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Editorial

Why the need for another journal?
The formation of this new journal, African Journal of Technical Education and Management (AJTEM) marks the evolution of technical education from its infancy to maturity. In the last two decades or so, African governments have embarked on improving technical education and training as a means of providing graduates with entrepreneurial skills to achieve desirable goals of employment, increased productivity and positive flow-on benefits to the rest of the economy. Although there are numerous media for the publication of articles in technical education, there have been some profound changes in technical education across countries in Africa. The complexity of evaluating the quality of training has meant it is time to devote an entire journal to focusing on technical education and assessing its impact on African economies.

The AJTEM has been established in response to the perceived need for policymakers, academics and economic agents engaged in a business activity of the importance of technical education and training. That, there is today a shortage of those with entrepreneurial skills to meet the challenges of a changing global economy. This journal is devoted to advancing scholarship in the areas of Science and Engineering, Technology, Applied Sciences, Business and Management Studies and the Arts. The AJTEM presents an excellent forum for reporting high-quality, original, and empirical findings which range from theoretical, conceptual and methodological framework to other national and international policy-oriented works. Furthermore, this journal would serve as a platform for policy discourse and the critical analysis of trends and developments in technical education in Africa and other developing countries. The articles published in this journal are refereed by experts in the field, and would also offer an opportunity for less formal communication that is presented as Research Note, Policy Note or Letter. Contributions are invited from all those engaged in policy formulation and implementation government, business decision making, and in academia.

We are indebted to the following personalities who did the pioneering work to kick-start the process for the establishment of the journal: Dr. Divine Novieto, Dr. Richard Gbadegbe, Dr. Martin Donani, Mr. Mathias Ashiboe-Mensah, Mr. Etornam Anku, Mr. Carlos Ankora, Mr. Noble Kuadey, Mr. Moses Kpordzo, and Ms. Lawrenda Adiasany.

This venture could not have been successful without the support of Management of Ho Technical University, Ho, Ghana. I would like to mention, in particular, the encouragement received from Professor Emmanuel K. Sakyi (Vice Chancellor) and Dr. Peter K. Agbodza. The Office of the Vice Chancellor has provided immense support to the speedy publication of the

journal. Special mention should be made of Mr. Michael T.K. Todoko and Mr. Magnus Akaba of the Ho Technical University. Special thanks to our expert reviewers who have significantly contributed to maintaining the high standard of AJTEM and look forward to their future participation in the review process of the journal.

Finally, the journal begins its journey, and I am pleased with the quality of articles submitted for publication in this inaugural issue. I look forward to the future submission of manuscripts for publication in the AJTEM.

Frank W. Agbola
Editor in Chief
University of Newcastle, Australia &
Visiting Professor, Ho Technical University, Ho, Ghana
August 2017

A note from the Vice Chancellor of Ho Technical University

I welcome you to the maiden volume of the African Journal of Technical Educational and Management (AJTEM). The AJTEM is part of the vision of the Vice Chancellor and captured in the 2011 – 2016 Strategic Plan of the Ho Technical University. Our objective is to create a platform for budding academics to publish original research. The journal also aim to provide a forum for critical theoretical and analytical discourse so as to extend the frontiers of knowledge about the problems of technical, vocational, engineering and management education in Africa and to generate new ideas and innovative solutions to tackle them.

International and multidisciplinary as the journal is, the articles in this volume examine and present findings in respect of the relevance of technical education, export crop production, ethnographic analyses of technological advancement in West Africa and Ghana in particular. Specific topics captured in this maiden volume include:

- The Political Economy of Food Safety in Export Crops Production in Ghana: A case of mango production and access to the export crops Market;
- Cultural assimilation of technology development in Ghana: an ethnographic approach;
- Occupational health and safety practices: an assessment of the electricity company of Ghana;
- The role of the new technical universities in the improvement and implementation of TVET in Ghana;
- Industry Skills Need and Skills Level met by Polytechnic Engineering Graduates in Ghana and Sierra Leone; and
- Effect of Sunlight on the Vitamin C content of watermelons

It is our hope that the journal will be patronized by both local and international authors.

Prof. Emmanuel K. Sakyi
Interim Vice Chancellor
Ho Technical University, Ho, Ghana

Effect of Sunlight on the Vitamin C Content of Watermelons

ABSTRACT

The study was carried out to investigate the effect of sunlight on the vitamin C content of watermelons. Nine watermelons were selected from a farm in Greater Accra for vitamin C analysis at the Food Research Institute in Accra. The factorial experimental design was used to determine the amount of vitamin C in sliced and unsliced watermelons kept at room conditions and those exposed to sunlight. Among the findings were that the loss of vitamin C from whole and sliced watermelons under room temperature and when exposed to sunlight ranged between 12.2% and 66.2%. The loss was greater when the watermelons were sliced and exposed to direct rays of the sun. It is recommended that watermelons should be kept in cool temperatures and should be consumed immediately once they are sliced so as to limit vitamin C losses to some extent. Again, it is recommended that traders and consumers should be educated on the importance of vitamin C for health, its instability as well as factors that cause the losses so as to help avoid keeping watermelons in the scorching sun, whether sliced or whole.

Keywords

Sliced watermelons, Sunlight, Watermelons, Vitamin C.

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INTRODUCTION

Background

Within the last few years, the relationship between food and health has become a concern for many people. People are becoming increasingly aware of what and how much to eat in relation to their health. King and Burgess (1998) posited that while balanced foods are eaten for health, eating for enjoyment is also important to many people today, thus people are now very conscious of the kinds of food they select and eat. The foods eaten are chosen from different groups of food items, including fruits, and they are often eaten raw or mildly cooked. Many of these fruits contain vital substances which are essential for the effective metabolism of some other food nutrients (Roth, 2011). Some vitamins such as vitamin C (Ascorbic acid) and some B group vitamins are unstable since they are very sensitive to certain temperature conditions and thus they are easily destroyed by oxygen, light, heat and water.

Several studies have reported that vitamin C is very unstable (Barasi & Mottram, 1993; Fox & Cameron, 1995; Mateljan, 2011; Savage & King, 1998). The loss of vitamins in foods, especially vitamin C has multifactoral causes, which include the handling practices of people-from the farms to the seller, at the market place and even by consumers in their homes. Other factors that can also lead to the loss of vitamin C may include the method of preparation of a particular fruit, production factors, climate, temperature, oxygen and even sunlight can considerable cause the loss of some nutrients in fruits.

In Ghana watermelons are one of the types of fruits which are cultivated on commercial scale mostly along the coast, in the Brong Ahafo region and some parts of the North. They are transported from the places where they are produced to places where they cannot be produced for marketing. From observation, one can conclude that the rate of production as well as the consumption of watermelon has risen in Ghana, and especially in the warm sunny season people are seen buying and consuming large amounts of watermelons. The production is very high between April and September and watermelons can be seen in heaps everywhere in the cities, along the streets and in the market. Watermelon producers are often seen and heard complaining bitterly about Governments' inability to assist them in marketing their products.

According to Vaclavik and Christian (2008), food quality is an important concept since the choice of food for consumption is dependent on the quality of the food. One can see producers of watermelons pile them along the roadsides waiting for transport to carry them to the sales points. The traders also stack the watermelons in big, often unclean trucks, boxes and basins, thus rendering them bruised, cut and often together with spoiled ones. These handling practices do not augur well for the vitamins in the fruits as sunlight, bruises, cuts, wilting are known to destroy vitamin C (Barasi & Mottram, 1993).

Watermelons are consumed by a number of people in the country these days. Producers and traders are seen transporting heaps of watermelons in big trucks from far places to the marketing centres and also heap them along the roads under the tropical sun, particularly when they are in season. The watermelon retailers are seen carrying sliced watermelons, covering them with transparent polythene bags and hawking them in the scorching sun everywhere because they cannot carry big and

heavy watermelons. They are seen in markets, along the streets, at work places as well as near residential apartments. From informal conversations with colleagues and friends as well as relatives, it can be deduced that some people eat watermelons due to its colourful nature and the water content which is refreshing and is believed to quench thirst especially during hot afternoons. For most Ghanaians who eat watermelons, the considerations in selecting watermelons are based on the physical appearance (whether it is bruised or not), the outer colour (which ranges from light green to deep green), and the inner colour which also ranges from rose pink to deep red. Aside these, some consumers consider the inconveniences of carrying whole watermelons which are quite heavy, from the market place to their homes or work places. Sometimes too, watermelons can be very expensive especially when it is getting out of season and as a result, most consumers find it difficult to purchase whole fruits and so they select the sliced watermelons.

Vitamin C is known to be very important for the growth and repair of tissues in all parts of the body. Ehrlich (2009) and Medlineplus (2010) posit that vitamin C helps the body to make collagen, an important protein used to develop the skin, cartilage, tendons, ligaments, and blood vessels. Vitamin C is essential for healing wounds, and for repairing and maintaining bones and teeth. Further studies by Ehrlich proved that vitamin C is an antioxidant and it blocks damages made by free radicals which occur naturally when our bodies transform food into energy, and it also boosts the immune system functions. Other health benefits of vitamin C provided by Ehrlich are: lowering of cholesterol levels and reduction of the overall risk of heart attack, as well as the protection of arteries against damage. Commenting on the popular belief of most people that vitamin C helps in curing cold, Ehrlich concluded that scientific evidence does not support this notion, rather regular intake of vitamin C produces only a small reduction in the duration of a cold. Vitamin C helps in healing burns and wounds and in the treatment of allergy-related conditions, such as asthma, eczema, and hay fever, also called allergic rhinitis (Ehrlich, 2009; Medlineplus, 2010).

The numerous health benefits of vitamin C do not go without caution. Studies by a number of researchers including Barasi and Mottram (1993), Bryan (2000), Chang and Fernandes (2000), Khander (2004), Mullick (2007) and Stevens (1980) found a number of factors causing the depletion of vitamin C in fruits. Notable among the factors are: Oxygen, found to be the most destructive element in causing degradation of vitamin C; fructose, production practices such as the use of fertilizers and other agricultural chemicals, heat, ripening, addition of sodium bicarbonate, among others. This study has been carried out to investigate the effect of sunlight on vitamin C content in watermelons so as to suggest the best ways watermelons should be handled to prevent loss of vitamin C.

Statement of Problem

Watermelon is an excellent source of vitamin C. As a matter of fact, high intakes of vitamin C and beta-carotene have been shown in a number of scientific studies to reduce the risk of heart disease, reduce the airway spasm that occurs in asthma, reduce the risk of colon cancer, and alleviate some of the symptoms of osteoarthritis and rheumatoid arthritis. A cup of watermelon juice provides 24.3% of the daily value for vitamin C, (Mateljan, 2011). It also contains other nutrients in different

proportions.

According to Barasi and Mottram (1993), sunlight destroys vitamin C and also the wilting, bruising and exposure of cut surfaces do decrease vitamin C levels in watermelon. Temperatures above 85oC and oxidizing enzymes can also destroy the vitamin C in watermelons. Further studies by Barasi and Mottram revealed that keeping fruits under the sun for some time is very destructive to vitamin C and that when fruits are kept under the sun for 15 minutes, a quarter of the original amount is lost and after 90 minutes three quarters is lost. Barasi and Mottram argued that the problem is greater when fruits are transported from farm gates under the sun to distant markets; in this case the loss is inevitable. Mateljan (2011) also added that sun-drying of fruits results in loss of vitamins. For example, when mangoes are sun dried, it results in the loss of 94% of beta- carotene and 84% of vitamin C. Mateljan therefore recommended that consumers should choose fresh fruits over dried fruit.

As whole watermelons are heaped in the sun or sliced watermelons are being hawked under the high scorching tropical sunlight, producers, transporters, traders as well as consumers buy them, unaware of the effects of sunlight on the nutrients in the watermelon, especially the vitamin C content. Vitamin C is important in the body as it acts as an antioxidant, prevents scurvy, helps wounds and cold to heal fast. If we buy watermelons that have almost lost all its vitamins C, then it is of much concern to public health. Ghana is in a tropical zone and the intensity of sunlight is quite high for most part of the year. Barasi and Mottram (1993) came out with a revelation that the variety of watermelon used; the levels of maturity of the watermelon; the locality and soil type and the freshness of the watermelons affect the amount of vitamin C content. There is therefore the possibility that an appreciable amount of vitamin C might have been lost even before consumers buy them, judging from the manner the fruit is handled by traders and the number of days watermelons are left in the sun before consumers get them. The study was therefore instituted to find out the seriousness or otherwise, of the effect of sunlight on the vitamin C content in watermelons being sold in our markets.

Significance of the Study

Ghana is in a tropical zone and the intensity of sunlight is quite high for most part of the year. Consumers buy watermelons without considering the loss of nutrients, particularly vitamin C, which is very unstable to heat. The results of the research would be used to suggest effective ways of transporting and keeping watermelons on the markets to prevent direct sunlight exposure leading to loss of vitamin C. The results, if adopted, will be of help to people to know the best conditions under which watermelons can be purchased. It will also assist Community and Public Health personnel in their health education programmes in addressing the problem of lack of vitamins C in communities.

Limitations and Delimitations

The study has some limitations in that vitamin C is one of the most unstable vitamins and factors such as the type of soil on which the watermelon crops are cultivated, the time of harvest, place of harvest, the plant from which the watermelons are obtained and even the positions of the watermelons on the plant can affect vitamin C content of watermelons. In addition to these, how the watermelon samples are collected, how samples are transported

to the laboratory so that there are no bruises or damages and the level of maturity (which should be the same with all the samples), do affect the results. In addition, even if a single day elapses before the experiment is undertaken; it can affect the results of the experiment.

The above factors were taken into consideration as much as practicable for accurate results and the assistance of the farm manager was sought. The first attempt at minimizing the above problems were: i). Because the analysis was to be done at the Food Research Institute, a watermelon plantation close to the research institute was selected; ii). The fruit samples were collected from the same type of soil on which the watermelon crops were cultivated. The time, place of harvest and the plant from which the watermelons were obtained were therefore not different. The level of maturity was the same with all the samples. The watermelon samples were collected, placed in similar big ice chests and transported to the laboratory on the same day at the same time and care was taken so that there were no bruises or damages. The bases of the study were limited to the effects of sunlight on watermelons samples collected from a farm close to Accra and so the results may not be generalized to all watermelons in the country.

LITERATURE REVIEW

Health Benefits of Fruits

According to Khader (2004), fresh fruits contain (70- 96%) water, (3 - 27%) carbohydrate and (0 - 3.1%) fibre, and a low amount of protein, fat and minerals. Also, fruits are important sources of pro-vitamin A and vitamin C. Fruits contain pigments which are responsible for their colour. The orange-yellow fruits contain beta- carotene which is converted to vitamin A when absorbed from the digestive tract. Most fruits contain edible parts and inedible parts. Khadder added that fruits such as banana, sweet lime, oranges and pineapple contain a third or more inedible roughage. The carbohydrate content of fruits varies from 3% in watermelon to 27% in banana. Most of the energy from fruits (80-96%) is provided by the sugar present. Therefore fruits or fruit juices are given when a quick source of energy is needed. Examples are appetizers and as refreshing drinks for athletes. Some dry fruits are rich in minerals such as calcium and iron. The cellulose and the laxative property of fruit acids also safeguards against constipation, especially in a meat diet (Kinne, 2009).

Fruits are usually sweet and acidic in nature, and have a protective tissue which takes the form of rind, skin, and peel (Decuyprere, 2000). A research reported in 'nutrition-and-you.com' (2011) concluded that many fruits have very high anti-oxidant values which is something measured by their "Oxygen Radical Absorbent Capacity" or ORAC. Anthocyanin, a flavonoid, are found in some blue fruits like blue-black grapes, mulberries, acai berry, chokeberries, blueberries, blackberries, and in many vegetables featuring blue or deep purple colour. These compounds have potent anti-oxidant properties. Taking fruits as part of diet is one sure way to a healthier body. A daily intake of fruits can be of great benefit to the body in various ways. For instance, eating a healthier diet to help lose weight, or just a way to become more energetic, a diet high in fruits, vegetables and whole grains is a great way to start. Again, eating more fruit makes the body feel better.

It is common knowledge to drink lots of water. However, some people do not get the recommended six to eight daily glasses of water. Fruits luckily contain 80% water, so adding fruit to diets increases the overall water

intake. No other food on this planet exists that has that much amount of water. Digestive problems such as constipation, diarrhoea or abdominal cramping, can be alleviated by eating fruit. Fruits that contain natural fiber can also help regulate bowel movements. Fruits have also been proven effective when it comes to lowering cholesterol levels. This can help prevent strokes and heart diseases.

Watermelon and its Nutritional Value

The following is a description on the nutritive value of watermelons as given by Mateljan (2011). Watermelon also scientifically known as *Citrulluslanatus* belongs to the family Cucurbitaceae. It is a vine-like (scrambler and trailer) flowering plant originally from southern Africa. Some Botanists refer to watermelon as 'pepo', a berry which has a thick rind (exocarp) and fleshy center (mesocarp and endocarp). Watermelon is derived from an inferior ovary, and is characteristic of the Cucurbitaceae. The watermelon fruit, loosely considered as a type of melon, although not in the genus Cucumis, has a smooth exterior rind (green, yellow and sometimes white) and a juicy, sweet interior flesh (usually pink, but sometimes orange, yellow, red and sometimes green if not ripe) (Mateljan, 2011).

Watermelon is also related to the cantaloupe, squash and pumpkin and other plants that also grow on vines on the ground. Watermelons can be round, oblong or spherical in shape and feature thick green rinds that are often spotted or striped. They range in size from a few pounds to upward of ninety pounds. It is mostly in season or available during summer or sunny seasons.

Watermelon is an excellent source of vitamin C and a very good source of vitamin A, notably through its concentration of beta-carotene. As a matter of fact, high intakes of vitamin C and beta-carotene have been shown in a number of scientific studies to reduce the risk of heart disease, reduce the airway spasm that occurs in asthma, reduce the risk of colon cancer, and alleviate some of the symptoms of osteoarthritis and rheumatoid arthritis. A cup of watermelon juice provides 24.3% of the daily value for vitamin C, and, through its beta-carotene, 11.1% of the DV for vitamin A (Mateljan, 2011). It also contains other nutrients in different proportions. Figure 1 shows the nutritive value of a diced watermelon;

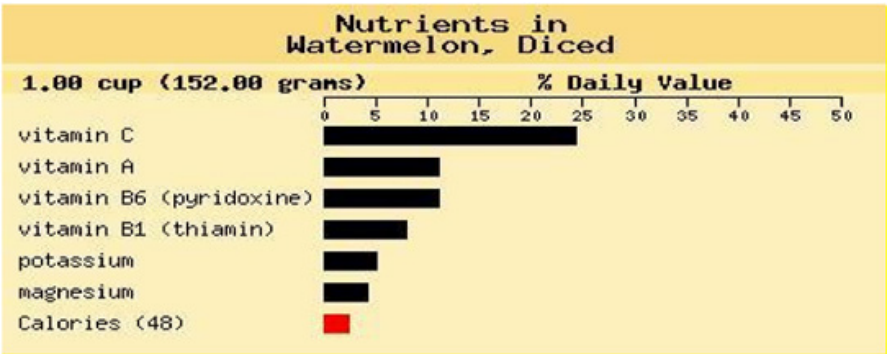

Figure 1: Nutritional Content of Watermelon

Source: Mateljan (2011)

Vitamins

Generally, vitamins are defined as essential organic substances that are used in trace amounts. Examples of vitamins include vitamins A, D, E and K, and these are fat-soluble vitamins, while vitamins C and the B complex group are water-soluble vitamins (Johnson, 2003).

Vitamin C (Ascorbic Acid)

Chang and Fernandes (2000) reported that in the 1753, there was a discovery that citrus fruits, which contain large amounts of ascorbic acid, were able to cure scurvy. Vitamin C, a water- soluble vitamin has the chemical formula C6H8O6, and it is an organic compound of carbon, hydrogen and oxygen. It can be prepared by mammals but humans and other primates as well as bat obtain vitamin C from food. Fresh fruits and vegetables provide abundance of vitamin C if only there is absence of heat, water, light and oxygen (Chang & Fernandes, 2000).

