendly and a means of livelihood for the urban poor. This study sought to determine the feasibility of adopting the alternative waste management approach that deals with urban poor re-use of refuse by analyzing Low – Income Communities' perception on re-use of refuse and also determining the types and quantity of waste generated in the Municipality. A cross – sectional descriptive study employing quantitative tools was used. The study was conducted in four (4) Urban Poor Communities in the New Juaben Municipality. A total of two hundred questionnaires were randomly distributed for the study. Majority of the respondents (55%) did not want to be associated with a job related to refuse re-use due to the stigma and the health implications. 30.5 % somehow like the idea of refuse re-use and will want such a job on a temporal basis. However, 13% are very much interested in the idea and will want such a job on permanent basis. There were no significant associations between perception on refuse re-use and socio demographic characteristics. Waste generated declines at 5% per annum. The perception that refuse is not worth re-using dominates even though it can be a source of livelihood for most income poor communities. There is therefore the need to educate people on this erroneous impression created in order to reduce the stigma associated with refuse re-use.

Keywords: Refuse re-use, waste recycling, waste management, income generation from waste, and community- based waste management.

Introduction

Poor Sanitation is a major public health and environmental challenge in most countries (WHO, 1992, 2000). The burden it creates is so enormous that it has called for international attention. The United Nations Conference on Environment and Development (The Earth Summit) held in 1992 is one of the major international platforms committed to promote, strengthen as well as expand waste re-use and recycling systems in all cities that wish to enhance urban sustainability (UNCED,1992). Despite the efforts among nations to reduce waste, most urban communities are still engulfed with filth. This has called for the setting of targets under the Millennium Development- Goals to half the percentage of people without access to improved sanitation by 2015. (Adebola, 2006)

In Ghana, waste management is one of the critical concerns of the districts and the municipal assemblies since they have not been able to manage the waste generated properly. This situation has reached a critical level especially among most low-income communities due to lack of know-how in waste management, inadequate logistics and inability to pay for services of waste collection (Bindu 2008).

An alternative and innovative strategy of waste management being advocated globally among low-income urban communities is the re-use of urban refuse as an environmental management process and income generation activity (Furedy, 1992). Unfortunately most Sub-Saharan African countries have not adopted the concept of refuse re-use in most urban poor communities even though low-income urban communities dominate such countries (Brugmann, 2002). These low-income urban communities need to be sensitized on the economic and the environmental benefits of this new approach to waste management. In the light of the abysmal patronage of waste re-use, this study seeks to determine the people's perception on refuse re-use and analyze the types and quantities of waste available in the study area.

Materials and Methods

This is a cross-sectional descriptive study which employed the use of questionnaire as quantitative method of data collection.

The New Juaben Municipality is made up of 52 Communities and out of these, 15 are classified as urban poor. A simple random sampling method was used to select 8 low-income communities out of the 15 for the study. 25 low-income households were selected from each low-income community. A total of 200 respondents were used for the study.

The data were analyzed using SPSS version 17.0. The confidence interval was fixed at 95% while, 0.05 level of significance was used for statistical difference. A descriptive statistical analysis was applied, ANOVA, Cure fit analysis and the Tukey Index were used to determine the power behind the level of association among variables.

Results

To determine whether rural communities in the New Juaben Municipality are willing to re-use refuse as an income generating activity, the Researchers solicited their perception on refuse re-use and the results are shown in table 1. Over half of the respondents (55 %) do not want to re-use any type of refuse for income generation. As many as 30% of respondents somehow want to re-use refuse. This category wanted to be involved in re-use of refuse only as a temporal job. Only 1 % (2 respondents) of the respondents liked the concept of refuse re-use very much and were interested to engage in such a venture permanently.

The level of significance between the perception of refuse re-use and socio demographic characteristics is shown in tables 2, 3, 4 and 5. None of the socio demographic characteristics were significantly associated with the perception of re-use of refuse. This suggests that irrespective of people's age, sex, level of education and income, almost all of them would not want to be associated with re-use of refuse.