There are fruits such as guava and cashew fruits, which are extremely good sources of vitamin C, providing 135 to 600mg of vitamin C per 100g of the edible part of the fruit (Khader, 2004). Some excellent sources of vitamin C are oranges, green peppers, watermelon, papaya, grapefruit, cantaloupe, strawberries, kiwi, mango, broccoli, tomatoes, Brussels sprouts, cauliflower, cabbage, and citrus juices or juices fortified with vitamin C. Raw and cooked leafy greens (turnip greens, spinach), red and green peppers, canned and fresh tomatoes, potatoes, winter squash, raspberries, blueberries, cranberries, and pineapple are also rich sources of vitamin C. Vitamin C is sensitive to light, air, and heat, so most of the vitamin C is obtained if fruits and vegetables are eaten raw or slightly cooked.

Vitamin C is important for the growth and repair of tissues in all parts of the body. It helps the body to produce collagen, an important protein used to develop the skin, cartilage, tendons, ligaments, and blood vessels. Vitamin C is essential for healing wounds, and for repairing and maintaining bones and teeth (Davies, 1995; Ehrlich, 2009; Medlineplus, 2010).

From further studies made by Ehrlich (2009), vitamin C is an antioxidant. This antioxidant blocks damages made by free radicals which occur naturally when our bodies transform food into energy. It is known to provide the body with some health benefits. Vitamin C is said not to lower cholesterol levels or reduce the overall risk of heart attack, but evidence suggests that it may help protect arteries against damage. According to Ehrlich, the popular belief of most people is that vitamin C helps in curing cold but scientific evidence does not support this notion. But rather regular intake of vitamin C produces only a small reduction in the duration of a cold. Other health benefits of vitamin C provided by Ehrlich include the following:

i. Boosting immune system function;
ii. Maintaining healthy gums;
iii. Improving vision for those with uveitis (an inflammation of the middle part of the eye);
iv. Treating allergy-related conditions, such as asthma, eczema, and hay fever (called allergic rhinitis);
v. Reducing effects of sun exposure, such as sunburn or redness (called erythema);
vi. Alleviating dry mouth, particularly from antidepressant medications (a common side effect from these drugs);
vii. Healing burns and wounds; and
viii. Decreasing blood sugar in people with diabetes (Ehrlich, 2009).

Factors that Cause Depletion of Vitamin C in Fruits

In an earlier research by Stevens (1980), oxygen was found to be the most destructive element in causing degradation of vitamin C. In the same study, he also found that a major sugar (fructose) which was found in fruits also causes the depletion of vitamin C and therefore concluded that the higher the fructose content the greater the loss of vitamin C. Further studies by Stevens showed that the production practices, such as the use of fertilizers and other agricultural chemicals, could affect the vitamin C levels of fruits.

In a similar research by Bryan (2000), heat was revealed as a factor that depletes the levels of vitamin C. The total available heat in climate also affects vitamin C levels of fruit. Areas with cool temperatures produce fruits such as watermelons and oranges which have high vitamin C content. Ripening is another factor that causes vitamin C depletion in fruits and should be avoided. Addition of sodium bicarbonate greatly increases the destruction of vitamin C and should be avoided (Mullick, 2007). In another related study by Chang and Fernandes (2000), vitamin C is denatured in the skin by exposure to blue light and also to ultra violet light. The evidence helps to conclude that exposure to factors such as heat, water, light and oxygen depletes the amount of vitamins of fruits.

The Effect of Sunlight on Vitamin C of Watermelon

According to Barasi and Mottram (1993) and Tull, (1996), sunlight destroys vitamin C and also wilting, bruising and exposure of cut surfaces do decrease vitamin C levels in watermelon. Temperature above 85oC and oxidizing enzymes can also destroy the vitamin C in watermelon. Further studies, by Barasi and Mottram and Tull, show that fruits kept under the sun for some time is very destructive to vitamin C. When kept under the sun for 15 minutes, a quarter of the original amount is lost and after 90 minutes three quarters is lost. The problem is greater when fruits are transported from farm gates under the sun to distance market. In this case, the loss is inevitable. In a related study, sunlight was found to decrease the jelly power of pectin; that is, degradation of pectin found in the walls of fruits may occur if the fruits are kept under the sun above 80oC. This makes the jelly tough due to over concentration.

Matelyan (2006) stated that sun drying of fruits results in loss of vitamins. For example, when mangoes are sun dried, it results in the loss of 94% of beta- carotene and 84% of vitamin C. Therefore, he recommended that fresh fruits should be chosen over dried fruit.

METHODOLOGY

Research Design

This study was an experimental research. An experimental research design has at least, one independent variable which is manipulated and then what will happen to the subjects is observed (Amedahe, 2005). The experimental design was useful in the determination of the vitamin C content of watermelon samples placed under different conditions in the study. In the experimental design, there is a control over one or more factors in the study that may influence the behaviour of the other variable. Amedahe (2005) again added that in the experimental design, the researcher manipulates a factor. In this study, the watermelon samples were placed under different conditions and the vitamin C content in the watermelon samples were

assessed. The type of experimental design used was a factorial design. This is applicable when more than one independent variable is included in the study. Factorial designs are basically elaboration of true experimental designs and permit investigation of two or more variables individually and in interaction with each other. From the definition the independent variables used were sunlight and the different temperature conditions (Amedahe, 2005; Owens, (2002).

Population

The population for the study was centered on watermelons. It was not possible to get the population of all watermelons produced in the Greater Accra region, neither was it possible to get the quantity of watermelons farms in and around Tema. The watermelons were picked from a farm near Accra, on the way to Tema because it is closer to the Food Research Institute. Proximity to the Food Research Institute was based on the warning by Barasi and Mottram (1993) who state that even if a single day lapses before the experiment is undertaken or the fruit is eaten, the vitamin C content is lowered.

Sample and Sampling Techniques

Samples of watermelon were collected from the selected farm at 6:00am. With assistance from the farm manager, nine fruits were picked from the same creeping watermelon plant but caution was taken to make sure all the fruits had the same level of maturity, had no bruises or cracks as vitamin C content can be influenced by these conditions (Mullick, 2007). They were placed in big chests, well covered and transported in a private car to the Food Research Institute, Accra so that the fruits do not roll up and down in the vehicle. All these precautions were taken to make sure there were no bruises or cuts.

Instruments

The following instruments were used in the determination of the vitamin C of the watermelon samples.

A. Vitamin C Determination

i. Distilled water
ii. 5ml methaphosphoric acid
iii. Knife
iv. 150ml volumetric flask
v. Squeezer
vi. Pipette
vii. Burette
viii. Filter
ix. Watermelon juice

Data Collection Techniques

The first aspect of the data collection involved the determination of vitamin C of watermelons right after harvest and the losses which occur after exposure to sunlight. At the institute, the watermelons were thoroughly cleaned of any impurities. The nine samples of watermelons collected were used as follows: one whole watermelon was used as the control; four sliced watermelons were tested at different temperatures and time of the day and four whole watermelons tested at different temperatures and time of the day. The times of the day the tests were carried out were 11:00am, 1:00pm and 3:00pm.

Determination of Vitamin C (Ascorbic Acid) Content of Watermelons (Pre-test)

The Standard Indophenols Method was used in the determination of vitamin C. The Comparative Titration Method was employed:

Procedure:

1. Squeeze out juice from watermelon using a squeezer.
2. Strain juice with a sieve to separate juice

from chaff.

3. Pipette 10ml of watermelon juice into 150ml volumetric flask
4. Add 5ml of 20% metaphosphoric acid as stabilizing agent and make up to the maven with 1 00ml of distilled water.
5. Add 2ml of acetone to the solution.
6. Titrate with 2-6 dichlorophenolindophenol solution until a faint pink colour persists for about 15 seconds.
7. Calculate the vitamin C content in the sample as mg per 100ml.

The nature of the study demanded analyses of whole and sliced watermelons in order to determine the effects of varying temperature on the vitamin C content, and then compares results so as to make inferences from them. Some of the samples were kept at room temperature and some in the sun at different times of the day from 1 1.00am, 1.00pm and 3.00pm. Juices from samples of whole and sliced watermelons were tested at 2 hours intervals and the tests were done in triplicate. This procedure was applied to each sample of watermelon in order to collect data on the vitamin C content of the whole and sliced watermelons at room temperature and after exposure to the sunlight.

Data Analysis

The analysis of the data was done manually. Each computation was based on Mass of Vitamin C (mg) per 100mls of juice. The mean for each sample was computed based on Mass of Vitamin C (mg) per 100mls of juice. The data is presented using a table.

RESULTS AND DISCUSSION

Determination of Vitamin C (Ascorbic Acid) Content of Watermelons

Juices from samples of whole and sliced watermelons were tested at 2 hours intervals and the tests were done in triplicate and then the mean for each sample was computed. Data presented in Table 1 presents the results obtained after the experiment.

Sample		Time Intervals	Mass of Vitamin C (mg/100ml)	% of Vitamin C	Mean Vitamin C loss (mg/ 100ml)	% Loss
Control		0 hours	7.4mg	100	-	-
Sliced watermelon, temperature	sun	2 hours	3.7mg	50.0	3.7mg	50.0
Sliced watermelon, room temperature		2 hours	5.7mg	77.0	1.7mg	23.0
Whole watermelon, temperature	sun	2 hours	5.0mg	67.6	2.4mg	32.4
Whole watermelon, room temperature		2 hours	6.5mg	87.8	0.9mg	12.2
Sliced watermelon, temperature	sun	4 hours	2.5mg	33.8	4.9mg	66.2
Sliced watermelon, room temperature		4 hours	3.7mg	50.0	3.7mg	50.0
Whole watermelon, temperature	sun	4 hours	3.5mg	47.3	3.9mg	52.7
Whole watermelon, room temperature		4 hours	5.7mg	77.0	1.7mg	23.0

Source: Field Data, 2015

Table 1: Vitamin C Levels in the Various Samples of Watermelons

The mass of vitamin C obtained in the juice for the control, which was kept at the laboratory temperature of about 250C, was 7.4mg/100mls and the mass was taken as 100.0% of vitamin C (United States Department of Agriculture, 2011). All the results were compared with 7.4mg/100mls to get the actual mass of vitamin C at the end of the two hours interval. Table 1 presents the vitamin C levels in the various samples of watermelons used.

An examination of Table 1 indicates that there were differences in the mass of vitamin C in the various samples of watermelon and the details are as follows:

a. The mass of vitamin C in the juice of the sliced watermelon kept in the sun temperature from 11:00 am to 1:00pm (2 hours) was 3.7mg/100ml, which meant 50% vitamin C loss. The juice from the sliced watermelon kept at room temperature from 11:00am to 1 :00pm (2hours), had a mass of 5.7mg/100ml, representing a percentage 77.0% of vitamin C. The amount of vitamin C loss was 1.7mg and its percentage was 23.0%.
b. The mass of vitamin C in the juice of the whole watermelon kept at sun temperature from 11.00am till 1.00pm (2 hours) was 5.0mg/100ml (67.6%) and the percentage of vitamin C loss was 32.4%. The juice from the whole watermelon kept at room temperature from 11 .0am till 1:00pm (2hours), had a mass of 6.5mg/100ml of vitamin C and a percentage of 87.8%. The amount of vitamin C loss was 0.9mg, and its percentage loss was 12.2%.
c. The juice from the sliced watermelon kept at room temperature from 11 .00am to 3:00pm (4 hours), had a mass of 3.7mg/100ml and a percentage of 50.0%. The amount of vitamin C loss was 3.7mg and its percentage loss was also 50.0%. The mass of vitamin C in the juice of the sliced watermelon kept at sun temperature from 11 .00am to 3:00pm (4 hours) was 2.5mg/1 00ml with a percentage of 33.8% and the percentage of vitamin C loss was 66.2%.
d. The mass of vitamin C in the juice of the whole watermelon kept at sun temperature from 1 1.00am to 3:00pm (4 hours) was 3.5mg/100ml, with a percentage of 47.3% and the percentage of vitamin C loss was 52.7%. The juice from the whole watermelon kept at room temperature from 1 1.00am to 3:00pm (4 hours) had a mass of 5.7mg/100ml and a percentage of 77.0%. The amount of vitamin C loss was 1.7mg and its percentage was 23.0 %.

The first result of interest was that of the control. According to United States Department of Agriculture (2011), a 100g of watermelon contains 8.1mg of vitamin C. However, the results from this study indicate that the control sample had 7.4mg/100ml of vitamin C, which is lower than the vitamin C content of watermelon from the USA. The difference in values of the vitamin C is not surprising and it also gives credence to the fact that in a similar research by Bryan (2000), heat was revealed as a factor that depletes the levels of vitamin C. Bryan further found out that the total available heat in climate also affects vitamin C levels of fruit and so areas with cool temperatures produce fruits such as watermelons and oranges which have high vitamin C content. Accra is in a warm area so the vitamin is likely to be lower than the watermelons from USA.

The results also confirm that a number of factors identified by Barasi and Mottram (1993) and Mullkick (2007) as being the reasons for changes in values of vitamin C, even from the same fruits are very real and should be of concern to consumers. These included: The variety of watermelon used; the levels of maturity of the watermelon; the locality and soil type for the cultivation also result in the difference in value of vitamin C and in addition, even if a single day lapse before the experiment is undertaken or the fruit is eaten, the vitamin C content is lowered (Barasi & Mattram, 1993).

The loss of vitamin C in watermelons in the presence of sunlight or heat obtained in this study therefore confirms a number of studies on effects of light /sunlight on vitamin C. For example, in a research by Stevens (1980), oxygen was found to be the most destructive element in causing degradation of vitamin C. In a similar research by Bryan (2000), heat was revealed as a factor that depletes the levels of vitamin C. Bryan further found out that the total available heat in climate also affects vitamin C levels of fruit. Areas with cool temperatures produce fruits such as watermelons and oranges which have high vitamin C content. According to Chang and Fernandes (2000), fresh fruits and vegetables provide abundance of vitamin C if only there is absence of these conditions: heat, water, light and oxygen.

From all results from this experimental study, it is clear that sunlight had a negative effect on vitamin C of watermelons in this study. Also the loss was greater when the watermelon was sliced and kept under the sun. In spite of the fact that a number of these factors could not be completely controlled; there is adequate evidence of the instability of vitamin C in fruits and vegetables, and for this study watermelons in particular.

CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to investigate the effect of light on the vitamin C content of watermelons. The specific objective focused on the effect of sunlight on the vitamin C content of selected fresh whole and sliced watermelons kept in the room and in the sun. These were tested after two hours intervals. Factorial experimental design was used as the research design for the study and the analysis was carried out manually.

The major findings of the research objectives were as follows: After two hours of exposure of sliced watermelons to the sun, there was a 50.0% loss of vitamin C and after four hours the loss was 66.2%. However, the loss of vitamin C of sliced watermelons kept at room temperature for two hours was 23.0% and after four hours the loss was 50.0%. After two hours of keeping whole watermelons under the sun the amount of vitamin C loss was 32.4% and after four hours the vitamin C loss was 52.7%. This means the difference in vitamin C loss in the whole watermelons kept at room temperature for two hours was 20.2%. After four hours of keeping whole watermelons under sun, the amount of vitamin C loss was 52.7% as compared to whole watermelons kept at room temperature which had a loss of 23.0%. Thus the difference in vitamin C loss in the two samples was 2 9.7%.

Based on the findings from the study, this paper posits that the losses of vitamin C in whole watermelons kept in the room are lower than those exposed to sunlight. The losses of vitamin C in sliced watermelons kept in the room are lower than the sliced watermelons exposed to

sunlight. Losses in the sliced watermelons are greater than those of whole watermelons. The loss of vitamin C in watermelons increases its exposure to sunlight also increases.

From the general review of the related literature and the results of the study, which confirm that sunlight brings about the loss of vitamin C content in watermelons, this paper recommends that consumers need to buy whole watermelons that are kept under shade, and if possible from the cool rooms of supermarkets and fruits and vegetables stores. Again, as much as possible, all individuals and institutions involved in the production and marketing of watermelons should make it a point to prevent exposure of watermelons to sunlight and high temperatures. In addition, watermelons that are harvested should be transported to consumers in acceptable conditions, such as packing them in large covered boxes. They can also be transported in well-ventilated cargo vehicles or at the back of open vehicles, covered with thick fabrics during the transportation. In the marketing of watermelons to consumers, the usual practice of keeping heaps of watermelons exposed to sunlight must be avoided. Furthermore, the general public should be educated on the importance of vitamin C (Ascorbic Acid) to health, factors that will deplete it and how to prevent or limit vitamin losses in food items generally.

In conclusion, further research should be carried on to determine the vitamin C content of watermelons that have been harvested and kept for periods between two and seven days. Another study can be carried on the vitamin C content of watermelons produced from different parts of the country.

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Food Safety and Mango Export Crop Production in Ghana

ABSTRACT

This article investigates Ghana's agriculture policy on food safety and safety compliance. The research was conducted in Yilo Krobo and Kintampo North, two major mango growing districts in Ghana. Primary data was collected from forty-three (43) respondents made up of 32 farmers and 11 key informants from key state institutions, development partners and processors. The study concludes that close proximity of food safety standards compliance bodies, bilateral and multilateral cooperation by injection of funds, input and skills training play major roles in food safety compliance. Embargo (sanctions) and economic power (money) are resources at the disposal of regulating bodies and consumers' to invoke for non-compliant to food safety standards. These resources are deterrent enough to compel mango producers and exporters to adhere to production standards. The author recommends that state funding to the institutions and agencies responsible for food safety enforcement and monitoring should be regular to sustain the momentum on compliance with food safety.

Keywords

Food Safety, Kintampo, Mango, Yilo Krobo.

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INTRODUCTION

Ghana is noted for its intercontinental trade in export crops such as Cocoa, Coffee, Palm Oil and Shea butter (Frimpong-Ansah, 1991; Killick, 1978; Mikell, 1989;). The country's trade in these commodities significantly integrates the economy into the international division of labour. The production of cocoa, oil palm and shea trees led to the intrusion of smallholder farmers into the frontiers of virgin forest (Amanor, 1994; Hill, 1963). Several studies on Ghana's major export crop production noted that though cocoa and oil palm production are dominated by male adults, the same cannot be said of shea whose extraction and processing into butter is mainly the preserve of adult female folks (Chalfin, 2004; Daddieh, 1994; Hill, 1963; Mikell, 1989). The literature further stated that the commercial organisation of production of cocoa, oil palm and shea butter which started in the late 19th century was dominated by smallholder farmers (Amoah, 1998; Mikell, 1998; Hill, 1963).

The economic fortunes of cocoa production and export to Ghana's socio-economic development are enormous (Frimpong-Ansah, 1991; Killick, 1978; Mikell, 1998). Revenue accrued from cocoa export was expended on infrastructure development, provision of social amenities, payment of salary to public sector workers and scholarship scheme for cocoa farmers' children/dependents and outstanding Ghanaian scholars (Amoah, 1998; Frimpong-Ansah, 1991; Killick, 1978; Mikell, 1998). However, cocoa production dropped and foreign exchange earnings fell in the 1970s and therefore cocoa's contribution to the economy dwindled (Killick, 1978; Frimpong-Ansah, 1991; Dzorgbo, 2001). Major factors which influenced the fall in production were: farm neglect due to lower producer price of cocoa, high import tax on production inputs, and cocoa smuggling into neighbouring countries (Gyemah-Boadi and Jeffries, 2000; Dzorgbo, 2001; Chalfin, 2004). The situation worsened in the 1980s to the extent that the then Rawlings-led government prioritised diversification of export crops production particularly mango.