Analysis of the quantities of waste generated from 2000 to 2009 was carried out. Table 6 shows the different types of waste and their associated quantities. It also shows the gross quantities for each year. There was notable decline in the waste generated over the period. Apart from year 2002, which registered the highest waste generated (65219.59 tons) which was followed by year 2004 (47489.89 tons), there was a sharp decline in the rest of the period. The largest single decline was registered in 2008 with 32568.73 tons. In the ranked order of quantities based on

types of waste generated, metals, bottles and plastics were very dominant components.

The trend analysis in fig 1 shows that all the types of waste generated in the study area are declining at a fast rate. The most significant decline was among metals, plastic and bottles. It is estimated that by 2015 every metal produced would have been re-used while it will take between 2010 to 2020 for bottles and plastics, respectively, to reach zero waste status as shown in fig 2, 3, and 4 respectively. Projections from fig 5 and 6 shows that the re-use of paper and others (kitchen waste) have no likelihood of declining in the near future, because the potential of re-using these categories of waste in the study area has not been utilized.

Table 1 Perceptions on waste re-use

Responses	Frequency	Percentage (%)
Like it very much	2	1.0
Like it much	27	13.5
Somehow like it	61	30.5
Don't like it	110	55.0
Total	200	100

Table 2. Levels of significance between perceptions on waste re-use and age respondents using Tukey HSD

Perception	N	Age(Yrs)	N	Subset for alpha = 0.05
Like it very much	2	+ 60	40	1.5000
Like it much	27	50 – 59	27	1.5556
Somehow like it	61	40 – 49	23	1.6087
Don't like it	110	30 – 39	44	1.6136
		20 – 29	48	1.6667
		Less 20	18	1.7222
Significance				0.8741

Table 3. Levels of significance between perceptions on waste re-use and level of education of respondents using Tukey HSD

Perception	N	Age(Yrs)	N	Subset for alpha = 0.05
Like it very much	2	SHS and Above	16	1.5000
Like it much	27	JSH and Below	72	1.6111
Somehow like it	61	No formal edu.	112	1.6161
Don't like it	110			
Significance				0.798

Table 4 & 5 Perception on waste re-use and level Income/Gender using ANOVA

ANOVA

PERCEPTION OF RESPONDENTS ON WASTE REUSE BY INCOME LEVEL

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.110	1	.110	.192	.662
Within Groups	113.685	198	.574		
Total	113.795	199			

ANOVA

PERCEPTION OF RESPONDENTS ON WASTE REUSE BY GENDER

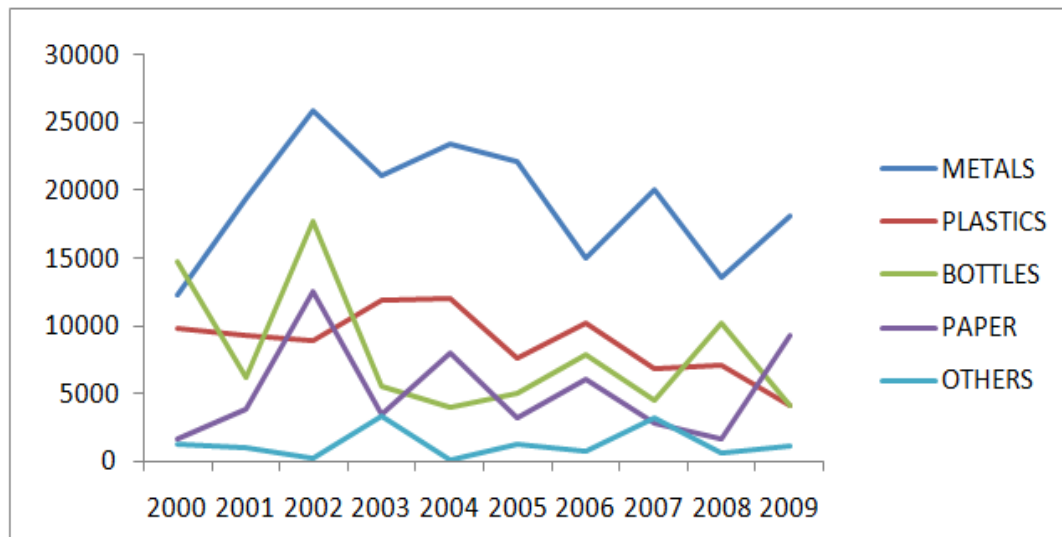
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.005	1	.005	.009	.926
Within Groups	113.790	198	.575		
Total	113.795	199			

Table 6. Quantities of waste generated

	ANNUAL QUANTITIES (IN TONNES)					
YEAR	METALS	PLASTICS	BOTTLES	PAPER	OTHERS	TOTAL
2000	12318	9854.4	14781.6	1642.4	1320	38596.4
2001	19503.5	9361.68	6241.12	3900.7	1096.23	39007
2002	25939.61	8893.58	17787.16	12599.24	251.9848	65219.59
2003	21122.25	11969.28	5632.6	3520.375	3346	42244.5
2004	23410.51	12039.69	4013.23	8026.46	160.5292	47489.89
2005	22239.99	7625.14	5083.426667	3177.142	1340	38125.7
2006	15091.42	10262.16	7847.536667	6036.567	776	39237.68
2007	20071.57	6881.68	4587.786667	2867.367	3214	34408.4
2008	13619.96	7082.378	10232	1634.395	652	32568.73
2009	18114.54	4140.467	4140.466667	9316.05	1182	35711.53

SOURCE: NEW JUABEN MUNICIPAL ASSEMBLY, JAN. 2010

Fig 6.1 the trend of waste generated in tons (per year)



Projections Of waste generated using curve fit estimator

MODEL: MOD_1.

□

Independent: YEAR

Dependent	Mth	Rsqr	d.f.	F	Sigf	b0	b1
METALS	LIN	.025	8	.20	.664	476159	-227.99
PLASTICS	LIN	.426	8	5.93	.041	1065436	-527.13
BOTTLES	LIN	.234	8	2.44	.157	1540152	-764.34
PAPER	LIN	.001	8	.01	.920	-82666	43.8704
OTHERS	LIN	.004	8	.03	.858	-46385	23.8057