The literature on export crops production in Ghana is replete with anthropological and sociological analyses of foreign agencies and state policy influences in the implementation of food safety standards in cocoa, palm oil and shea butter processing and export (Amoah, 1998; Daddieh, 1994; Chalfin, 2004). The same cannot be said of mango in Ghana. The literature on compliance with food safety standards in the cocoa industry in Ghana shows that the state intervened to safeguard safety of exportable cocoa beans (Amoah, 1998). Globally, literature on food safety indicated that compliance with food safety standards is achievable through schemes such as contract farming and farmer based organisation (Narrod et al, 2008; Humphrey and Schmitz 2001). However, the Ghanaian context on food safety did not give details of whether contract farming or farmer based organisation schemes were used to ensure food safety compliance.

Thus, in order to fill the sociological gap in the literature on the emerging mango industry in Ghana, this paper investigates the state's policy on food safety compliance and its influence on multiple extension services delivery in ensuring food safety, as well as the processes of integrating mango farmers into the global food safety standards compliance.

The rest of the article is organised into seven sections which are as follows: Section II looks at the global perspective of food safety in crop exports. This is followed by section

III which deals with the compliance of food safety standards in the cocoa export crop production in Ghana, and serves as a precursor to the safety standards in other horticultural export crops production. Section IV focuses on a brief historical trajectory of mango export crop production in Ghana. Sections V discusses the research methods employed in the study, while the theoretical framework used in conceptualising food safety standards regulations is discussed in Section VI . Major results and discussions are in section VII while conclusion is drawn in section VIII.

Food Safety and Crop Exports--A Global Perspective

Food markets in developed countries such as Netherland, United Kingdom, France, Germany and other European Union member states have instituted several changes in the requirements of agricultural production and these changes have far-reaching implications for crops production and export growth in developing countries. According to (Okello and Swinton, 2007:269), micro-organisms and pesticides food contamination have generated apprehension for the shopper in Europe and America and these phenomena led states in Europe to ratify stringent food safety regulations. They add that developing countries (where most fruits and vegetables are produced) and European Union representative firms of fresh produce retailers and exporters are obliged to respect and adopt the International Food Safety Standards.

> These requirements have been summarised as: ''(i) pesticide use and handling standards; (ii) traceability systems and (iii) hygiene standards'' (Okello and Swinton, 2007:270).

The necessity to control microorganisms and pesticides and ensuring safe export crops production requires specialised skill and capital investments which small-scale farmers, without a doubt, cannot afford. The danger, then, is that quality standards and food safety rules of consumers and retailers in developed countries can act as effective barriers to small-scale fruit crops producers in a country like Ghana in participating in the export markets.

The debate on how to link smallholder horticultural export crop producers to the global market under the International Food Safety Standards has been reduced to two schools of thought (Narrod et.al., 2009; Humphrey and Schmitz, 2001). Thus while Humphrey and Schmitz (2001) focuses on contract/fostering system, Nerrod et al.(2009) advocate for collective action or farmer base organisation as channels of ensuring compliance with food safety standards.

Humphrey and Schmitz (2001) state that the ''fostering system'' is adopted by multilateral and bilateral donor agencies in providing effective technical assistance to producers of horticultural export crops through transnational company-smallholder farmers partnership. The fostering system works well under contract farming because it meets the frequent need of adjusting production practices while adhering to international food safety standards. They focused on contract farming as a strategy for integrating farmers into food safety compliance. Under the scheme, transnational companies, mostly supermarkets, specify the food safety quality system, transmit information about the quality system and enforce farm auditing, inspection and certification compliance. Humphrey and Schmitz (2001) note that these companies employed trained technical

assistants as farm managers while agronomists were engaged for regular and unannounced farm visits. On the other hand, Narrod et al. (2008) centred on collective action or farmer-based organisation as the channel for integrating farmers into food safety compliance in the production process. They suggested that the strict requirement of food safety standards and the obligation of tighter food safety standards led to considerable organisational changes in farmer mobilisation with a preference for collective action or farmer group organisation. They noted that collective action arises when the efforts of individuals are needed to accomplish an outcome and it was believed that these collective actions ensure economies of scale and solution to specific skills for meeting the safety standards that smallholders have limited resources to meet. Narrod et al. (2008) study shows that small producers of fruits and vegetables in Kenya and India have coped with stringent demands for food safety from their main export markets through public–private partnerships. The partnership played major role creating farm linkages which met market demands for food safety at the same time as retaining smallholders in the supply chain.

Compliance with Food Safety Standards in Cocoa Export Crop Production in Ghana

Food safety standards compliance in Ghana's cocoa industry from the 1890s to 1966 was managed and controlled by Cadbury Brothers Limited (CBL) an expatriate institution agency with collaboration from Cocoa Research Institution of Ghana-CRIG (Amoah, 1998). In the 1890s, CBL appointed agricultural instructors from Trinidad, Sao Tome and Principe to establish demonstration farms in Ghana and strengthen the already existing headquarters of Agriculture Station at Aburi in 1907 (Amoah, 1998:3).

The CRIG, a state institution headquartered at Tafo in the Eastern Region of Ghana supported the success of cocoa production in Ghana from 1910 to 1977. CRIG undertook disease control and the education of farmers on agronomy practices to ensure food safety in the cocoa industry. The CRIG in 1936 declared cocoa swollen shoot virus, cocoa mirids (capsid) and cocoa black pod disease (caused by fungus Phytophthora Palmivora) as an infectious disease and recommended cutting off the infected cocoa trees (Amoah, 1998).

According to Amoah (1998:136-140), "cocoa losses to these diseases were estimated to constitute about 20 percent (for cocoa mirids) and 10 percent (black pod disease) respectively of world crops annually". He further stated that subsequent to the earlier events, the Cocoa Services Division of Ghana (CSD) estimated that ''the state lose about 4,559,057 cocoa trees in 1994 to about 7,525,714 cocoa trees in 1996 to cocoa diseases'' (Amoah, 1998:139).

During the colonial era, cocoa farmers resisted the cutting of cocoa trees. They feared that the colonialists were trying to destroy their livelihood and suspected them of establishing new cocoa farms in South-eastern Asia to compete with Gold Coast producers. Subsequently, Nkrumah's government in 1962 mandated the United Ghana Farmers' Co-Operative Council (UGFCC) to be in charge of controlling cocoa disease but the farmers refused and alleged that UGFCC targeted the destruction of cocoa farms belonging to farmers who were sympathisers of the opposition United Gold Coast Convention (UGCC) particularly in Eastern and Ashanti Regions (Gyimah-Boadi and Jeffries, 2000; Amoah,

1998; Killick, 1978). Also, the farmers accused UGFCC as being an appendage of Convention Peoples' Party (CPP).

In view of this fierce resistance from the farmers to the idea of cutting affected cocoa trees, the state recommended spraying affected farms and subsidising the price of spraying machines and insecticides to encourage farmers to spray their farms. However, insecticides which were used in the control of these diseases were found to have high toxic for food safety among cocoa growing areas (Amoah, 1998). In 1988, 46 cocoa black pod districts including farmers in Akumadan and Bechem in Ashanti and Brong-Ahafo Regions respectively were identified. Thus, farmers in these areas benefited from a three-year programme of mass cocoa spraying through farmers' training and education on how to control the black pod disease.

According to Amoah (1998) study, the cocoa swollen diseases to a larger extent negatively affected cocoa production in Ghana. The author said:

> Government subsidy on spraying machine in 1973/74 season was 84 percent and this figure rose in 1981/82 seasons to 95 percent. Subsidy on insecticide in 1973/74 was 11 percent, in 1979/80 the figure rose to 99 percent (Amoah, 1998:137). Government of Ghana from1970 to 1988 spent USD 143.59 million on replanting disease resistant cocoa seedlings in order to ensure increase cocoa production and disease prevention (Amoah, 1998:145).

Food safety policy on post-harvest cocoa beans was centred on fermentation, drying procedure and storage. The Produce Inspection Division (PID) of Cocoa Marketing Board (CMB) made sure that fresh mature cocoa beans are picked, pods broken and covered with the appropriate materials to enable adequate fermentation. They enforced a ban on drying cocoa beans by fire, but instead encouraged the drying of the beans with natural sunlight. This action prevented contamination of beans by fire and smoke. The inspectors, also, sample checked cocoa beans at depots to ensure the elimination of the purchase of adulterated cocoa (by the removal of mouldy, weevil-infested, and decayed beans) from being exported. Besides, buying centres and storage facilities were located closer to the farm gates to forestall wastage and deterioration of cocoa beans due to poor storage (Amoah, 1998).

Brief Historical Trajectory of Mango Export Crop Production in Ghana

The mango industry as an emerging economy is mostly controlled by the private sector due to a state policy of free market and trade liberalisation (MoFA, 2009; Gyimah-Boadi and Jeffries, 2000; Chalfin, 2004). Major attempts were made in the 1960s and 1970s for the production and export mango in Ghana (Abutiate, 1988; Frimpong-Ansah, 1991). First, the Nkrumah-led Convention Peoples Party (CPP) government agricultural policy partly focused on supply of input for production and research into yield and diseases control. Mango cultivars were imported and tried at several agriculture research centres such as Kpeve, Ejura, Somanya and Kwadaso (Abutiate, 1988). Second, the introduction of 'operation feed your industry' policy by the Acheampong-led Supreme Military Council was characterised by the subsidisation of production inputs, gradual tax reduction on production technology (Cutlass, equipment and agrochemical) and

further establishment of new experimental nurseries and farms at Kintampo and Wenchi.

Dixie and Sergeant (1998) note that Ghana's mango export figures from 1991 to 2003 was in tens of thousands metric tonnes. However, the figures changed to hundreds of thousands and beyond from 2004 to 2009.

Table 1: Trend of mango exported over the period 2001 to 2009

Year	Export Volume (MT)	Increase in Base Volume
2001	62	0
2002	64	2
2003	83	19
2004	179	96
2005	268	89
2006	295	27
2007	983	688
2008	1200	217
2009	2000	800

Source: Dixie and Sergeant (1998), MoFA (2010)

Notwithstanding the stringent food safety regulatory requirement, statistics on hectares of mango cultivated in Ghana in 2008 was 6,360 hectares (MoFA, 2010:8). Subsequently revenue generated from the export of horticultural fruit crops in 2010 was Ghc78, 662,250 (USD 54,724,537) where mango contributed about 2.4 percent to the earnings (GEPA 2010). Furthermore, processing industries generated Ghc 35,488,780 (USD 24,689,188) revenue from value-addition to fresh fruits in Ghana in 2010 (GEPA (2010).

RESEARCH METHODS

The study is qualitative with case study approach used in the investigation of food safety compliance and characteristics of mango farmers in Yilo Krobo District and Kintampo North Municipal in Eastern and Brong-Ahafo Regions of Ghana respectively. The rationales for selection were: first, mango is the main export crop grown in these two districts. Yilo Krobo is an old mango production area for export since the later part of the 1990s while, Kintampo North area is an emerging one. Therefore, the organisation of production and experience of mango farmers in the two areas differ which the study explored and analysed. Second, Yilo Krobo is a coastal savannah area closer to the national capital, Accra, while Kintampo North is located at the middle forest transitional ecological zone several kilometres away from Accra. These geographical features influence input and output market and cost of doing business. The primary data for the study was gathered from interviews conducted during two production seasons fieldwork from September 2012 (minor season) to August 2013 (major season). The secondary data was sourced from official publications, the Ministry of Food and Agriculture Policy and other government official statistical documents.

A total of forty-three (43) respondents were sampled. These comprised 32 mango farmers selected from a sample frame of 111 and 11 key informants from fruit processors and exporters, key state institutions and foreign development partners.

Snowballing and purposive sampling methods which are qualitative research methods were used in the selection of sampled respondents. The snowballing sampling technique enabled the interview to start with known farmers who served as a link person to other farmers. The purposive sampling technique focused on mango farmers who produced exportable products and whose farms were certified for food safety standards compliance. The purposive sampling technique was used in the selection of key Informants.

The instrument used for the in-depth interview was unstructured interview schedule with pre-selected themes. The method of analysis adopted for the study was mixed methods approach to data analysis which was thematic and content analyses based on the author's subjective evidence during the fieldwork.

Theoretical Framework

In conceptualising compliance with food safety standards in mango production for export in Ghana, I chose Giddens's theory of structuration as espoused by sociological theorists (Giddens and Sutton, 2015; Turner, 2007; Ritzer and Goodman, 2004; Haralambo, Holborn and Heald (1991) to explain food safety standards compliance regiment in mango production and export chains. Giddens's structuration theory postulates that ''in every society, communities and groups, peoples' behaviour follow a regular and predictable ways because individuals perform certain actions or activities in accordance with their knowledge on the structure that guides such behaviour'' (Giddens and Sutton, 2015:90). Resorting to the structuration theory, Turner (2007: 461-2), Ritzer and Goodman (2004:380) and Haralambo et al. (1991) stated that the theory focuses on individuals social activities and how these social interactions are performed and coordinated within a structure. Structure has two properties, viz. rules and resources (Turner 2007; Haralambo et al. 1991). Turner (2007) stated that rules are what people (actors) internalised as knowledge which guide their repeated interactions or in the reproduction of behaviours. Resources, the second property of structure is identified as authoritative non-material resources (Haralambo et al. 1991) or materials that give power to actors in mobilising and shaping action/activities of others (Turner 2007).

Compliance with food safety standards in mango production for export is embedded in transnational level social activity. Implicit or explicit in this transnational social activity is a well-defined structure (rules and resources) which are monitored and enforced by the state (public) or private institutions and agencies. Food safety standards regulation is more than making rule. According to Havinga (2006:2), standard regulations transcend ''standards setting, monitoring compliance and enforcement'' as such, ''these are legal rules backed by sanctions in order to sustain attempt to alter the behaviour of others according to defined standards''.

In this paper, farming, agronomic practices and institutional (public and private) support are all regarded as social practices or interactions which culminated into the compliance with food safety standards. The adherence to food

safety standards in mango production for export in Ghana, in itself, a social activity did not occur in a vacuum, rather, the agronomic practices in mango farming and off-farm post-harvest handling activities are regulated by a certain structure (rules and resources-coercive power). The rules of behaviour (agronomic practices) which the individual actor (farmer) follows are standards of production set by international bodies, state institutions and private agencies backed by sanctions. The standards regulating agencies are: International Plant Protection Council (IPPC), state agencies include Environmental Protection Authority (EPA), Ghana Standards Authority (GSA) and Plant Protection Regulation Services Division (PPRSD). The private regulatory agencies are: AfriCert, Blue Skies fruit processing company while the development partner agencies are: USAID and GIZ. These food safety regulating institutions and agencies have the power to shape the production and exporting activities of farmers and exporters. The embargo (sanctions) and loss of economic power (money) are resources at the disposal of regulating bodies and consumers' to invoke for non-compliant to food safety standards. These resources are deterrent enough to compel mango producers and exporters to adhere to production standards.

RESULTS AND DISCUSSION

This section focuses on four thematic areas. These are: monitoring the state's agriculture policy on food safety standards in crops production, integrating mango farmers into global food safety compliance, multilateral/ multiple extension services delivery and its influence on ensuring food safety compliance with global food safety. However, the discussion of the major results is preceded by the sociodemographic characteristics of respondents.

Socio-Demographic Characteristics of Respondents

A total of thirty-two (32) farmers were interviewed which consisted of twenty-eight (28) males and four (4) females. The key informants in the study were nine (9) males and two (2) females totalling eleven (11). Table 2 below shows the frequency of the respondents.

Table 2: Gender and respondents category

Category	Male	Female	Total
Farmer	28	4	32
Key informants	9	2	11
Total	37	6	43

Source: Author's field data, 2013

In table 2, the gender category of the mango farmers revealed that only four (4) female farmers met the sampling criteria of producing mango for ten years and their farm sizes are 2 hectares and above. These farms were certified with Global Good Agriculture Practice (GAP) certificate. The two female key informants indicated earlier in table 1 were head of the Plant Protection Regulatory Services Division (PPRSD) of the Ministry of Food and Agriculture (MoFA) at Pokuase in Ga West Municipal in Greater Accra Region and the second female was the procurement officer of Blue Skies fruit processing company.

These 32 farmers have a total farm size of 404 hectares with an average of 12.6 hectares. The farm sizes in hectares are presented as follows:

Table 3: Farm sizes and frequency of respondents

Farm size (Hectare)	Frequency of Respondents
2-10	21
11-20	6
21-30	1
31-40	3
91-95	1
Total	32

Source: Field data, 2013 (not drawn to scale and 2.47 acres equals a hectare)

Table 3 shows that majority of the farmers (21) cultivated between two and ten hectares. The 21 farmers include three (3) females and they are classified in the study as small-scale holder farmers. The farmers who cultivated between 11 hectares to 20 hectares include a female. Analysis of the farm sizes pointed to one thing. That is female representation is comparatively low among large-scale mango farmers. The author attributes this situation to multiple livelihood practices that the few engaged in thus making not solely a mango farmer.

The educational level of farmers featured prominently in adherence to food safety standards in mango production. This is because of the fewer number of extension service providers who were expected to disseminate contemporary production technology and information to scattered smallholder mango farmers. The educational levels of farmers are presented in Table 3.

Table 3. Education Level and Gender

Level	Male	Female	Total
Basic	8	2	10
Secondary	13	2	15
Post-Secondary	4	0	4
University	3	0	3
Total	28	4	32

Source: Author's field data, 2013

The cross-tabulation of education and gender indicated that two females had basic and secondary education respectively. It is instructive to note that in this study, none of the female respondents had a post-secondary or university education. The article could not conclude that women with higher education do not want to venture into mango farming largely because of the sample and representativeness of females in the study. The importance of education is amply stated in the statement of the chief agronomist of GIZ and Blue Skies

simultaneously as follows that:

> *The high number of farmers who had secondary education (15), post-secondary (4) and university (3) facilitated easy dissemination and adoption of information on current technology on mango production.*

Premised on the assertion of the agronomists, the author held the view that the high number of farmers who had pre-university and university degrees played a prominent role in adoption of scientific technology in food safety standards compliance. Coupled with that, majority of the farmers were experienced in farming and agribusiness activities as well as experiences from public and civil service. This made them appreciate the importance of food safety in production, post-harvest handling of fruits and export demands.

Monitoring Agriculture Policy on Food Safety

The State Policy on food safety standards revealed that monitoring of international food safety standards is decentralised in the production communities in Ghana. A key informant from development partner agencies stated that

> *to adhere to the International Plant Protection Council's food safety standards, food processing companies in Ghana such as; Blue Skies, Integrated Tamale Fruit Company and Hans Peter Werder and AfriCert, a certification body accredited by International Organic Accredited Service in USA were the foreign agencies and institutions who played gate-keeping role on behalf of brand-name retailers and supermarkets in Europe in ensuring food safety standards compliance in Ghana.*

These agencies and institutions monitor production practices such as agrochemicals used in enhancing soil fertility, control of weed, pests, and insects. They, also, evaluate post-harvest handling and storage of fruits to prevent food contamination in the packaging process.

As part of the globalisation ideology, the Government of Ghana has created a national governance structure to regulate the activities of export crop producers in the country. The agencies and institutions that perform these functions are the Ghana Standard Authority (GSA), Environmental Protection Authority (EPA) and Plant Protection Regulation Services Division (PPRSD).

The GSA sets Ghanaian food safety standards in compliance with IPPC standards and certifies mango fruits after the fruits are subjected to maximum residual level (MRL) test. The EPA regulates import, registration, publication and use of agrochemicals in the production of mango. Also, the PPRSD does biological control of plant pest and diseases on mango crop and certifies or quarantines infested mangoes meant for export. Careful analysis of food safety policies shows that the structure is demarcated into legislative, executive and judiciary functions and roles. Where some agencies made the regulation, others trained farmers to execute food safety standards compliance and some judge farmers' production processes by issuing farm compliance certificates.