Fig .2 Projections on Metals

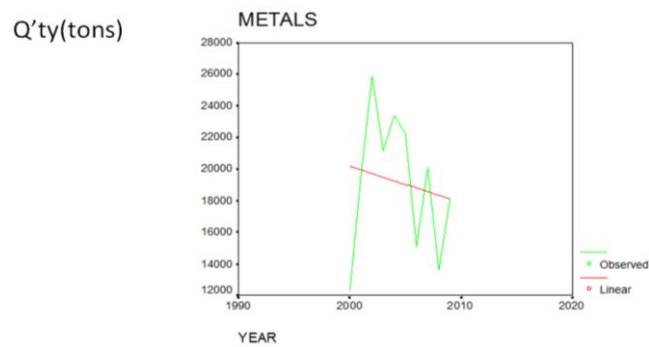


Fig .3 Projections on Plastics

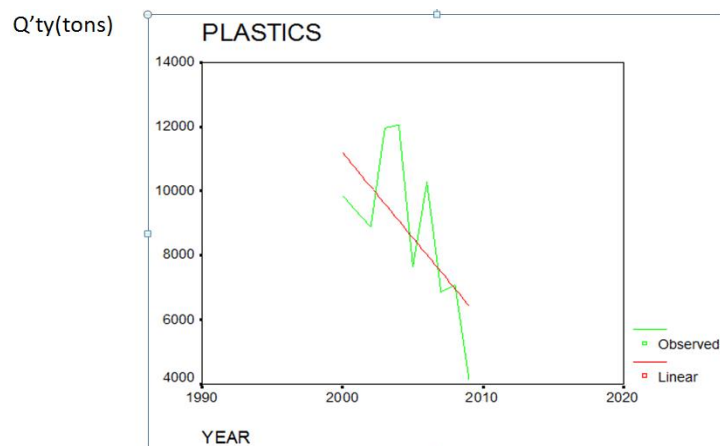


Fig .4 Projections on Bottles

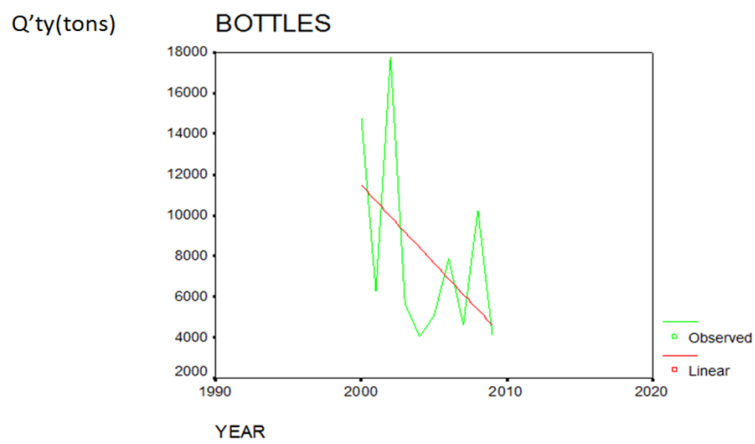


Fig .5 Projections on Paper

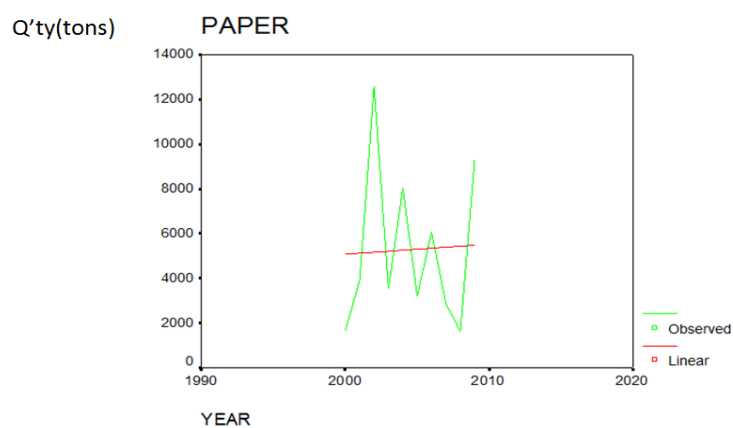
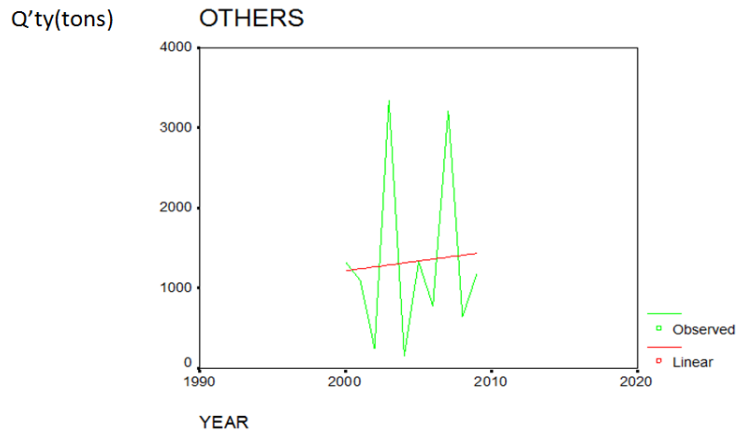


Fig .6 Projections on Others (kitchen waste)



Discussion

Studies on perceptions are very important in understanding people's attitude and behavior as well as the level of understanding on a phenomenon. It is also used to determine the acceptability of emerging concept into practices among communities. (Pervez and Kjell, 2002).