Integrating Mango Farmers into Global Food Safety Compliance

Ghana's Food and Agricultural Sector Development Policy (FASDEP II) identified

the farmer-based organisation as the most cost-effective channel to ensure delivery of extension service to scattered smallholder farmers all over the country through which food safety standards could be achieved (MoFA, 2009). However, according to an extension officer from the Ministry of Food and Agriculture, the ministry realised that the research unit and public sector extension is not well funded. Consequently, the state espouses access to multiple extension service providers. This gesture enabled direct contact of development partners with mango farming communities and made the contribution of development partners in the promotion of increasing productivity and food safety compliance in the mango industry paramount.

The identified development partners and state agencies and institutions who were engaged in integrating the Ghanaian mango farmers into global food safety were USAID, GIZ and Ghanaian extension technicians from PPRSD, EPA and GSA. Evidence of these collaborations is explained in accordance with each institution and agency. The data analysis revealed that the foreign and state agencies and institutions identified in the study collaborate in building the capacity of farmers to comply with food safety standards in mango production.

The study indicates that the 32 farmers got their mango seedlings from certified mango nursery operators who were trained and certified as mango nursery operators through GIZ's African Cashew Initiative (ACi) and USAID's sponsored ADRA Programmes. The initiative of the GIZ and USAID in ensuring that seedling supply to farmers for cultivation came from certified mango nursery operators certifies one of the International Plant Protection Council's (IPPC) major requirement which states that planting materials (including seedlings) for exportable products must come from certified sources to prevent harmful organisms injurious to plant or plant products and human health to be exported and consumed (IPPC, 2000). The fulfilment of this requirement integrated mango farmers in Ghana into compliance of IPPC's standard of getting planting materials from accredited sources.

Multiple Extension Services Delivery and Its Influence on Food Safety Compliance

Under the sponsorship of development partner agencies like USAID and GIZ, specialised agronomists from South Africa and Germany collaborated with the Ghanaian extension service officers from MoFA training and capacity building for mango farmers. This is evident in one of the respondent's statement that:

> *the training focused on farm maintenance cultures such as pruning, agrochemical (weedicides, pesticides/insecticides and fertiliser for flower induction) usage, farm hygiene, farmer safety, harvesting and post-harvest handling of fruits. Other areas were the identification of mango pests and diseases and farm record-keeping on agrochemical usage and interval of application and other daily farm activities carried out.*

This feast was achieved through the farmer based association for the dissemination of information on food safety standards and compliance set by wholesaler and retailers in developed countries. The pivotal role played by the farmer based organisation in the study communities (Yilo Krobo and Kintampo North) confirms other studies (see Narrod et

al. 2009; Humphrey and Schmitz 2001) on the importance of farm-based organisation in gathering scattered smallholders for education on crops production practices.

Agrochemicals used in mango production are sensitive issues for both the country of origin of production and destination of consumption. The Environmental Protection Authority (EPA) regulates the agrochemical industry by licensing chemical manufacture, importation and the use of pesticides for agriculture, horticulture, gardening, public health and other pesticides related uses (MoFA 2010). The mango farmers revealed that the EPA periodically publishes recommended herbicides and insecticides allowed on mango field. This is a social phenomenon which guided farmers in the purchase of their agro-input from private agrochemical store operators. As a consequence, the MoFA, development partner organisations and fruit processing companies, particularly Blue Skies, engage mango farmers constantly in updating them on the appropriate registered and approved agrochemicals to be used on their farms. Careful analysis of success in the use of appropriate agrochemical for production and adoption of required food safety standards compliance was as a result of high level of education of the farmers.

The PPRSD, another state institution, played a major role in the sensitisation and training of farmers on plant protection. An official of PPRSD in charge of the biological control unit stated that farmer sensitisation and training includes plant, insects and disease control on the farm. He said:
The unit has identified fruit fly, mango stone weevil, mealy bug, anthracnose and mango scarp.

According to the official, PPRSD taught farmers the need to prune their mango trees to reduce dense canopy, pick falling and rotten mangoes from the farm and make sure that they are buried to avoid the continuation of the life cycle of the diseases that affect the fruits.

Specific technical assistance which the Biological Control Unit of PPRSD gives farmers are mainly geared toward pests and diseases control is termed ''Bus Stopping control measure''. The BCU officer explains that:

> *By the bus stopping control measure, all reported incidence of pest infestation, compelled BCU to visit the epidemic area, assess the situation in order to ascertain the veracity of the infestation. Upon their assessment, the farmers were advised on the management of the phenomenon. This is because experience had shown that whenever farmers are desperate they use any available agrochemicals without recourse to expert advice and this act of desperation has economic or financial, health and ecological effects on the farmer, consumer, and biodiversity. The advice sometimes touches on the feeding habit of the insect or pest such that they can use either systemic or contact pesticides in controlling the epidemic.*

The rationale for the bus stop control measure as stated by the official was that:
It is believed that farmers should take precaution not to build up pest and disease population in the ecology from production to harvest.

The Head of PPRSD at Pokuase in the Greater Accra Region emphasised that her unit (Plant Protection and Regulatory Services

Department) collaborated with the Tropical Crops Research Institute in Benin and the Lebanese government assistance to help farmers control the fruit fly by deploying pheromone trap also called fruit bait. She stated that:

> *Mangoes from Ghana to Lebanon were embargoed in 2008 because fruit fly was detected on the exported cargo. However, in 2012 when the bilateral agreement was signed, Lebanese agronomists collaborated with other agencies and farmers to meet the IPPC fruit safety standards leading to the resumption of mango export to Lebanon again.*

The economic effects of mango pests and diseases infestation can lead to fruit spoilage, economic income loss, export ban and high probability of crop failure. Farmers have adhered to the recommended remedy for the control of pests and diseases by pruning the plants to allow aeration, avoidance of high plant population and dense plant canopy and good farm management practices. The successful implementation of PPRSD's mandated function and compliance of food safety in mango production were attributed to farmers' experience in farming over the years, agricultural tours of farmers to mango farms in South Africa and food fair tours to Germany and farmers' level of education.

The field data established a pattern in the provision of the farm infrastructure. Seventeen (17) farmers have erected sheds for the storage of mangoes and farm inputs. The 32 farmers have constructed places of convenience on their farms. Eight (8) farmers had dug wells on their farms to enable them to have access to good and safe water and twenty-four (24) have access to river water. The enormity of the cost of constructing on-farm infrastructure is a drain on the small-scale farmers especially.

Also, farm certification is safety standard in mango production in order to access the export market. The certification is on good agricultural practice (GAP). The study identified three farm certification schemes which were Eurep GAP, Global GAP and Ghana GAP which implement safety standards set by European retailers, global and the Ghana Standard Authority (GSA). One key informant, an agronomist, pointed out that:

> *The certification scheme covers traceability records of individual farmers. The records take cognisance of plant protection (chemicals used for pest control) and plant growth regulation (flower inducing chemicals).*

An executive of the FBOs in Yilo Krobo stated that the farmers' association have appointed internal farm auditors who visit their farms to acquaint themselves with records of agronomic practices that were going on prior to external assessment by AfriCert and fruit processing companies. The rationale for this internal assessment is that the external assessment and certification were group based and the inaction of a member can cause the entire membership for non-compliance. During the period of data collection (September 2012 to May 2013), the 32 farmers' farms were certified by AfriCert IPPC, a recognised body from East Africa based in Kenya. The result shows that Ghana Standard Authority gives a certificate of proof of Maximum Residual Level (MRL) test conducted on the mango fruit. A farmer in Kintampo North made a statement on MRL test by saying that:

> *I got my fruits and that of those who operate the nucleus farm scheme under me tested by the GSA. Internal farm auditors go to the farms, pick fruits from the trees diagonally at random. At least hundred fruits are taken from ten trees. This is labelled as a specimen and sent to GSA for testing and certification. The cost of a group test of the specimen in 2012 was two hundred and fifty Ghana cedis (Ghc250.00).*

Accounts given by agronomists from Blue Skies Fruit Processors suggest that mango farmers who produce for them have their fruits tested for MRL by internationally recognised body in the United Kingdom. Analysis of farmers' investment in storage, water and sanitation and subjection of their fruits to MRL test was premised on their collective willingness to produce safe and quality mango that would meet the international market requirement. This was because the farmers recognised that revenue/income from accessing international market commensurate the cost of investment they made.

Plant Quarantine Unit of PPRSD is the recognised competent authority in Ghana to undertake mandatory phytosanitary inspection and Quarantine of exporters' pack-houses. Phytosanitary officials usually observe how the fruits are washed with chlorinated water and the application of wax on the fruits before they are packed for export. Again, at exit ports, the inspection officials undertake a visual inspection of boxes packed with mango fruits. They sample and pick boxes containing treated mango destined for export markets. When laid down procedures are exhausted, then the Plant Quarantine Unit certifies every consignment of mango fruits that leaves the Ghanaian shore. During the study period, 2070 metric tonnes of mango was sold for export to exporters and processors. The volume of mango exported was the evidence that food safety standards compliance is attained in the mango industry.

CONCLUSION

The article focused on agriculture food safety policies, mango farmers' integration into compliance with global food safety standards, multiple extension services delivery, and how they influence compliance with food safety. These factors (policy, integration and multiple extension services delivery) affected mango production organisation, international or global recognition of safe mango production in Ghana, and the subsequent increase in export volume.

The paper found that the state is strongly committed to compliance with food safety standards in agriculture, particularly in mango production. This is amply demonstrated through the institutionalisation and empowering the Ghana Standards Authority, Environmental Protection Authority and Plant Protection Regulatory Services Division. These institutions regulate food safety at production and post-harvest handling levels, as well as pre-export certification.

Multiple extension services delivery by state agencies and development partners were timely interventions that strengthened the cash trap state extension unit in building capacity for farmers. The collaboration that existed between the MoFA and the development partner organisations in the mango production sector pointed to an overwhelming fact that the extension services were heavily reliant on external sources for funding. Effective

control of pests and diseases attack on mango trees, use of appropriate agrochemicals and input, rigorous activities carried out in farm certification, maximum residual level test, and commodity certification bore ample testimony to the fact that state institutions such as GSA, PPRSD and development partner agencies are responsible for making sure that food safety is assured and achieved in mango production in Ghana. Besides, farmers' level of education experience in farming, farmers' health consciousness of consumers, the proximity of food safety regulatory bodies and willingness to access high premium market significantly played a major role in the food safety standards compliance.

The institutionalisation of farmer based organisations was an effective medium for smallholders in mango production to acquire skills in good husbandry practices in farm sanitation improvement. Food safety standards compliance has a positive effect on the environment and ecosystem. By the use of appropriate chemical and dosage in controlling pest and diseases, the rapid depopulation of agents of pollination such as friendly pest, birds and other living organisms which co-existed for sustainable and renewal of the ecosystem are maintained. The author recommend that state funding to the institutions and agencies responsible for food safety enforcement and monitoring should be regular to sustain the momentum on compliance with food safety.

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Industry Skills Need and Skills Level Met by Polytechnic Engineering Graduates in Ghana and Sierra Leone

[1]Gerald Kojo Ahorbo, Etornam Kosi Anku and Isaac Kojo Arah

ABSTRACT

Deficits in skills of engineering graduates from the Polytechnics in Ghana and Sierra Leone have been of great concern to both industry and the training institutions because they threaten the very survival of the training institutions and the student body. The key objectives of this study are to determine (1) the specific skills and attributes industries emphasised for new engineering graduates of polytechnics, and (2) the level of the skills and attributes that was met by the new engineering graduates at the various companies. Data was collected through the use of open-ended structured questionnaires and interviews. Findings revealed that (1) skills need of the industries comprised both technical and non-technical, (2) the industries attached equal importance to both the technical and non-technical skills and attributes, and (3) the industry's estimate of the skills Polytechnic Engineering graduates met at the point of entry was 50 to 60% depth of knowledge, 40 to 45% of technical skills for those without industry experience and 50 to 55% technical skills for those who had industrial attachment. This study provides industry specific information on skills and attributes expected from Polytechnic Engineering graduates and also guides trainers in developing appropriate curricula and training modules.

Keywords:

Ghana, industry skills, Polytechnic, Polytechnic Engineering graduates, Sierra Leone.

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INTRODUCTION

Industry skills needs have garnered significant attention in popular discourse, research work and policies across the world (Curtis and McKenzie, 2001; Hwang *et al.*, 2014; Kassim and Ali, 2010; Lee *et al.*, 1995; Melguizo and Perea, 2016; Royle and Laing, 2014; Runciman, 2014) probably because of employers' growing concern that new recruits do not meet their skills expectations (Alaimo *et al.*, 2015; Cappelli, 2015; Cyphert and Lyle, 2016; Osterman and Weaver, 2014; Perkins and Nigel, 2015). This contributes to the increasing rate of unemployment globally (Acheboune and Driouchi, 2014; Bhaduri *et al.*, 2015; Constantinescu, 2015). This suggests that the requisite skills required by industries are probably not being transferred effectively to the trainees at the educational institutions.

The available literature shows that there are gaps in the skills expectation of employers as a result of weak linkages between training institutions and local industries for hands-on-experience for both instructors and trainees (Dasmani, 2011). For instance, Giffi *et al.* (2015) showed that many industries in the United States of America reported that high school students have demonstrated a lack of proficiency in Mathematics and Science required on the job. The Minerals Council of Australia (2005) also showed that many graduates in the mining sector of Australia exhibited poor understanding of how their theoretical knowledge can be applied in practice. In the Middle East and North Africa regions, the managers of companies indicated that, what the graduates needed most was improvement in communication, time management and continuous learning (Ramadi *et al.*, 2016). In the sub-Saharan region, a study by Arai *et al.* (2010) on multinational mining companies in Sierra Leone identified the skills needs as literacy, experience in operating and repairing heavy machinery; experience in designing, planning, and constructing mine sites for the civil and electrical engineering; and experience in determining terrestrial or three-dimensional space position of points and the distances and angles between them on the earth's surface for mining surveyors. Additionally, the skills needed in the Agriculture sector relates to operating and maintaining heavy duty farm equipment such as bulldozers, tractors, hydraulic operated ploughs and harrows, boom sprayers, combine harvesters, planters and manure spreaders. According to GISDC (2005), the shortage of skills associated to processing operations in Ghana are related to installation, commissioning, maintenance and repair of modern automated electro-mechanical plants, working on pneumatic and hydraulic equipment, welding and material joining, fitting, machining, working as a member of a team, and communicating effectively with colleagues.

Often times the newly trained graduates in developing countries such as Sierra Leone and Ghana have to be retrained by their employers before they could perform competently on their new jobs. Because of the lack of suitably skilled staff, some companies are unable to acquire new technologies or update their equipment. However, those that did, often have to bring in expertise from outside the company (most often outside the country) to solve critical problems related to equipment breakdown (Mbroh, Personal Communication, 12 March, 2009). Most of such companies in Ghana which use expertise from outside were found to be using automated processing machinery regulated by Programmable Logic Control (PLC) and in some cases, the advanced Supervisory Control and Data Acquisition (SCADA)

systems (GISDC, 2005). Governments and other organisations have however made several attempts through some donor supported interventions and projects to narrow the skills gap (Dias and Escoval, 2014). For example, in Sierra Leone, the Youth Employment and Support Programme (YESP) was pursued by the government (Dumbuya, 2017), while in Ghana, interventions such as the Skill Training and Employment Placement (STEP) Programme, the National Youth Employment Programme (NYEP) [[now Ghana Youth Employment and Entrepreneurial Development Agency (GYEEDA)], were also pursued (Baah-Boateng and Baffour-Awuah, 2015). Attempts have also been made in some cases to implement Competency Based Training (CBT) programmes in some educational institutions to improve the hands-on skills training.

Regardless of all these concerted efforts of governments and industries, there is still employers' growing concern that new recruits are not meeting their skills expectations. In fact, research by Holzer (2015) and World Economic Forum (2014) show that industries still complain that it is becoming difficult to get the right calibre of people to fill vacancies. It is even more worrying to know from Perkins and Nigel (2015) that the skills gap seems to be widening year by year. The problem currently faced by the engineering industry, which tends to be the drive for this study is that, the Polytechnic institutions in Sierra Leone and Ghana are not supplying the right calibre of skills to the labour market. Jackson (2015) suggests a combination of traditional and academic study with student exposure to the world-of-work in their chosen profession as a way of addressing such problems. However, this study on Sierra Leone and Ghana goes further to find the exact skills and attributes industries expect from polytechnic engineering graduates to facilitate the bridging of skills gap.

The study had two primary objectives which sought to determine: (1) The specific skills and attributes industries emphasised for new engineering graduates of polytechnics; and (2) the level of the skills and attributes that were met by the new engineering graduates at the various companies.

The findings of the study will inform policy makers of the attributes and skills to be emphasised in the engineering training curriculum. The study will also add to the limited empirical studies on the skills needs of engineering industries and the level of skills exhibited in industry by polytechnic engineering graduates in Sierra Leone and Ghana.

LITERATURE REVIEW

The acquisition of technologies and equipment to improve productivity often requires skilled people as a source of competitive advantage. Spinks *et al*. (2007) put skills required by industries into three broad categories: technical, personal and business skills. The technical skills seem to be the most emphasised in engineering companies probably because they form the core requirement for an engineer and also the substance for mastering new technologies. A study by Zaharim *et al*. (2009), identified some of these technical skills and attributes as the ability to acquire and apply knowledge of engineering fundamentals; having the competence in theoretical and research engineering; having the know-how in application and practical oriented engineering; having in-depth technical competence in a specific engineering discipline; the ability to utilise a systems approach to design and evaluate operational performance; and the ability to design and conduct experiments as

well as to analyse and interpret data. Apart from being skilled in the sense of having the required knowledge in a specific discipline and having the necessary technical skills required in a profession, engineering graduates are also expected to have generic skills such as communication skills and interpersonal skills (Smith and Kruger, 2008).

The engineering work is very complex because technical and social skills are inextricably intertwined and as such, theoretical knowledge; technical skills; management skills; and engineering principles are skills needed for technology-based engineering (Motsoeneng *et al*., 2013). All these add to the notion that engineers need to acquire a large number of technical skills, generic skills, and profound technical knowledge, of which very little is learned at university (Trevelyan, 2008) as well as polytechnics. The narrow training technical specialist receive is a thing of the past (Spinks *et al*., 2007) and most employers allude to this assertion. Currently, employers look out for people with multi-technical skills and so, an ideal engineering graduate is expected to be the best in the field, be highly competent in at least one technical skill, and also have an understanding of the other engineering and technical disciplines. At least 73% of employers attached great importance to all the technical competencies identified by Zaharim *et al*. (2009) while 85.5% expects engineering graduates to be competent in both application and practical oriented engineering.

Personal skills and attributes concerning communication were also seen as important in every engineering role today and have been linked to the ability to work with others such as customers, suppliers, and other business partners outside the company's boundary (Spinks *et al*., 2007). Other personal attributes emphasised include creativity and innovation, and drive and enthusiasm. Employers increasingly cite deficiencies not only in up-to-date technical skills training of job applicants but also in the "employability skills", creativity, problem-solving, teamwork, leadership, self-esteem and integrity that are indispensable to productivity in today's workplace (Frimpong, 2011). Business leaders have often reported deficiencies in both hard and soft skills in four key areas: basic skills (which include communications and basic business acumen skills); technical and professionals skills (technology skills); management and leadership skills (covering areas such as supervision, team building, planning, decision-making and ethical judgment); and emotional intelligence skills (such as self-awareness, self-discipline, persistence and empathy) (ASTD Public Policy Council, 2012).

Again, business leaders are looking for people with a far wider range of skills than ever before (Tiernan, 2014). A high percentage of employers (86.7%) put much emphasis on the ability to communicate effectively with engineers and non-engineers and almost the same number (85.1%) emphasised the ability to function effectively as an individual and in a group with the capacity to be a leader or manager as well as an effective team member (Zaharim *et al*., 2009). In this regard, business and commercial skills have been found to be an essential requirement for engineers. However, Spinks *et al*. (2007) indicate that though important, it is not something that engineering graduates were expected to be adept in when they were recruited. Rather, the potential to develop (including developing appropriate management skills) is of immense relevance (Spinks *et al*., 2007). This was supported by Cai

(2013) and Bui and Porter (2010) who indicated that in addition to knowledge, employers also demanded good personality attributes from the graduates and among which the important factors considered are the ability to adapt to the culture of the firm and the desire to learn continuously.

Basic entrepreneurial skills were considered by a moderate number of employers (57.6%) as important (Zaharim *et al.*, 2009). "The days of lifetime careers are gone; chameleon-like employees who apply their skills whenever and wherever they are needed are now in high demand" (Tiernan, 2014). In recent years, it is not sufficient for graduate applicants to simply list skills they have developed but employers want graduates who can help them deal with change (Markes, 2006). A study carried out by Martin *et al*. (2005) indicated that Chemical Engineering graduates identified their weaknesses to be related to working in multi-disciplinary teams, leadership, practical preparation and managerial skills. In the current knowledge era, Horn (2006) views proficiency in mathematics, computation, reading, writing, the effective use of resources and information, interpersonal skills, an understanding of systems, and mastering of technology and flexibility in coping with change in the workplace as the new competencies required by Engineers. As the world is moving with an unprecedented speed into a high-tech future, Science, Technology, Engineering, and Mathematics (STEM) education and the ability to have a skilled and educated manpower are very paramount for business development (Ahmed, 2016).

In emerging economies such as Ghana and Sierra Leone, where technology acquisition for industrialisation is necessary to reduce the productivity gap between developed and developing countries (Athreye and Kapur, 2015) and also to contribute significantly to GDP, it is critical for companies to have access to a skillful, knowledgeable, and disciplined workforce (Kodzi, 2008).

Methods

Study Area and Data Collection

The study focused on thirteen (13) active engineering companies purposively sampled from four (4) industry sectors (Manufacturing and Processing, Oil and Gas, Mining, and Agricultural Engineering) in Ghana and Sierra Leone. The data for the study was completely primary data gathered through a survey by the use of an open-ended structured questionnaire aided by in-depth face-to-face formal and informal interviews. The questionnaire was designed to collect a range of data on: types of skills and attributes (both technical and non-technical) the company looks for when employing new engineering graduates, and level of theoretical knowledge and technical skills exhibited by the new engineering graduates. The questionnaires were self-administered by any two or more employees in their capacity as Training Officer, Maintenance Manager, Managing Director, Operation Manager, Chief Inspector of Mines, Works Manager, Human Resource Manager, Division Training and Development Manager, Supervisor, Production Manager or Chief Engineer, while the interview was administered by the researcher on any two or more of those respondents as mentioned above.

Data Analysis

The data gathered was categorised into both technical and non-technical skills and attributes, and they were compared with the

following listed skills and attributes compiled from Zaharim *et al*. (2009), Bui and Porter (2010), Frimpong (2011), Horn (2006), Spinks *et al*. (2007), and Zaharim *et al*. (2009).

a. Ability to acquire and apply knowledge of engineering fundamentals
b. Having the competence in theoretical and research engineering
c. Having know-how in application and practical oriented engineering
d. Having in-depth technical competence in a specific engineering discipline
e. Ability to utilise a systems approach to design and evaluate operational performance
f. Ability to design and conduct experiments, as well as to analyse and interpret data
g. Ability to work and communicate effectively, not only with engineers but also with others such as customers, suppliers, and other business partners outside the company's boundary and the community at large
h. Ability to undertake problem identification, formulation and solution
i. Ability to function effectively as an individual and in a group with the capacity to be a leader or manager as well as an effective team member
j. Having the understanding of the social, cultural, global and environmental responsibilities and ethics of a professional engineer and the need for sustainable development
k. Recognising the need to undertake lifelong learning, and possessing/ acquiring the capacity to do so.
l. Having the knowledge of contemporary issues and the flexibility in coping with change in the workplace
m. Having the basic entrepreneurial skills
n. Having the creativity and innovation skills
o. Having the drive and enthusiasm
p. Having the self-esteem and integrity
q. Ability to adapt to the culture of the firm
r. Having the proficiency in mathematics, computation, information technology, reading, and writing
s. The effective use of resources and information
t. Having interpersonal skills
u. Understanding of systems and mastering of technology

The technical skills and attributes are from A to F, while the non-technical skills and attributes are from G to U. Descriptive statistics was employed to discuss the similarities and differences in the skills and attributes across the industries and Microsoft Excel Version 2010 was used to process the data. An independent-sample t-test was conducted to validate the findings.

RESULTS AND DISCUSSION

Figure 1 represents the percentage of technical and non-technical skills and attributes of the twenty-one (21) listed skills (A to U inclusive) that industries emphasised as required of the new engineering graduates from Polytechnics.

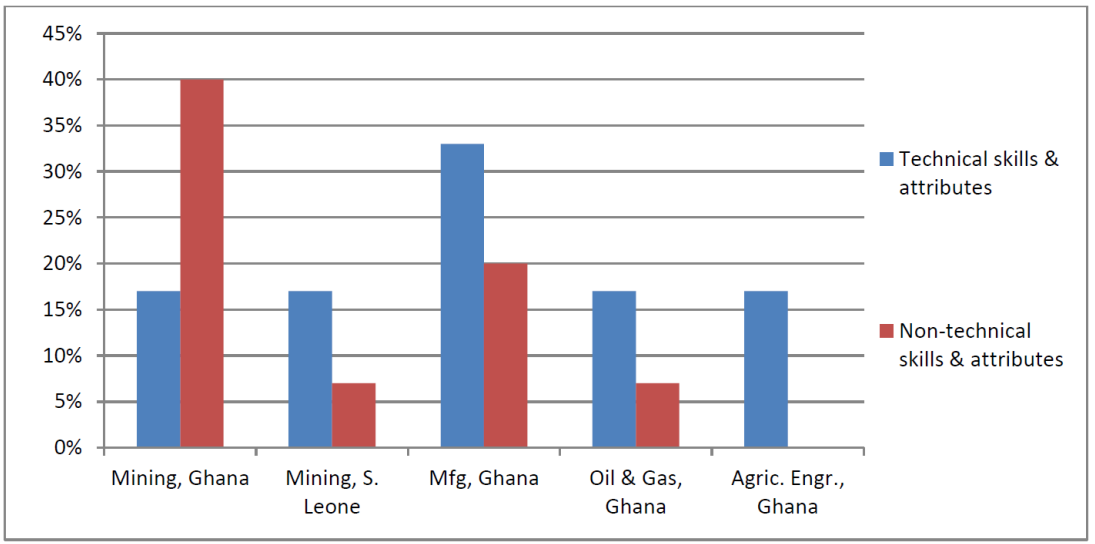

Figure 1: Level of technical and non-technical skills and attributes emphasised by the industries for Polytechnic Engineering graduates.

Source: Field Survey (2009 and 2010).

As Figure 1 shows, all the industries except one (Agricultural Engineering) emphasised the need for both technical and non-technical skills and attributes for new engineering graduates. This suggests that technical skills are core skills required for an engineer or technician in the engineering profession and industry (see Spinks *et al.*, 2007; Zaharim *et al.*, 2009).

The mining industry in Ghana seems to lay much emphasis (40%) on the non-technical skills as against 17% technical skills and attributes. This may be an indication that in Ghana, new engineering graduates have little or none of the expected non-technical skills and attributes which are now very important for the improvement in business performance. A study by Bhamra et al. (2015) indicated that combined technical and non-technical skills create a powerful workforce that is able to respond to continuously changing technology, as against those with technical skills only.

Figure 2 shows the percentage of industries that emphasised the specific skills and attributes new engineering graduates from polytechnics should exhibit.

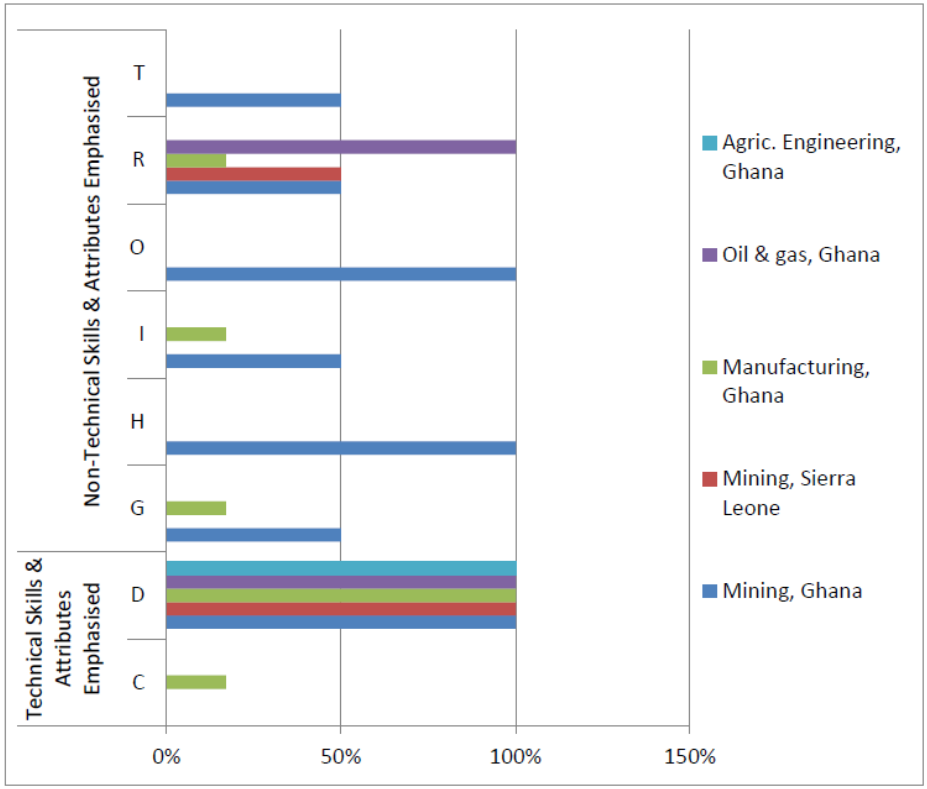

Figure 2: Percentage of the industry that emphasised the needed skills and attributes (C-T defined in the Research Methodology) of new engineering graduates of polytechnics.

Source: Field Survey (2009 and 2010).

Exactly 100% of the mining industry in Ghana emphasised D, H, and O while 50% emphasised G, I, R, and T. However, in the case of Sierra Leone's mining industry, all the companies emphasised D and 50% emphasised R. The whole manufacturing and processing industry emphasised D (a technical skill) while only 17% emphasised the technical skill C and non-technical skills G, I, R, and T. The study on the Oil and Gas industry covered an Oil Well servicing company and a mechanical engineering company that provides machining, welding and fabrication services in addition to other non-engineering Oil and Gas services. Both companies fully emphasised D and R. The Agricultural Engineering Services Directorate (AESD) only emphasised D for the new Engineering graduates.

Table 1 presents the responses of the employers and industry experts on the industry skills needs of the company (categorised as technical and non-technical skills and attributes) and also the skills level met by the new employed Engineering graduates from the Polytechnic.

Table 1: Industry Skills Need and Skills Level Met by New Engineering Graduates

Industry	Company	Technical skills and attributes	Non-Technical skills and attributes	Skills level met in percentage
Solid Mineral Mining	AngloGold Ashanti, Ghana.*	Boiler making skills, fitting and machining skills, and electrical skills (which include working on electronics and Programmable Logic Control (PLC)).	Problem-solving skills, drive and interpersonal skills.	The new HND graduates exhibited up to 45% of the technical skills of what the job requires at the point of entry, and about 70% within 3 months of training on the job.
	Ghana Bauxite Company Limited.	A multi technical skilled workforce with skill in plumbing, carpentry, masonry, vehicle repair and maintenance, and some other mechanical and electrical areas.	Communicate effectively, read and write well, work with other people, solve problems, show initiative, plan and manage workload with minimum supervision.	Not available
	Sierra Rutile Limited, Sierra Leone.	Skills in instrumentation and control for the engineering and maintenance department.	Not available	Not available
	London Mining Plc,Sierra Leone.	Middle-level skills such as heavy duty equipment fitting, boiler making, crane operating, plumbing and electricals.	Information technology (IT) skills.	Not available

Manufacturing and Processing	Coca-Cola Bottling Company of Ghana Limited	Production and machine maintenance (involving fault diagnosing, machine component identification, dismantling and assembling) and instrumentation and controls (including working on PLC equipment) skills. Workforce with multi-technical skills.	Not available	The new engineering employees exhibited less than 40% of the company's skills requirement at the point of entry.
	Fan..Milk Limited, Ghana.	Mechanical (including fitting) skills, electrical and refrigeration skills, and engineering drawing skills.	Not available	About 50% depth of knowledge of the trade was exhibited at interview and about 40% level of the practical skills required of the company was exhibited on the job.
	Ghacem Limited, Ghana.	Multi-technical skilled person with two or more skills related to fabrication, machining, electric motor rewinding and maintenance.	Strong general education background in the basics of writing, reading and simple mathematics. Skills of report writing, communication and working under minimum supervision.	Not available

	Volta Aluminium Company (VALCO), Ghana.	Multi-technical skilled workforce was much desired. Machining, welding and fabrication, instrumentation, and electric motor rewinding skills are needed.	Not available	The new engineering employees only met about 20% of the skills required by the company.
	Tex Styles Ghana Limited	Skills related to precision measuring, engineering drawing, manufacturing of machine components, the use and understanding of technical manuals and diagrams.	Not available	The depth of theoretical knowledge was about 50 to 60%. About 40 to 45% of the practical skills required by the company were met by the graduates at the point of entry. Exceptional cases of 50 to 55% skills level were found with those who had some level of industrial attachment.
	Accra Brewery Limited, Ghana.	Mechanical skills related to machining of parts, welding and fabrication, dismantling and assembling of machine parts, and electrical skills.	Not available	The depth of knowledge and level of skill of most applicants has been below 50% of the company's requirement.

Upstream Oil and Gas	Baker Hughes (Ghana) Limited	Skills in directional drilling, formation evaluation, completion and production practices and techniques, and Well intervention and remediation. Additionally, warehouse activities, machining, non-destructive testing and inspection.	Fundamental skills in mathematics, basic sciences such as chemistry and physics, mechanical aptitude, ICT, transportation and logistics will also be needed.	Not available
	Seaweld Engineering Limited, Ghana.	Mechanical skills such as machining, measuring, welding and fabrication, and safety.	Skills in information and communication technology (ICT), basic science and mathematics.	Not available
Agriculture	Agricultural Engineering Services Directorate (AESD), Ghana.	Skills required for manufacturing agricultural equipment, diagnosing and solving of problems that relates to the hydraulic, electronic and sensor systems on agricultural machinery and implements.	Not available	The engineering graduates' knowledge in the trade was about 40% and the level of practical competence acquired was from 50 to 55% of what the work requires.

Source: Field survey, *2009, 2010.

Apparently, almost all the four industries stressed the need for basic skills and attributes of machining, welding and fitting. However, for the electrical engineering or trade skills, the emphasis was on instrumentation, electric motor servicing or rewinding, and working on electronic and PLC equipment (Table 1). These are basic skills required at where machines are operated and maintained. The soft skills and attributes stressed by the Ghanaian companies are problem-solving, effective communication, and teamwork (Table 1). The skills level met by the new engineering graduates engaged by AngloGold Ashanti was 45% of the technical skills required of the company. However, this level shot up to about 70% after a 3 month when an in-house skills upgrading training was organised for the new recruited engineering graduates.

The technical skills emphasised mostly were general plant maintenance (mechanical and electrical) and process engineering. The non-technical skills emphasised were report writing, communication and working under minimum supervision. Surprisingly, only one manufacturing and processing company emphasised this probably because the other companies expect such skills to be picked on the job as indicated by Spinks et al. (2007). Generally, all the manufacturing and processing companies placed much emphasis on the technical skills of which less than 45% was exhibited by the new engineering graduates from the Polytechnics. VALCO estimated the level of skills exhibited by these graduates to be about 20% of what the company required, and this represented the least amongst what was recorded for all the other companies probably because of the high standard of engineering practice and professionalism associated with the company. The level of theoretical knowledge met for all the companies was less than 60%.

Most of the mining and manufacturing companies indicated that they preferred people with multi-technical skills and who are prepared to continue to learn (Table 1). In some of the informal discussions with the employers, it came up that having a multi-technical skilled workforce helped greatly in situations of reassigning workers to temporal roles during emergencies. There was also the flexibility of moving the skilled workforce around and that cuts down on operational cost since one multi-technical skilled person could handle a task that will require more than one person. This confirms the findings of Spinks *et al*. (2007) and Tiernan (2014) that employers no more want narrow technical specialists but multi-technical skilled employees who apply their skills whenever and wherever they are needed. Most of the companies especially VALCO and AngloGold Ashanti provided such comprehensive basic skills training to the new engineering graduate employees before putting them on the job. In almost all the companies, the soft skills formed part of the in-house training lined out for the new employees; hence little or no emphasis was laid on it during recruitment of new graduates.

The upstream Oil and Gas industry is quite new in Ghana and it was yet to have graduate engineers with specialised oil and gas skills from the Polytechnics. However, skills related to metal machining, welding and fabrication, repair and maintenance that are acquired from the traditional engineering courses are quite very relevant and could fill gaps in the business line of services in the industry, as found with the activities of Seaweld Engineering Limited, a provider of flexible and well-resourced inspection, repair and maintenance services to the oil, gas and petrochemical industries.

The AESD realised that the newly employed Polytechnic engineering graduates exhibited only 40% of the trade knowledge and 50 to 55% of the level of practical competence of what the company required. From earlier informal discussions, it was understood that most of the new engineering graduates were found to have difficulty in doing analysis that entails calculations, using working drawings to manufacture and in some cases deducing the mechanisms behind the operations of some agricultural equipment such as the rice mill, irrigation pump and some other field machinery. The soft skills such as ICT and effective communication were also found to be weak. This confirms the assertion of the Mineral Council of Australia (2005) that graduates often have a poor understanding of how to apply theoretical knowledge in practice.

The non-technical skills identified and required of the new engineering graduates relate to problem-solving ability, effective communication ability, the ability to interact with others well, showing drive and initiative, effective planning and managing workload, and good report writing ability (Table 1). This confirms the findings of ASTD Public Policy Council (2006), Smith and Kruger (2008), and Tiernan (2014). Strong general education background with grounding in basic writing, reading and mathematics were recommended to enable those with good technical skills but minimum schooling to fit well and function properly in the engineering industry. This is consistent with the findings of Horn (2006) which also identified the skills mentioned above as being amongst the new competencies required of engineers.

Outcomes of an independent-sample non-directional two-tailed t-test conducted to compare the industry's mean response on technical skills and non-technical skills and attributes show that there was not a significant difference in the mean scores for technical skills and attributes (M=2.333, SD=1.862) and non-technical skills and attributes (M=1.273, SD=0.467) conditions; t (5) =1.372, p = 0.228. These results suggest that the industries place equal emphasis on the technical and non-technical skills and attributes. This finding concurs with that of Smith and Kruger (2008), Motsoeneng et al. (2013) and Trevelyan (2008).

CONCLUSION

There is a huge gap between the skills needs of industry (which comprised both technical and non-technical skills and attributes) and the skills acquired by the engineering graduates from the Polytechnics in Ghana and Sierra Leone. Therefore, the Polytechnics have to give equal importance to both technical and non-technical skills and attributes in a well-ordered teaching methodology that emphasises hands-on training and industrial attachment for the engineering students. Industry should take the initiative to introduce new technologies to both lecturers and students and also play a key role in facilitating training in the institutions. Periodic upgrade of the curricula to reflect the skills needs of industry is critical because inaction could threaten the survival of the engineering departments and the faculty. It is therefore imperative that industrial attachment for students should as a matter of policy, be made a requirement for the award of certificates. Tertiary institutions (Polytechnics) should consult industry in the development of their teaching curricula and skills training activities in order to respond adequately to industry skills needs and also enhance the employability of their trainees.