The concept of refuse re-use is being advocated globally among low income urban communities as an environmental management process and income generation activity (Furedy, 1992; Brugman, 2002). There is therefore the need to determine people's perception on the concept of re-use of refuse. It was found that 55 percent do not like to re-use refuse as an income generating activity. They perceive waste to be a filthy substance that should not be worked on by "Descent people". It was again found that the stigma associated with having to work on waste for a living was so high that most people did not want to associate with waste re-use. It was further revealed that due to the health implications associated with waste re-use, most urban poor would prefer remaining poor rather than to be engaged in refuse re-use.

Only 30.5 percent indicated that they somehow like to re-use refuse as an income generating activity. It was found that even this category of people want it only as a temporal job and whenever they are able to raise enough funds to start a better job, they would stop the re-use of refuse. Another category of people constituting 13.5 percent indicated that they like it much so far as it is lucrative and they can earn a living from it. Only 1 percent indicated that they like the concept very much and would like to engage in it so far as it is sustainable.

A test of significance indicated that there is no significant relation between people's age, sex, level of education, level of income and their perception on re-use of waste. This signifies that since almost all the respondents live below the daily minimum wage, they have no or little formal education and the stigma associated with refuse re-use affects all age and sexes, and the attitude of the people towards refuse re-use will invariably be almost the same. It can be concluded from the studies on the perception of refuse re-use that about 15 percent of the respondents are prepared to re-use refuse so far as it is lucrative and sustainable while about 30 percent wanted it only as a temporal job. This emerging statistics give the hope that with intensified education, poor communities will embrace the concept of refuse re-use as an environmental management process as well as an income generation activity.

Another dimension to this study was to determine how sustainable refuse re-use could be. To do this, secondary data on the types of waste generated were collected and analyzed. A general trend emerging was that even though there was a lot of waste generated from 2000 – 2009, the rate of generation declines at an annual rate of about 5 percent. The likely reasons for these decline in waste generation might be that there is judicious use of resources such that very little is left as waste. This assertion can be right due to the recent global economic crunch. Another reason for the decline might be due to the fact that most people are now searching, picking and selling used materials such as metals, plastics and bottles and as such reduces the waste generated. Scavenging for scraps seems to be a new job opportunity for most unemployed youth in most cities nowadays due to its lucrative nature. Waste Recycling Ghana (2008), indicated that a tone of assorted metals costs GH¢1,050. This high price has attracted people to scavenge, pick and sell any metal they can lay hands on, as scrap. This explains why it is expected that 20 years from now, all metal waste generated in the study area will be re-used and scarcely will people have scraps deposited in the community for reuse or for sale. The projections further revealed that it will take less than ten years for all used bottles to get exhausted. It was found that most expensive used bottles such as old schnapps and wine bottles e.tc. had already been sold out in most homes. Whereas the projections for metals, bottles and plastics revealed a sharp decline, paper and others such as kitchen waste are rising, signifying that it is limitless. The likely reason for this trend is that the market value for re-using papers and kitchen waste is small and thus, not attractive. Until higher utility values are placed on recycled paper as well as kitchen waste to make them attractive for people to work on such waste, this trend will persist.

Even though it is being advocated globally that urban poor communities should embrace the concept of refuse re-use, it has been found that most valuable resources that can be re-used from refuse such as metals, bottles, and plastics have a limited time for such waste to be exhausted and as such it is not a very sustainable venture since the rate of their decline is so fast. Other types of waste such as paper, kitchen waste and solid waste whose rate of decline is moderate can be used instead of metals, plastics and bottles.

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RAPPORTEURS GENERALS REPORT

Charity Ossom and Bismark Agbelengor

The conference started on the 12th July, 2011. The theme of the conference is **Ghana's Emerging Oil Economy: The contribution of the Polytechnics.**

The opening ceremony started at 10:27am under the chairmanship of Mr. Richard Okra of the Employers Association and a member of Koforidua Polytechnic Council.