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Cultural Assimilation of Technology Development in Ghana: An Ethnographic Approach

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ABSTRACT

Intrinsic to economic development is the intertwining of the application of science and technology for competitive production of goods and services. Ghana, like other sub-Saharan African countries, lacks a strong domestic technology base, despite decades of industrialisation efforts. This study, through an ethnographic approach, seeks to understand the situation of technology drawback in Ghana, by investigating a cross-section of the traditional and formal sectors of the Ghanaian society. The study, also, reflects on development remedy initiatives like the Appropriate Technology (AT) movement, National Innovation Systems (NIS) and other development interventions as exogenous efforts yielding no lasting solutions. Findings from the study showed an absence of a framework for dialogue between both sectors for development. Further, there is a disconnection between the Ghana Educational System and the traditional structure, thus, disallowing knowledge exchange and amalgamation of production practices, which should lead to the assimilation of modern technologies into the cultural structure for indigenous technology advancement. There is therefore, the need for a 'sense of commonality' to serve as the vehicle to cut across cultural, ethnic and social barriers in order to stimulate and sustain the drive in a culturally inclusive setting.

Keywords:

Africa, economic development, Ghana, science and technology, traditional and formal sectors

INTRODUCTION

The Inkosi [chief] told us that bringing development to the community has been his most important duty since 1994 when he and his community first learned about development.

The above quote was taken from the work of Englebert (2002) as cited from the field notes of Williams (2000). The quotation, among other things, suggests a late entry of the concept of 'development' into the African culture. This study would, therefore, endeavour to explore and bring to the fore how the cultural setting, referred here as the traditional sector, is positioning itself in its quest for development.

The role of science and technology (focusing on the latter) in the development of any community or nation cannot be overstated (Bauer, 2016). In Africa, contrariwise, the application of the principles of science and technology has been selective and on the low side (Baijnath & James, 2015). The adoption of technology of prevailing technologies has been the trend as far as history can recall, according to the work of Austin & Headrick (1983).

Historical accounts on African issues have often been expressed by non-Africans, who generally rely on anthropological artefacts to arrive at their conclusions. These conclusions are mostly derived from interpretations influenced by the cultural background and perceptions of these non-African historian authors (Gyekye, 2003). Such perceptions are generally alien to the African setting, and incorporate little consideration towards indigenous reasoning (Mawere 2014). Indeed, scholarly discourses on Africa's socio-techno-economic matters have been widespread, though described by many scholars as problematic for the relatively slow pace of development (Aitsi-Selmi, et al., 2016; Lall & Pitroballi, 2002). In addition, Africa's state formation was constituted with little recognition for indigenous institutions (Herbst, 1997; Kieh-Jr, 2007; Davidson, 1992; Herbst, 2000 and Chabal, 1994). As a result, government policies on science and technology do not readily consider the inclusion of the traditional sector for its cultural assimilation. This is where this study wishes to position itself, calling for cultural inclusion.

It indeed behoves on African authors to present African cultural perspectives to fit into mainstream modernisation intent for technology development. This, invariably, calls for a rewriting of the African history through a paradigm shift towards science, technology development and innovation for a strong economic base. Here, the advocacy is to argue for the African narrative (Donani, 2015) towards technological development for economic growth and stability.

This paper emanates from a background of Operations Management/Research and employs a Soft Operations approach in the research design. Its methodology is predominantly utilised in the social sciences (Seagriff & Lord, (n.d.) which employs an ethnographic approach, where narratives are constructed from a sociological perspective. The aim is to bring to the fore the significant role the traditional sector and its leadership could play in the expansion of science and technology in Ghana for economic growth leading to indigenous industrialisation explosion for goods and services.

The traditional sector is seen to possess the potential to contribute towards establishing a lasting development trajectory, though the sector has consistently been given marginal

significance. The traditional sector, which is described with cultural connotations, is seen as conservative; but findings in this study show its readiness to embrace modernisation. However, the traditional sector seems to lack the initiative and impetus to develop its own developmental identity, as such; it relies on or duplicates existing structures. A typical example is the modern educational system in place, which takes on a formal approach with little or no cultural identities embedded in it.

This study, therefore, taking excerpts from already expanded work on technology development for Africa, (Donani, 2014), proposes a model for development that encapsulates the inclusion and participation of indigenous knowledge and general inputs from the traditional sector. It hopes to achieve this feat within the framework of creating a *sense of commonality* for an even playing ground. Such framework is vital to provide a uniting factor, seeing Ghana as a highly mixed-cultural and multi-ethnic society.

In summary, this study advocates for the inclusion of the traditional sector in government policies for the advancement of science and technology. A methodology of micro-ethnography (Wolcott, 1990) was employed. The findings were used in a comparative critique of previous scholars' work on historical claims, institutional assertion and cultural interpretation of Africa's technological lag. A development framework was proposed as a model for development.

LITERATURE REVIEW

The low level of technology usage and development in general for the developing world has been problematic and a topical point of discussion for many scholarly works, philanthropists and well-meaning donor-organisations and national bodies. Evidence on the ground however continues to point to the fact that the problem persists to date, even though varying approaches and interventions are employed.

The failure for any of the employed approaches to yield a lasting outcome calls for retrospection; which revealed the exogenous nature by which African issues have been handled, often from non-African perspective, leaving out indigenous considerations and local content. This paper is of the view that there has not been adequate exploration of the wisdom and solutions embedded in the African cultural and traditional structures. On this backdrop, therefore, this section of the study seeks to explore the works of other scholars, to highlight and critique, where appropriate, such approaches put forward as a remedy for technical change, taking a critical perspective on the movement of appropriate technology (AT) movement. Here, AT is only considered within the framework of it being proposed under the definition as a low-level, renewable, labour-intensive, intermediate, etc., technology most suited for the developing world.

This paper draws from scholarly works of varying fields of study that are concerned with such ideologies as *intermediate technologies*, and from the comments in those works on the AT movement and other similar interventions, it is readily noticeable that those initiatives were orchestrated out of the goodwill of mainly non-African originators. This leaves the concepts lacking indigenous component, hence, their unsustainable nature. They are, therefore, exogenous to the beneficiary societies who have little or no contribution to the whole process and solution build up.

Exogenous Nature of Africa's Development Approach

Africa's development, or rather, under development, has been a topical issue among scholars. There have been several approaches to the issue, often, from an exogenous initiative rather than evolving from indigenous knowledge and experiences. The exogenous emergence relates directly to the planners' and development agents who are generally experts from non-African backgrounds (Tabusso, 2016; Chevalier et al., 1992). As a result, they tend to lack the requisite intrinsic first-hand knowledge of Africa's indigenous processes and customary and cultural interpretations (Cox & Trotter, 2016; Mawere, 2014). The development agents nevertheless, proceed, with all good intentions, to propose well thought out and ready 'cooked' schemes/models/solutions for Africa's development challenges without due regard to/for local content (Baijnath & James 2015). Contributions from African scholarly performance in this direction remains somehow invisible, by reason of low publicity (Hanlin & Kaplinsky, 2016), and low recognition or adoption by the implementing powers. Some common examples of the exogenous remedies cumulate into such popular and accepted concepts as the highly acclaimed Appropriate Technology (AT) movement, in conjunction with its adjunct technology transfer concept (Hanlin & Kaplinsky, 2016; Akubue, 2000; Jequier, 1976). Proponents and detractors of AT argue from varying opposing grounds. However, a neutral observation by the technology historian, Edgerton (2008), points out that no developing nation has yet been put on record to have grown its economy out of poverty through the application of AT principles, hence, casting doubt on its appropriateness as a development tool.

Similarly, other intended transformational concepts like the National Innovation Systems (NIS) (Zuniga, 2016; Lundvall, et al., 2002) have been highlighted by authors as suited for application in the industrialised nations rather than in the context of developing nations (Zuniga, 2016). This is however, in opposition to the fact that the initial data used for the formation of NIS were collated from the developing world. Its application has, however, turned out to be highly problematic (Johnson, et al., 2003).

Indeed, authors like Chavelier (1992), Sachs (1992), and Portes (1976) debunk exogenous models for development, claiming they are characterised by parochial sense of judgment on the part of the developers. Their call remains valid and invariably points to a non-alien approach to sustainable self-maintainable development model as in the case of Myanmar (Abe & Dutta, 2014), which would be to the advantage of the developing nation.

Ethnocentrism in Africa's Development

The described historic underdevelopment in Africa compelled many more scholars to seek answers to the challenge. In their efforts, they have had to put forward a number of theories and narratives often with assumptions and speculations (Austin & Headrick, 1983). This is due to the absence of written historical records on the part of Africans (Davidson, et al., 1965). Some of the additional theories emerging from different fields of study such as: economics, history and some aspects of sociology, conclude that the solution to the trajectory of Africa's development could be summed up in the following thematic areas: the provision of infrastructure into the African continent (Juma, 2011); a restructuring of Africa's

weak institutional framework (Acemoglua & Robinson, 2010; Lall, and Kraemer-Mbula, 2005); the establishment of institutional linkages among African firms through learning (Lundvall, 2010, Szogs, et al., 2009 & Johnson, et al., 2003); a change in the African cultural orientation (Austin & Headrick, 1983); and provision of appropriate technology (Jequier, 1976; Schumacher, 1974). This study agrees with previous authors that these approaches have not yielded any appreciable results.

In simple terms, these approaches seem to lack the African narrative and initiative (Donani, 2015) and have been described by scholars as 'invisible ethnocentrism' by non-African authors (Chevalier et al., 1992). For example, according to Davidson et al. (1965), some *Africanist* historians claim Africa has no history of its own. On the contrary, Africans are noted to have a long history of their own, which, indeed, forms part of the human history (Gyekye, 2003). Similarly, as noted by Edgerton (2008), technology historians have noted that there is no record of invention emanating from Africa. Such notions are still considered as true despite the fact that Africa discovered/invented iron smelting independently from the rest of the world (Davidsonet al., 1965).

Consequently, with the intent to establish a difference in the discourse, and relying on the ethnographic data obtained from Ghana, this study thus, contributes to correcting the misconstrued representation of Africa's ingenuity owing to its low level of technology usage and development. The ensuing discussion as in the findings of this study, to a large extent, represents the African narrative on the subject from the Ghanaian perspective. The following section, therefore, attempts to present from fieldwork, the researchers' understanding of the Ghanaian society, for a common playing ground within the context of the formal and traditional sector and the chieftaincy institution with support from existing literature.

METHODOLOGY

In view of the sensitivity and human centred-nature of the subject matter of this study, caution has to be considered in the choice of a methodology that could be relied on for its techniques and procedure for reliable results. Its human centred-nature generally would call for the application of *soft operations*, which is predominantly a social science research methodology. The methodology, therefore, employed in this study was ethnography. Ethnography is the culturally oriented qualitative research methodology equipped with tools and techniques for obtaining first-hand information where culture makes an entry (Wolcott 1990). This section discusses what ethnography is.

Ethnography, traditionally found in Cultural Anthropology, both as a research methodology and product of research (Marcus and Cushman, 1982), is, for the vast fields of study adopting and identifying with it, confronted with the difficulty of definition and representation (Atkinson and Hammersley, (1994). It may, however, be described as a research methodology with intimate interaction with participants to adequately reflect the participants' perspective and behaviours (Schensul, 2005). It embraces scrutiny of emerging challenges in genre and traditional procedures, (Thomas, 1991), thus, making ethnography an evolving methodology. As part of the dynamism inherent in the methodology, the progressing discourse of practice and genre in ethnography, considering its realism, postmodern and deconstructivist

debate, (Marcus and Cushman, 1982; Sangren, 1988) argues against its traditional branding procedures, description and definitions (Thomas, 1991; Clifford, 1988). The contention in its feature of fluidity and plasticity garners a wider spread of application beyond its traditional confines, as expressed by Wolcott (1990), where procedures and presentation, are no longer restricted within the tenets of Anthropology and traditional ethnography.

Traditional presentation of ethnography is fundamentally being reshaped by the growing trend of epistemological concerns of the processes of how interpretations are constructed and how they are contextually presented (Marcus and Cushman, 1982). Thus, narrative representation, reporting and constructivist approaches are inherently embedded as a social science feature on epistemological issues. It has, therefore, become an integral part of the cultural analysis, where anyone engaged in ethnography assumes the responsibility of contributing to the reshaping dialogue (Wolcott, 1990).

The methods employed for data collection in this study are observation, photographing, conversation, focus group, semi-structured and structured interviews. The qualitative data analytical technique embedded in *grounded theory* was adopted in coding while data collection continued.

Ethnography is distinct from other forms of qualitative methodologies by the ethnographer having to live among the population being studied, working with informants who are particularly knowledgeable or well placed to collect information (Bryman, 2012). This involves fieldwork, which may last over a year. Micro-ethnography, however, permits much shorter duration of stay, depending on the circumstances of the researcher, for example, a student with limited time (Wolcott 1990).
In this study, a total of one month and a week was spent in two different rural communities in the Upper West and Northern Regions of Ghana.

Participants in this study included the Chief, community elders, farmers, housewives and local producers among the community folks. The study was expanded to cover the urban areas where structured interviews were conducted with the Directors at Government Ministries and Agencies. Company Executive Members (or representatives) and business owners were also interviewed.

Outcomes of the corpus of data collated during the fieldwork are presented as narratives in the following sections. Some of the findings confirm existing information.

FINDINGS AND ANALYSIS

The findings of this research were arrived at from statements by respondents during the fieldwork and are presented under six thematic areas of discussion. They emerged from the coding and analysis of the corpus of qualitative data collated. The discussions invariably provide a level of insight from first hand information so as to arrive at more substantive conclusions not based on speculation and assumptions as found in the work of earlier scholars on the subject of discussion.

The Ghana Traditional and Formal Sectors

Ghana, like the rest of sub-Saharan Africa, is noted to be highly ethnic with strong family and social ties (Beall and Ngonyama, 2009). The bureaucracy that comes with

modernisation is stated to be problematic in the Ghanaian cultural setting (Price, 1975). This poses a challenge to the presence and growth of the modernisation agenda. The traditional sector, which is generally of a cultural mindset could be considered to have political capacity to play a central role to facilitate a rapid and smooth transition to the assimilation of modern processes into the cultural structure for technology development. This study, as a result, sought firsthand knowledge from the ground through field work, to establish the linkage between technology development and the traditional setting.

Among other things, the findings from the fieldwork partly confirmed existing literature about the division that exists between the traditional (customary/cultural/rural) and the formal (urban/modern) sectors. Some authors described it as the dualism of structure of power (Englebert, 2002). Others see it as institutional multiplicity (Beall and Ngonyama, 2009) or rural/modern sector divide (Chevalier et al., 1992). Chevalier and his colleagues described the traditional sector as 'the rural people alienated from modernisation' (p. 366) and the formal sector as 'extension of colonial era' (p.367).

The traditional sector in Ghana could be described using the indigenous leadership structure, i.e. the Chieftaincy institution. Chieftaincy in Ghana constitutes a major cultural distinction. It has a tremendous effect on the political economy of the nation, controlling about 80% of total landmass with the Government keeping 10% for development and the remaining 10% distributed among businesses and individuals (Odotei and Awedoba, 2006). The traditional sector is however mainly rural, peasant, and generally lacking formal education and modernisation (Mawere, 2014). The formal sector, on the other hand, holds the seat of Government. This sector is expanded to include formally educated professionals both in public and private sector employment and often urban dwellers.

During the fieldwork of this study, the ethnographer was each time introduced to the village chief where a research was to be conducted. Before the commencement of work to engage the informants, each community chief has to be in the picture. Their receptions were however very welcoming.

Chieftaincy and Development Intent in Ghana

The chieftaincy institution in Ghana has a long history, predating the colonial administration. It survived colonial rule, post-independence political and the military regimes (Odotei and Awedoba, 2006). As opposed to the expectation of modern theorists, the traditional African system of governance is not disappearing to be replaced by modern institutional authorities (Kleist, 2011), but it is experiencing a resurgence and recognition by central government administrations (Englebert, 2002). Authors have shown that in Ghana, the chiefs wield much power over their people, but not central government. The institution is, however, confronted with a vague future in relation to its political status. This can be deduced from the news article; 'Review Constitutional Provision on Chieftaincy' (Government-of-Ghana-Official-Website, 2013). There, the President of the National House of Chiefs called for a review of the Ghanaian Constitution on Chieftaincy to allow for active political participation. The Constitution, though recognising the institution and having institutionalised it, debars chiefs from partisan politics. They are however allowed

to hold public offices, but not as chiefs, thus, limiting their role to customary interpretations and conflict resolution (Chieftaincy, 2012). As a result of such limitation, development inputs by the chiefs engaged with in this study could be carried forward to influence policy making as it lacks the requisite power and authority to influence a change for his people.

Also, though they may wield much power over land and their subjects, their economic prowess was observed to be highly limited, as they often depended on government or other external bodies for funding (Fieldnote: 2012; Englebert 2002).Their limited economic generating capability, besides the sale of [stool] land, could be interpreted to mean that traditional African institutional frameworks are not very successful in economic development initiatives, possibly, for its late entry, as was the case with the Inkosi. Arhin, (1990) provides useful insights on wealth accumulation in the Ashanti State in the nineteenth century, noting that the invading Europeans' development economic policy was more appealing than that of the indigenous institutions. This could be considered as a departure from self-sustenance and development.

This, therefore, supports the observation that the concept of economic development is a new phenomenon to the African culture, as noted by the *Inkosi*. It is suggested here to have been introduced into the African culture through colonialism. But since culture evolves and 'not immutable' (Beall and Ngonyama, 2009), a compromise is possibly an option to develop the traditional sector through the chieftaincy institution, which wields much power over its people.

As of 2015, and to the best knowledge of the authors of this report, no structure in the traditional sector for the running and development of formal education in science and technology exists in Ghana for technological advancement. The Chieftaincy, as an institution of significant authority, did not seem to establish or advance existing indigenous structures for development consciously. For example, the institution's approach to acquiring development funds is through government lobbying, non-governmental organisations (NGOs), or from personal earnings of chiefs in public sector employment (Kleist, 2011). Though the Chiefs may be keen on developing their communities, their efforts do not seem to be harmonised with their *cultural identity*. This being that their 'projects' tend to simply replicate government's efforts, which, itself, are replicas of the international economic development models. As such, the concept of development in Ghana is expected to resemble what is available at the international front, thus, lacking originality or indigenous content.

In the case of, for instance, the Ashantihene (King of Ashanti) Educational Fund, which is now emulated by other chiefs (Englebert, 2002); it simply augments government's efforts in providing education. It does not in itself constitute an independent system of education evolving culturally from the vast knowledge of the traditional sector as in *oral tradition* and indigenous artefacts. This, in effect, provides the evidence that the traditional setup, lacking its own springboard, is willing to partner with the government (liaise with the formal sector) in its development efforts.

By this, therefore, the aspiration to see the development of indigenous knowledge of science and technology move side-by-side with modern formal systems in education and

policy-making does not seem forthcoming. A typical case is the traditional production process for shea butter extraction, which has never been improved upon for generations past since inception. The attitude of the traditional sector here gives an impression of 'a culture of waiting', as observed; waiting for Government; an NGO; or some philanthropist to bring them development.

This paper is not advocating (neither opposing) a parallel system of development in Ghana but highlights the invisibility of a development initiative by the traditional sector towards a culture of science and technology development and the seeming abandonment of the traditional sector by the formal sector authorities. There seems to be the absence of a harmonising force between the sectors. The traditional sector, however, shows a significant inclination to embrace science and technology application.

Inclination towards Science and Technology

This section presents some of the features identified during the fieldwork that may help to explain the position and mindset of the Ghanaian society in relation to science and technology. This is from both the standpoint of the traditional and formal sectors. As discussed far, it has been shown how the Ghanaian/ African traditional sector is setting a paradigm to position itself for change so as to embrace development and modernisation. Though the sector has not been able to present itself as a global leader to reckon with, it exhibits an inherent capability to adapt and develop technologically. Indeed, this observation is supported by scholars as shown by some authors like Austin and Headrick (1983) stating:

> *Africans have demonstrated a capability for developing their own technology and adapting imported devices where these seemed compatible with local needs and perception* (Austine & Headrick, 1983; p. 178).

It is however, worth noting how Africa's technology development trajectory has not been in conformity with the rest of the world as in its evolution and diffusion. For example, according to Cline (1937) cited in Austin and Headrick (1983), Africa moved from Stone Age straight to Iron Age, missing the transitional Bronze and Copper Ages. In the fieldwork of this study, the traditional communities visited had detailed oral tradition (history) of iron smelting. The main respondent, through an interpreter explained thus;

> *Our forefathers were much wiser than we are today. They knew how to make many things by themselves. They made iron for their hoes and arrows from those large stones [iron ore] you see over there. They are called, 'bensa-kwansibe'.* (Source: Fieldnote; 2011; Conversation with an Elder from a village in north of Ghana).

The respondent's attribution of higher wisdom to their ancestry probably could suggest a lack of confidence in the capability of present generation. This, invariably therefore, points to the need for an external impetus, such as a development framework or policy to help stimulate the drive for growth in the sector.

Traditional Sector Selective Towards Technology Adaptation

As shown by Austin & Headrick (1983), the traditional African setup is 'selective' in adopting new technological methods, but not ignorant. This observation by the authors

conforms to the findings of this study. For example, in a conversation with a respondent during the fieldwork, the respondent, pointing to a mountain nearby noted: *that mountain contains gold, the Kusasi people go there to collect gold whenever it rains heavily*. Intrigued at the mention of gold, this ethnographer asked the respondent; 'why don't you go collect some gold for yourself too? It fetches a lot of money. The respondent replied, showing the *selective attitude* and not ignorance;

> *No, we don't do gold, we farm and keep cattle. They do gold, we are farmers*

(Source: Field note; 2011; Conversation with an Elder from a village in the Upper West Region of Ghana).

This response confirms a mindset of 'tribal division of labour' or tribal vocation specialisation (Austin and Headrick, 1983). This practice, surprisingly, was not found to lead to tribal inter-dependability; rather the tribal and family internal ties remained strong within the tribe interacted with during this study. They, however, maintain weak ties with other groups. It may be stated here that within such a framework of dispersed social cohesion, cross-cultural knowledge exchange is hampered, thus, affecting the subject of *inclusion* of the cultural/traditional sector in the technology development agenda of the nation. Cultural segregation seems to take a stronger foothold within the traditional setting.

Tribal Dichotomy of the Ghanaian Society

In addition to the 'tribal division of labour and division of labour', which characterizes the traditional sector, there seems to be another dimension to the social structure of the sector, describable, here, as tribal 'statehoods'. Here, the tribal connotation tends to assume established identity secluding them from each other. This tendency of tribal identity seems to permeate the formal sector, hence affecting the social homogeneity of the country.

Such conclusion was deduced from the response of a respondent when asked about the relationship of their village with neighbouring ethnic groups. The respondent replied;

> *We are different from them. We do not interact except sometimes when they come to marry one of us or we go to them, but it hardly happens... In the olden days, war over land or herds of cattle could bring us to meet them, if not we do nothing together. They do not take part in our festivals, neither do we in theirs* (Source: Field note; 2011; Conversation with an Elder from a village in the Northern Region of Ghana).

The respondent's statement points to ethnic seclusion. The ethnic bond seems to cut across the country permeating the formal sector. This was deduced from an interview conducted with a respondent who is a top official in a multinational company in Ghana. When asked why his company did not purchase its machines from manufacturers in Ghana. The respondent replied thus:

> *Ghana is not known for machine building. Even if we made machines here, someone from a different tribe will prefer to import rather than buy the machine made by another tribesman for him to become more powerful and dominate him. Don't you see how we vote in this country? We vote on tribal lines. No one wants another tribe to come and lord it over*

> *him* (Source: Fieldnote; 2012; Interview with a top official of a multinational corporation operating in Ghana).

This position was however disputed by a different respondent, also a company executive, when asked how tribal tension among staff was addressed in his organisation. The respondent replied;

> *We do not have tribal tension in our organisation. There is no tribal tension in Ghana. If you take a look at our secondary schools and universities you would notice they are mixtures of all tribes? We recruit on merit, not on tribal affiliation....* (Source: Fieldnote; 2012; Interview with a top manager of a State Company in Ghana).

This claim by the respondent is however in contrast to the several reported cases of ethnic conflicts and clashes reported from different parts of Ghana. For example;

> ...there are several intra- [and inter-] ethnic conflicts over land [and chieftaincy and family successions] across the length and breadth of the country (Boafo-Arthur, 2006; p. 155).

The responses thus far could be summed up to imply that the ethnic dichotomies probably are only prominent at the social and traditional levels but minimised at the professional level through the enforcement of institutional codes of conduct. The codes of conduct, therefore, act as a vehicle to convey or establish that needed *sense of commonality* binding members of that group (the organisation) together.

The Traditional and Formal Sector Divide

This study found a clear disconnection between the Ghanaian formal sector and the traditional sector in a manner affecting technology dispersion not quite expressed in existing literature available to this study. The struggle for individual well-being in the social imbalance between the holds of the traditional sector, commonly rural based and the urban based formal sector counterpart is dramatically shifting towards a new paradigm. For the first time in Ghana, according to the Ghana Statistical Department, more than half (51.2%) of the economically active population live in urban areas (Daily-Guide, 2013). The rural areas, as previously indicated are generally underdeveloped and deprived compared to the towns and cities. According to scholars:

> Rural people [of sub-Saharan Africa] are alienated by efforts at modernization to which they are not a party to the decision-making and from which they do not benefit. The neglect of the modern-traditional boundary has resulted in disincentives to peasant participation (Chevalier et al., 1992; p. 366).

An institutional framework in Ghana for dialogue between the two sectors was not found by this study. This probably explains why, as shown in the work of Kleist (2011) and Englebert (2002), the traditional sector now seeks to install (enstool or enskin) chiefs who have some level of formal education.

The traditional sector becoming more flexible, as demonstrated by Beall and Ngonyama (2009), is seen in Ghana as making efforts to adapt to the modern world. These efforts put forward by

the traditional sector to embrace modernisation are not met with similar enthusiasm by the elite group and policy makers of the formal sector. Instead, the formal sector is more interested in catching up with the rest of the world, as noted by Chevalier, et al. (1992);

> African governments too often find themselves in the middles of the picture, trying to maintain a viable relationship with the OECD countries and the African modern sector (p. 367).

This assertion falls in line with findings in this research as can be deduced from a government department policy-maker, who states:

> *We will improve by renovating all scientific centres and laboratories in the country and put in modern equipment for scientific and technology generation and build science and innovation parks to welcome all. We will also contract Chinese loan to develop Nano-technology.* (Source: Field note; 2012; Interview with a Director at a Government Ministry in Ghana).

This respondent's statement tends to confirm the marginalisation of the traditional sector, which is generally unschooled, hence handicapped to participate in the development agenda by the policy makers.

It became apparent from the interview that more emphasis is placed on attaining higher technological levels than making science and technology relevant to the local and wider population. For example, developing such high-techs as '... *Nano-technology*...' in a country where basic structures for creation of production technologies are hard to come by for the local industry is problematic. This seems a major departure from efforts towards harmonising the two sectors to bridge the gap.

Also, from a review of a number of Ghana's national policy on science and technology documents (see Ministry-of-Environment-Science-and-Technology, 2010; Republic-of-Ghana, 2011; United Nations-Conference-on-Trade-and-Development, 2011), the findings from this study could not find any policy or framework incorporating the traditional sector into its science and technology development agenda.

Discussion – *where cultures meet in search for commonality*

Development in Africa has become a major political, economic and social encumbrance since post-colonial era and has been a huge challenge to the relatively new nation-states of Africa, such as Ghana, that emerged from colonialism. Scholars have shown how the colonial administration created an elite group of educated Africans, separated from the 'uneducated' natives, thus, creating a two-tier system here referred to as the traditional and the formal sectors. The elite group who understudied the bureaucratic processes of their colonial predecessors and took over the mantle of leadership on attainment of independence (Price, 1975) assumed an imaginary realm of professional superiority over their counterparts in the traditional sector. Indeed, the new African political leadership in many ways sought to flatten the traditional (cultural) landscape of their newly found mixed cultural nationhood (Herbst, 1997).

Ghana saw the need to develop its economy through industrialisation and consequently

made science and technology the cornerstone for development. As a result, the Nation set out for the expansion of the knowledge and application of the subject throughout the country. In this regard, a national policy for the expansion of science and technology was produced. However, it lacked the requisite cultural content.

This study, from fieldwork and existing literature, found that Ghana, in its planning agenda for the expansion of science and technology gave little or no consideration for input from the traditional sector and its leadership such as the chieftaincy institution. This ethnographic study, among other things, confirms the claim in existing literature about the divide between the formal and informal sectors. It sees the division as a major contributor to retarding the expansion intent, and also strengthens the belief that the absence of indigenous input prevents a cultural assimilation of development aspirations.

The traditional sector on its part saw that it was disadvantaged (Beall and Ngonyama, 2009) by the lack of formal education and now seeks to install educated Chiefs even when they lack sufficient traditional/cultural knowledge (Kleist, 2011). This is an indication of the Ghana traditional sector preparedness to embrace modernisation and development despite the vast cultural variances.

Differences in cultures are thus, argued in this study to cover the basic human needs for survival and development. For example; 'hunger knows no cultural barrier', as such, the quest for 'a sense of commonality' was proposed as a means of bridging the [cultural, ethnic social, traditional] and modern sector divide, while maintaining each distinctive cultural identity. The 'divide' is a complex phenomenon seeing that it cuts across both the traditional and formal sectors and individuals in the elite group all have their roots in the traditional sector, thereby, compounding the complexity of the divide syndrome. The specific 'commonality' suggested here as observed to be present in both sectors is the concept of 'economic development' through the *scientific manufacturing of technologies.* A national agenda to be centred on Ghanaian engineers being challenged to locally manufacture most of the production technologies required in the country is suggested as an appropriate vehicle to drive that 'sense of commonality'.

A model for the *scientific manufacturing of technologies* could form the basis for future work in this study, part of which has already been initiated in the work of Donani (2014) and excerpts are provided below.

Cultural Assimilation Framework

The overarching aim of this study was to seek an avenue for the development of indigenous technologies through inclusion of cultural principles in the development planning agenda in Ghana. This study argues that current strategies have consistently yielded disappointing results for exclusion of the traditional considerations. Inclusion of cultural and traditional systems of operations in modernity, with specific focus on enhancing technologies for indigenous processes could be particularly precarious seeing that cultures are highly varied from place to place. In addition, though cultures may be conservative, they are actually not static. The dynamism of cultures gives it certain fluidity that rolls out a level of social instability when imbibed into any mainstream setting. Some cultural practices are desirable while some may be detestable. Hence, an attempt to devise a

system to embrace cultures in the development processes may not assume a straightforward event, but rather, a careful understanding of the structures, processes entailed and the objective aimed for.

Drawing on previous study based on this backdrop and the above discussion, the following summary is given in the bullets below and represented, pictorially, in the following diagram (Figure 1) below.

- Traditional sector and its leadership are yet to demonstrate its visibility in self-initiated development efforts and sustainable long, medium and short term planning acumen
- An external driving force is needed to prompt the traditional sector; Government is to provide that drive, stimulus, impetus, funding and coordination for the development plan
- Existing academic and research institutions should be streamlined to focus attention on researching into indigenous technologies and local systems of operations and production
- The traditional sector (beneficiary society) to participate in contributing to the design, construction and finalisation of development projects
- Technologies and techniques developed to be disseminated into traditional productions of local enterprises; e.g. gari processing, shea butter production, kenté and other local textile production.

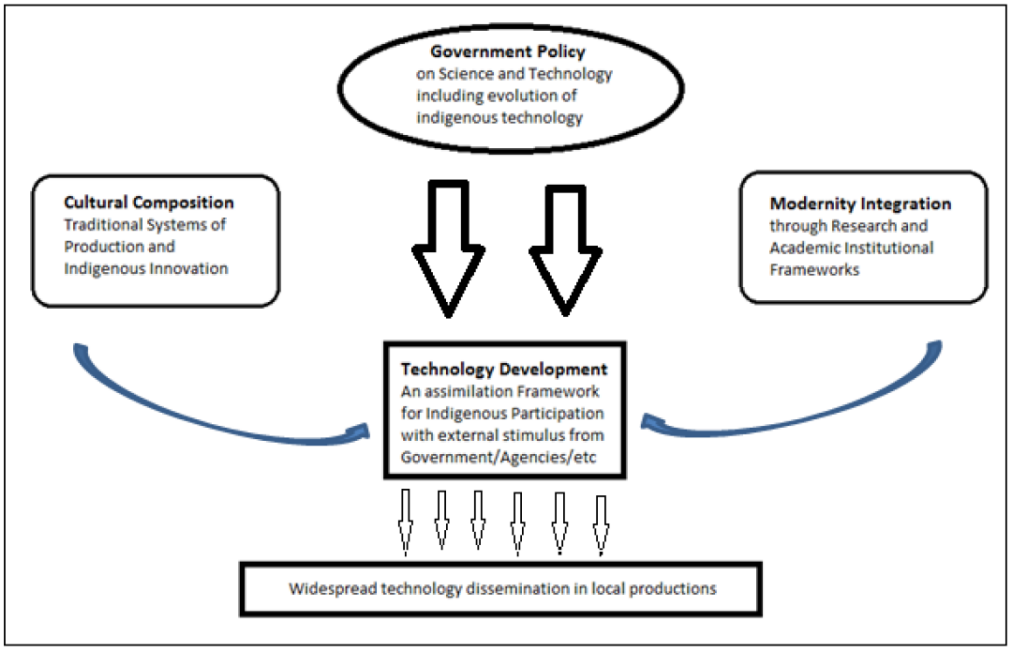

Fig. 1 Government spearhead inclusion of traditional sector in technology development planning

The Figure 1 above illustrates the call for Government involvement in incorporating cultural knowledge in the diffusion of science and technology by mandating an independent body to be specifically responsible for the cultural infusion into science and technology. That body in combining modern technologies and processes would invariably tap the vast problem-solving capabilities inherent in selected practices and processes of production culturally. The eventual outcome would be the creation of culturally influenced technological artefacts to enhance local productions for its assimilation, thus; leading to technical and social change as a normative.

CONCLUSION

The human society is defined by its culture, which could be used to drive the development aspiration of any nation or organisation for self-ownership. This study considers the traditional sector of Ghana, which is culturally oriented, as a potential vital tool for the expansion of science and technology for national development.

The findings suggest that in Ghana, the traditional sector is yet to make itself visible in the development agenda of the nation. It has contrariwise been relegated to customary interpretations and it is non-inclusive in the national development planning agenda. There is also a disconnection between the system of education (the educated elites) from the traditional system on the ground. This disconnection is seen to significantly contribute to the non-assimilation of prevailing technologies into the traditional sector to be used for development.

Indeed, major differences in culture, language, etc., were found to impact on technological development in Ghana. However, it is argued in this paper that the differences in cultures converge at a point of basic human needs for survival. As such, the quest for the search for 'a sense of commonality' was proposed as a means of bridging the [cultural, ethnic social, traditional] and formal sector divide, while maintaining each distinctive cultural identity. The 'divide' is a complex phenomenon that cuts across the traditional sector and the formal sector, as individuals in the elite group all have their roots in the traditional sector. The specific 'commonality' suggested here is the concept of economic development through the expansion of science and technology for indigenous assimilation of technological growth for the manufacturing of technologies. Therefore, with the understanding gained from the entirety of this study, the following recommendations are made: An independent body should be established and should be backed by legislation, solely for science and technology application in the local industry with cultural infusion. Also, conscious efforts should be made to solicit input from the traditional sector. In addition, the Government should meet the traditional sector midway, through intervention policies to reciprocate efforts by the traditional sector to assimilate modernisation. Furthermore, the Government should provide a platform for dialogue through, what may be termed here, 'technology extension Officers'.

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Occupational Health and Safety Practices: An Assessment of the Electricity Company of Ghana, Ho Division

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ABSTRACT

Providing a safe place of work has been a common law duty of organisations, especially, the potentially dangerous work environments. This mandates organisations to implement Occupational Health and Safety (OHS) practices which could prevent or control hazards at the workplace. The study of OHS practices in an electricity distributing organisation is crucial because electricity poses danger such as fatal electrocution of workers. This study is aimed at identifying the OHS practices in the Electricity Company of Ghana (ECG), assessing how OHS practices are implemented, and their perceived effects on the company. Using a descriptive survey strategy, 120 respondents from the Ho Regional Division of ECG were conveniently sampled. The findings indicated that OHS practices implemented were either centralised to the regional safety officer or decentralised to the supervisors. There was however, no well-designed institutional framework for the implementation of OHS practices. This led to an average rating of the perceived effects of OHS practices on the company. The originality of the study is focused on the empirical investigation of the practices in a typical engineering company other than mining in a developing country context. The implication of this study is that engineering companies should focus on OHS issues.

Keywords:

Electricity, Hazards, Occupational Health, Safety.

INTRODUCTION

It is quite obvious that the work domain has undergone enormous transformation over the last decade. For instance, the era of very heavy, dirty and dangerous industries, as well as the burden of diseases that accompanied working in such environments has virtually faded away. Nonetheless, the new working environments and conditions of work that have replaced them are not devoid of health and safety concerns (Rantanen, 1994). The public is increasingly becoming aware of the effects of exposure to physical, chemical, biological and psychosocial risk factors at the workplace. In this regard, expectations of society pertaining to health and safety at the workplace have also changed with increasing demands for better standards of protection and improvement of the quality of working life of employees (Health and Safety Executive, 1998).

It is in view of this new demand for safety in the workplace that the World Health Organisation (WHO) and the International Labour Organisation (ILO) have begun focusing on labour environments in developing nations, with projects such as Healthy Cities as evidence of their commitment to health and safety practices (Swuste & Eijkemans, 2002). Several other steps have been taken at the industry and national levels to safeguard the health and safety of employees.

These notwithstanding, most countries and industries still do not acknowledge occupational health and safety practices as a critical determinant of national development (Puplampu & Quartey, 2012). This is evident in the paucity of research available in the area of health and safety in Ghana and even Africa as a whole. According to Barling, Loughlin and Kelloway (2002), less than one out of a hundred studies at the organisational and national levels focused on occupational health and safety issues. As industries and governments have made very little effort to address occupational health and safety issues, majority of African countries are struggling with occupational health and safety practices (Regional Committee for Africa Report, 2004). One of the contributing factors to the poor occupational health and safety practices in Ghana may be the negative attitude towards occupational health and safety practices on the part of employers. According to the Ministry of Health Report (2007), most employers are not actually concerned about safeguarding employees' health and safety. Moreover, some do not even know that they have a legal obligation towards their employees' health and safety. In addition, there is lack of a comprehensive policy on OHS, poor infrastructure development and funding, insufficient number of qualified occupational health and safety practitioners, as well as the lack of adequate OHS information (Muchiri, 2003).

Globally, it is estimated that workers suffer 270 million occupational accidents and 160 million occupational diseases annually (ILO, 2005). Poor occupational health and safety does not only result in reduced working capacity, premature death, occupational accidents and injuries (Disease Control Priorities Project [DCPP], 2007; Tharaldsen, Mearns & Knudsen, 2010) but it may in turn, lead to economic loss (up to 10-20% of the Gross National Product) of a country (WHO, 1994).

Work-related diseases and accidents are estimated to account for economic losses as high as 4% of worldwide Gross Domestic Product [GDP] (ILO, 2003). As rightly said by Kofi Annan, a former UN Secretary-General,

occupational health and safety is not only a sound economic policy, it is a basic human right (Amponsah-Tawiah & Dartey- Baah, 2012). It is, therefore, pertinent for developing countries such as Ghana to begin to take giant steps in occupational health and safety research as well as implementing policies that ensure health and safety at the workplace.