In attendance was the Representative of the Regional Minister, Mr. Asante Baffour, Representative of the national Board for Professional and Technicians Examinations (NABPTEx) and National Accreditation Board (NAB) Mrs. Ofosu Nti.

The guest of honour was Dr. Akyem Appiah Kubi, the Eastern Regional Minister and the Keynote address was on the Topic: **Safety in the Oil and Gas Industry (On-shore and Off-Shore).** The address was delivered by Mr. Seth Foli of GNPC.

The Rector of Koforidua Polytechnic in his welcome speech reiterated the significance of the Annual Applied Research Conference: 'It affords members of the Polytechnic community the chance to publish their research findings as required by law and it enables the Polytechnic to remain relevant since the knowledge and ideas from across a section of academia, industry and research institutions on pertinent issues of national importance are polled together'. Moreover, the Rector declared that the Polytechnics are ready to partner and collaborate with the Government, MDEs and other stakeholders in building the oil economy.

The Keynote Address was captioned "Safety in the Oil & Gas Industry (Onshore & Offshore)" The speaker told the audience that the Jubilee Field lies within the WCTP and DT blocks offshore Ghana, approximately 63 km from the coastline in water depths of 900m to 1,400m

Jubilee Field was discovered in the Deep-water West Cape Three Points (WCTP) & Deep-water Tano Blocks in June 2007 by a Consortium of Companies:

Kosmos Energy Ghana (HC)

Tullow Oil, Partner (Unit Operator)

Anadarko Corporation

EO Group, Partner

Sabre Oil, Partner

Together with Ghana National Petroleum Corporation. Moreover, there is a **Jubilee Fields –Development Plan**

Phase1 production started in the 4th Quarter of 2010. It includes:

- Exploit 278 Million Barrel Reserve
- 120,000 Barrel/Day Oil Production
- 120-160MMSCF/Day Gas Production
- Drill 16 wells (9 producer, 2 gas injector, 6 water injectors)
- Wells tied back via subsea infrastructure to FPSO moored in the Field

Phase 2 production starts in 2013

- Additional infrastructure required
- 240,000 Barrel/Day Oil Production
- 240-320MMSCF/Day Gas Production

Produced Gas will be piped to Shore or injected.

The speaker gave the house the **Reasons for Safety** at the workplaces:

- 1 Protect workers from the suffering caused by accidents and ill health
- 2 Reduce absence and sick leave
- 3 Retain staff
- 4 Maintain the organization's reputation
- 5 Productivity and profits
- 6 Reduce your insurance premiums and legal cost

The speaker informed the house that safety issues are approached according to Regulations, Procedures & Standards such as: International Labour Organisation (ILO) has regulations on occupational safety; the European Union has health and safety legislation guide safety issues. . In addition there are policies which guide safety at the work place such as the Health & safety policy which is reviewed and updated when conditions change.

These measures keep up with standards such as: International Association of Oil and Gas Producers (OGP), International Organization for Standardization (ISO), Occupational Safety & Health Administration and the British Standard Institute. A very important activity in all these is **Risk Assessment**. This activity follows a pattern, find out the hazard is identified first, Find out who is at risk, Find out the likelihood and consequence of the hazard occurring, Put control measures in place to

reduce the risk to acceptable level. Another important aspect of the Safety measures is the Emergency Response Plan. Key features of an emergency response plan:

An effective organizational structure for implementing the plan.

A good command and control structure for managing incident.

Suitable training and competency assessment

Allocating staff to roles within the emergency plan.

Clear and well rehearsed procedure which include human reliability and error issues.

The speaker emphasized the need for constant appraisal of the safety system.

The guest of honour, The Regional Minister in his speech acknowledged the efforts of Koforidua Polytechnic in organizing the Annual Applied Research Conference. He described the endeavour as a step in the right direction especially in this time of the Oil find Polytechnics are expected to take up relevant challenges that count towards the growth and development of Ghana.

Importantly, the Eastern Regional minister expressed the fervent hope that the Applied Research Conferences would establish academic links between the polytechnics in Ghana and beyond.

In the acceptance and closing remarks of the Chairperson of the Opening Ceremony, the Chairman, Mr. Richard Okra reminded the house that the oil find is a catalyst for the growth of the country. Particularly, polytechnics have the challenge through research and product development to impact the process and rate of growth and development. Therefore he called for collaboration between polytechnics and Industry as partners in development. The Polytechnics must design programs to benefit SMEs and SSEs.

Technical Sessions

The technical section took off after a group photograph on the first day of the conference. The sections run concurrently at two venues: Abba Bentil Theater and the Business Development Office.

In all thirty (30) papers were presented by sixty (60) people. These could be grouped generally into three groups: Engineering, Business and Applied Science. Moreover, Papers concerning the Oil Find were seven (7).

This year's conference witnessed a much collaborative papers; this could be seen from the number of presenters: as many as sixty-two (62) people were involved in the presentations.

Findings of papers concerned with the Oil include:

- There are peculiar safety hazards inherent in the operations of the oil, gas and related energy industries that have the potential of causing havoc to the environment and the citizenry if not eliminated, controlled or properly managed. Therefore, there should be comprehensive national safety regulations that could guide the operations of the oil, gas and related energy industries.
- The major environmental risk associated with oil waste has been identified to be **pipe vandalization** and operational **failure**. Therefore, the effect of oil waste should not be underestimated but must be handled with care because effects are enormous
- People have high expectations of benefits from the oil find. Therefore, proper management of people's expectations as well as prudent environmental management in the exploitation of Ghana's crude enhances tourism development especially in the twin cities, Sekondi and Takoradi.
- The National ICT Policy for Accelerated Development must be implemented since ICT in the Oil economy is highly relevant.
- A Petroleum Technology Development Fund should be established to educate and train professionals for the Oil industry
- The creative arts have their role to play in the Oil Industry: marine painting. The study highlights human creativity as the ultimate economic resource which the industries of the 21st Century will depend on.
- Varied textile products are used in the Oil industry; therefore, the textile industry must take advantage of the Oil find in Ghana.

Other findings in the Business and Applied Science include:

- The solid waste generated in the Koforidua community can be recycled.
- A comprehensive model on the process of (Job Rotation) JR was presented.
- Quality Automotive Engineering education can be done through industrial exposure and linkages.
- Lateritic gravel can be used as all-in aggregate for non structural concrete.
- The student attachment programme in Koforidua Polytechnic is considered effective in providing opportunities for application of class knowledge to real-world situations. Students do acquire practical skills and integrate academic work with industrial experience.
- Fired clay balls made from sawdust and clay is suitable for use in 'soak-away' than stones. The clay balls absorb water, prevent stench and could create jobs for people.
- The pollution of surface water bodies through human activities makes the underground an alternative source of water everywhere including the Koforidua Polytechnic.

- Results from physic-chemical and bacteriological parameters of sachet water sampled from the Koforidua Municipality indicated that sachet water sold in the Municipality complies with the Ghana standards on drinking water.

A highlight of the Conference was a sight-seeing trip to Boti Falls, Huhunya. Participants had the opportunity see the Umbrella Rock, the Boti Falls and the spectacular Palm Tree with two shoots.

The Conference ended with a dinner at which prizes were awarded to deserving presenters.

The Overall prize went to Messrs J. K. Ahimah and S. A. Ofosu who presented a paper on “Evaluation of the Quality of Sachet Water Vended in the New Juaben Municipality

Reporting Officers: Mrs. Charity Ossom

Mr. Bismark Agbelengor

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140	Charles Hackman Essel	Koforidua Polytechnic
141	Lydia Amoakoa Boateng	Koforidua Polytechnic
142	Michael Odaano	Koforidua Polytechnic
143	Millicent Boateng	Koforidua Polytechnic
144	Prince Nti Adjei Jnr	Koforidua Polytechnic
145	Prince Kennedy Jnr.	Koforidua Polytechnic
146	Benjamin Yeboah	Koforidua Polytechnic
147	Patricia Crentsil (Mrs.)	Koforidua Polytechnic
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149	Florence Ohenewaa Appiah	Koforidua Polytechnic
150	Grace Adutwumwaa Agyei	Koforidua Polytechnic
151	Rita Akorli	Koforidua Polytechnic
152	Mavis Gyanewa	Koforidua Polytechnic
153	Ruth Asabea Addo	Koforidua Polytechnic
154	Veronica Angmortey	Koforidua Polytechnic
155	Alexander Twum-Barima	Koforidua Polytechnic
156	Joseph Wilfred Baidoo	Koforidua Polytechnic
157	Xiaaba D. Yidana	Koforidua Polytechnic
158	Afrifa-Takyi Rachel	Koforidua Polytechnic

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5	Francesca Evans-Solomon	Takoradi Polytechnic
6	Solomon Obuobisa Ayeh	Takoradi Polytechnic
7	Sampong Ofori Anyinam	Takoradi Polytechnic
8	Papa Kofi Kum-Essuon	Takoradi Polytechnic
9	Moses Akrofi	Takoradi Polytechnic
10	Nii Armah Tagoe Hyacinth	GH. AFC. Staff Co.
11	Osei Owusu-Acheaw (Dr.)	Kumasi Polytechnic
12	John Kwasi Afriyie(Dr.)	Kumasi Polytechnic
13	Koranteng Christian (Dr.)	KNUST
14	Edmund Ameko	Accra Polytechnic
15	Sa-eed Alhassan	Accra Polytechnic
16	Sylvester Achio(Dr.)	Accra Polytechnic
17	Barbara Simons	KNUST
18	Kwaku Amofah	Sunyani Polytechnic
19	Emmanuel Kojo	GNPC
20	Joyce Oppong Akyaa	SDA SHS

LIST OF DIGNITARIES

S/N	NAMES	INSTITUTION
1	James Asante Baffoe	Regional Coordinating Council, E/R
2	Seth Foli	GNPC
3	Stella Ofosu Nti (Mrs.)	National Accreditation Board
4	Francis Owusu-Mensah	NABPTEX
5	Patricia Owusu-Darko (Dr.)	Kumasi Polytechnic
6	Joseph A.A. Sackey	Takoradi Polytechnic
7	Daniel A. Nyarko (Rev. Prof.)	Takoradi Polytechnic
8	Magdalene Bartrop Abakah (Mrs.)	Cape Coast Polytechnic
9	Daniel A. Nyarko (Rev. Prof.)	Takoradi Polytechnic
10	K.Y. Acquah	Takoradi Polytechnic
11	G.K.S. Aflakpui (Dr.)	Wa Polytechnic

12	J.V.K. Afun (Dr.)	Ho Polytechnic
13	John Bosco Azigiwe	Bolgatanga Polytechnic
14	Braimah A. Clifford (Dr.)	Tamale Polytechnic
15	N.N. Nso-Nuamah (Prof.)	Kumasi Polytechnic
16	K.T. Djang-Fordjour	Sunyani Polytechnic

LIST OF CONFERENCE PLANNING COMMITTEE

S/N	NAMES	STATUS
1	Nii Annang Mensah-Livingstone	Co-ordinator
2	Dr. (Mrs.) Smile Dzisi	Member
3	MacClean Lovelace-Dodoo	Member
4	Ebenezer Miezah Kwofie	Member
5	Frank Asare	Member
6	Lucy Agbenyeke (Mrs.)	Member
7	Victoria A. Kuusangyele	Member
8	Isaac Afranie	Member
9	Patience Kwakyewaa Asirifi	Member