The Labour Act (2003), Act 651 of the Republic of Ghana also recognises the relevance of health and safety at the workplace. Accordingly, section 118(I) of the Labour Law mandates employers to ensure that every worker they employ works under satisfactory, safe and healthy environments at the workplace. Employers are therefore, required to ensure that their employees are not exposed to conditions that would result in unnecessary work-related injuries or illnesses. Employees are also required to ensure that they work according to the employer's standard operating procedures which must incorporate safety and health requirements (National Labour, (2003), Act 651). The question of whether both employers and employees are aware of these provisions and/or have taken steps within their organisations to enforce this law is a vital one which needs to be addressed.

Globally, the energy sector is considered a highly risky industry due to the difficult nature of the working conditions involved. This sector is noted for high levels of workplace fatalities (Kane, 2010; Mearns & Yule, 2009). The National Institute of Occupational Safety and Health (2012) noted that electricity poses a danger to many workers. Although a department has been devoted to OHS practices in Electricity Company of Ghana (ECG), there is virtually no documented evidence indicating that it has been discharging its obligations to employees. The present study, therefore, sought to identify the OHS practices available in the ECG, how these practices are implemented in the company and the perceived effects on the company. The motivation for the study lies in recent occupational accidents that occurred in some industries in Ghana (Ghana News Agency, 2009; 2013). The study is consistent with extant safety research which posits that organisations which focus attention on a positive safety climate may create improved safety performance and participation (Braunger *et al.*, 2015). This article does not only add to the body of knowledge on OHS practices, but it also provides empirical assessment of OHS practices in a non-mining engineering company in a developing country context.

LITERATURE REVIEW

Nature of Occupational Health and Safety (OHS)

Occupational Health and Safety is a multidisciplinary field which involves a host of specialists from different disciplines including engineers, management scientists, psychologists, biological scientists, lawyers, economists and statisticians (Annan, Addai, & Tulashie, 2015). Though, OHS measures may vary with the type of organisation and the stages of its development, issues of OHS affect all workers irrespective of their professions (Chen & Zorigt, 2013). In this regard, research and practice of OHS remain relevant now and in the future in so far as human beings engage in work-related activities which may be prone to accidents. Coupled with this is the fact that safe organisational climate and performance is perceived as a subsystem of organisational performance in general (Wu, Chen & Li, 2007 which may impact an employee's work behaviour and attitude. This assertion reflects the social systems theory which asserts that

social behaviour is the result of the interaction of the role of institutions and expectation as well as individual personality and needs (Getzels & Guba, 1957; Ornstein & Hunkins, 1993)

OHS management practices may be perceived as a system of standards, procedures and monitoring protocols aimed at promoting the health and safety of people in organisations as well as protecting the general public against occupationally related accidents to avoid the pain loss which results from workplace fatalities and injuries to individual and societies (Wilkinson & Dale, 1998; Chen & Zorigt, 2015).

The OHS measures, procedures and practices could be caged into preventive, curative and compensatory frameworks that are adopted by an organisation to shield its employees and the public against work-related accidents. Whilst some organisations and managers lack the requisite knowledge, skills and motivation to manage OHS issues, others perceive OHS as daunting (Haslam et al., 2016). In view of these, organisations adopt national and international standards, systems, and legislation to develop their organisation and occupation-specific safety standards (Chen & Zorigt, 2015). An implementation of effective OHS practices and procedures, therefore, provides an intervention aimed at breaking the chain of causation of accidents and workplace injuries. Consistent with the performance management framework, organisational safety climate is considered an important measure of organisational performance (Zacharatos, Barling & Iverson, 2005).

Trends and Overview of Occupational Health and Safety (OHS) Issues

In the late 19th and early 20th centuries, employers ran their organisations the way they deemed fit in order to make maximum profit, hence employee safety and health were not of paramount importance to them. However, since 1950, the ILO and the WHO have held joint sessions to deliberate on the role of employers and other stakeholders in the Health and Safety practices provided to employees in organisations. As a result of these deliberations, the ILO in 1959 provided that occupational health services should be established in or near a place of employment for the employees' welfare (ILO, 1959). Currently, most strategies towards health and safety policy and regulation are mainly entrenched in the 1960's during which time trade unions in many countries began to focus on issues regarding quality of working life, including job security, job satisfaction and occupational health and safety (Hermanus, 1999).

A joint definition of occupational health by ILO and WHO (1995) includes: promoting and maintaining the highest degree of physical, mental and social well-being of workers in all occupations; preventing deviations from health among employees as a result of their working conditions; protecting employees from risks resulting from factors adverse to their health; and placing employees in an occupational environment adjusted to suit their physiological and psychological capabilities. OHS, therefore, cuts across disciplines such as law, psychology, medicine, technology and economics (Leka, 2003). Despite the broad nature of OHS, it has not received the needed attention in these fields as far as research is concerned especially in Africa.

Whereas many countries around the world are increasing the quality, health and safety requirements in the work place due to the realisation of their relevance (Chen & Zorigt, 2013), Ghana is yet to have a comprehensive OHS policy (Ghana Health Service, 2007). The ILO convention 155 is yet to be sanctioned in Ghana (Annan, Addai &Tulashie, 2015). Similarly, ILO (2003) noted that some African countries are yet to provide OHS services for their public sector employees. Providing a safer and more efficient working practice helps to save cost as well as save lives (Health and Safety Executive, 2008). When health and safety policies are unavailable or ineffective, it contributes to the causes of accidents (Chen & Zorigt, 2013). Research has also suggested that employees who perceived their jobs as safe were more likely to be involved in fewer accidents than workers who perceived their jobs as dangerous (Hayes, Perander, Smecko, & Trask, 1998). This was confirmed by Wu, Chen and Li (2007) in their study to investigate the correlation among safety leadership, safety climate and safety performance, in which they found safety climate to be significantly related to safety performance and also mediated the relationship between safety leadership and safety performance. This implies that OHS practices may have important implications for job performance and productivity. The implementation of effective OHS practices is hence a necessity, especially in high-risk occupations like the energy sector.

OHS practices may differ from one organisation to another depending on the type of organisation and the level of risk workers are likely to be exposed to. Investigating the OHS practices implemented by various organisations and their effectiveness in safeguarding health and safety of workers is therefore, not out of place. Most OHS practices in Ghana are guided by the Factories, Offices, and Shops Act 1970 (Act 328) and the Mining Regulations 1970 LI 665 (Clarke, 2005). It is clear that Ghana's legislative provisions regarding OHS practices is limited and exempts most organisations, industries as well as the informal sector (Clarke, 2005). A major policy reform was the passage of the Labour Law 2003 (Act 651) which enjoins employers to adhere to health and safety procedures. However, most organisations do not have a clear guideline for managing OHS practices and it becomes difficult to ensure implementation of health and safety guidelines. Consequently, an implementation gap appears to exist between the law and OHS practices in Ghana. The few researches done in the area of OHS in Ghana focused on mining and manufacturing sectors with little knowledge on other sectors (Chen & Zorigt, 2013; Puplampu & Quartey, 2012; Li, 2012). The present study, therefore, examines OHS practices in the energy sector, focusing on the Electricity Company of Ghana (the major distributor of energy in the country).

Conceptual Framework

One of the common law duties of employers is to provide a safe place of work for employees and people who come in contact with the workplace. This common law duty has become one of the core human resource practices in organisations. The provision of a safe work environment is viewed by employees as the commitment of the organisation to them; which is in line with the social exchange framework (Whitener, 2001). This may be more applicable in an electricity company which is classified as one of the potentially dangerous work environments (National Institute of Occupational Safety and Health, 2012). Employees may, therefore, reciprocate by committing themselves to the

attainment of the organisation's goals. This is in line with the claim by Tompa et al., (2009), which states that competent management of occupational health and safety does not only reduce accidents and injuries but may be cost effective which increases competitiveness thus profitability.

This is where the high-performance work systems (HPWS) could be drawn on to improve workplace safety (Zacharatos, Barling & Iverson, 2005) because workplace safety has been tabled as a performance variable. HPWS assumes that employees are the most important source of competitive advantage and that workers have the capacity to continuously improve for higher level performance (Pfeffer, 1998a). This study, therefore, shares the view that employees make the greatest difference between success and failure of organisations. Hence, the need to place issues of employee health and safety on top of the agenda of organisations.

Research Questions

The study is driven by three main research questions which are as follows:

1. What types of OHS practices exist in ECG?
2. How are the OHS practices implemented?
3. What are the perceived effects of the OHS practices on the company?

Methods

Population and Sample

The population for the current study comprises employees of the ECG. Currently, the company has approximately 5,000 employees (Ghanaweb, 2013). The Ho Regional Division of the ECG was selected and used as a case study in the present research. The choice of the Ho Division was based on its proximity to the researcher and also the willingness of the management to participate in the research. From the population of 150 employees, 120 of them were selected using Convenience Sampling Technique in order to collect primary data from this set of respondents. Among the participants, 82.7% of them were males while 17.3% were females. The majority of participants also hold at least a bachelor's degree (55.8%), 27.9% were diploma holders and 16.3 % had technician certificates (I, II and III). 42.3% of the participants have worked with the company for 10 years and above, 27.9% have been working between 7 to 9 years while only 14.4% have been working with the company for less than 4 years.

Instruments and Data Collection

Primary data was collected through the use of questionnaire as the main instrument. The questionnaire was designed to provide first-hand information on OHS practices in the ECG. It was made up of both close-ended questions which presented the respondents with a fixed set of options and open-ended questions which encouraged them to share as much information as possible. The questionnaire had four sections (Sections A to D). Section A contained questions regarding the demographic characteristics of participants. Section B contained items on health and safety practices in ECG, Section C comprised questions regarding OHS implementation in ECG and Section D had questions on the effects of OHS practices.

Informed consent was sought from the company and participants. Those who were willing to take part in the study were given questionnaires to respond to. The questionnaires were later collected for analysis. Data for the study was collected in 2013. Participants were required to

provide information about the OHS practices within the company, how they are being implemented as well as their perceived effects on the company. Data was carefully examined to ensure that all items in the questionnaires were appropriately answered. All the close-ended questions were quantitatively coded using the Statistical Package for Social Sciences (SPSS). The data was tabulated using frequency tables and charts to display the results. Descriptive data analysis method was used to analyse the data and summaries of the results are presented in Tables 1and 2 and Figures 1 and 2.

RESULTS

Occupational Health and Safety (OHS) Practices

The findings showed that a department exists within the Ho ECG in charge of OHS practices (in the company). The study sought to find out which practices were being provided by the department. The results also revealed that the most prevalent OHS practices provided by the department (identified by the employees) were the provision of general health education, surveillance and treatment (45.2 %), followed by job placement, supervision of high-risk groups, safety training and control of recognized hazard (30.8%); and then safety training, treatment and identification of unrecognized hazards (24%). See Table 1 for the summary.

Table 1. Summary of most prevalent OHS practices in the Ho division of the ECG

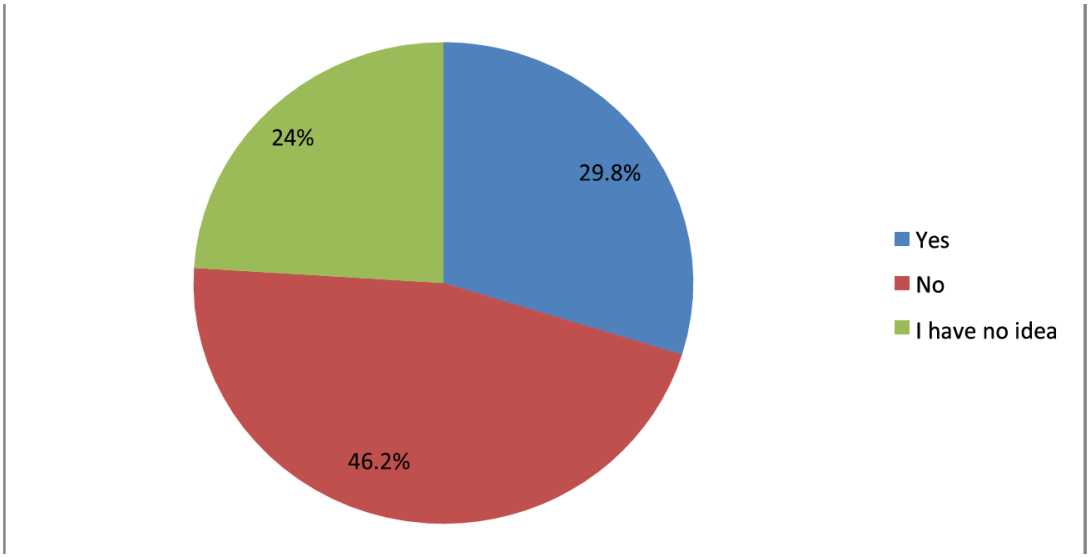
Response	Frequency f	Percentage %	Cumulative Percentage
Safety training, treatment and identification of unrecognised hazards	25	24.0	24.0
General health education and surveillance, and treatment	47	45.2	69.2
Job placement, safety training, supervision of high-risk groups and control of recognised hazard	32	30.8	100.0
Total	104	100.0	

Source: Survey Data, 2015

Implementation of OHS Practices

Regarding the implementation of OHS practices, respondents were asked whether ECG has a well designed institutional framework and feedback mechanisms for Health and Safety practices that have been properly implemented by the concerned stakeholders. In reply, the majority of the respondents forming 46.2% said 'no', 29.8% said 'yes', while 24.0% of them had no idea whether the framework exists or not. The variation in the responses as indicated in Figure 1 is of concern because institutional framework such as policies and procedures on OHS are expected to serve as guides to management and employees which suggest the preparedness of the company to respond to OHS issues.

Figure 1: Summary of responses on well-designed institutional framework and feedback mechanisms for Health and Safety Practices



Source: Survey Data, 2015

When quizzed on their thoughts with respect to the presence of a well-designed institutional framework and feedback mechanism, 23.1% of the respondents believed that the presence of a well-designed framework for the implementation of safety practices would provide the needed platform to facilitate regular report on safety education to stakeholders; 45.2 % of the respondents also believed that it would ensure the provision of proper documentation of events; while 31.7 % thought it would provide an effective link between the human resource department and safety department.

Regarding the mode of implementation of OHS practices in the Ho Regional Division of ECG (whether centralised or decentralised), 76 (73.1%) respondents indicated that job placement is centralised to the regional safety officer while 28 (26.9%) of them were of the view that this practice is decentralised to departmental supervisors. 73 (70.2%) of the respondents pointed out that safety training being one of the OHS practices is decentralised to departmental supervisors in ECG and the remaining 31 (29.8%) said the practice is centralised to the regional safety officer. Concerning supervision of high-risk groups, 75 (72.1%) and 29 (27.9%) of the respondents stated that this practice is decentralised to departmental supervisors and centralised to the regional safety officer respectively. 79 (76.0%) of the respondents constituting the majority opined that the practice of control of recognised hazards on the field is decentralised to departmental supervisors. Meanwhile, the rest 25 (24.0%) of the respondents said the practice is centralised to the regional safety officer. The identification of unrecognised hazards before and on the field is solely centralised to the regional safety officer as indicated by 72(69.2%) respondents while 32(30.8%) of

them upheld the view that the practice is decentralised to departmental supervisors. The treatment of injured employees is decentralised to departmental supervisors as pointed out by 65(62.5%) of the respondents who constituted the majority. The rest 39(37.5%) of them said the practice is centralised to the regional safety officer of ECG.

With respect to the provision of general health education and surveillance to the employees, the majority of the respondents, numbering 61(58.7%) pointed out that this practice in ECG is decentralised to departmental supervisors while 43(41.3%) of them said the practice is centralised to the regional safety officer (See Table 2 for summary).

Table 2: Summary of mode of implementation of OHS practices

Health and Safety practices	Centralised to regional safety officer		Decentralised to department supervisors		Total	
	F	%	f	%	f	%
Job placement	76	73.1	28	26.9	104	100.0
Safety training	31	29.8	73	70.2	104	100.0
Supervision of high-risk groups	29	27.9	75	72.1	104	100.0
Control of recognised hazards	25	24.0	79	76.0	104	100.0
Identification of unrecognised hazards	72	69.2	32	30.8	104	100.0
Treatment	39	37.5	65	62.5	104	100.0
General health education and surveillance	43	41.3	61	58.7	104	100.0

Source: Survey Data, 2015

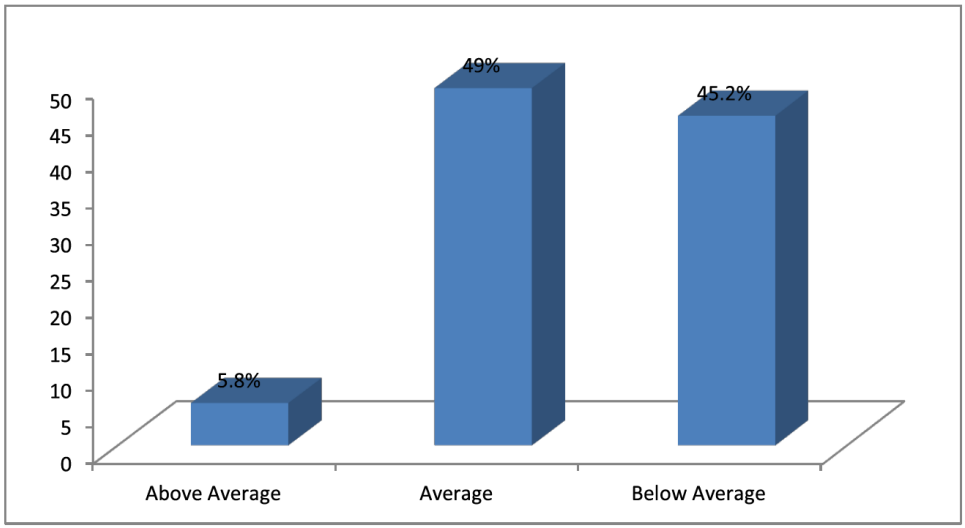
Effects of OHS Practices

The respondents were asked to rate the effects of Health and Safety practices on ECGs success: 5.8% and 49.0% of the respondents rated the effects 'above average' and 'average' respectively. 45.2% rated the effects of Health and Safety practices on ECG's success 'below average' as depicted in Figure 2.

Further, respondents were asked whether they recognised the effects of OHS practices in the

company. 48.1% responded in the affirmative while 40.4% said they did not recognise or appreciate the effects, while the remaining 11.5% said they had no idea about the effects of the OHS practices in the company. When asked to state their reasons for their responses, those who recognised the effects said they did so because they thought the practices prevented accidents and promoted the well-being of employees. The reason given by those who did not recognise the effects was that management only reacted when there was an accident. Thus, they believed that Health and Safety practices and policies are not properly implemented.

Figure 2: Employees' perception of effects of OHS practices



Source: Survey Data, 2015

DISCUSSION

The study is an attempt to assess occupational health and safety practices in the Electricity Company of Ghana, Ho Division. The Analysis revealed that a department exists in the company which is responsible for OHS services. Among the OHS practices, the most common practices discharged by the department include: the provision of general health education and surveillance, job placement, supervision of high-risk groups, safety training and control of recognised hazard, treatment and identification of unrecognised hazards. These practices are key to the general health and safety of employees. This is in line with the WHO's definition of what OHS should include. That is: the promotion and maintenance of physical, social and mental well-being, prevention of deviations from health as a result of working conditions, protection of employees from risks to their health and more importantly, placing and maintaining workers in a working environment suitable for their physical and psychological capabilities (WHO, 1995).

Also, the provision of general health education and surveillance in the ECG is targeted at promoting the health of workers

within the company. Supervision of high-risk groups, safety training and control of recognised hazards as well as identification of unrecognised hazards are all steps taken by the OHS department of ECG to protect employees from health and safety risks. An occupational health service has a responsibility to keep all employees informed about hazards in the workplace. High-risk groups such as pregnant women, the elderly and employees with known medical conditions are to be supervised and monitored to prevent health hazards. Job placement is also an important practice which helps to determine job unsuitability before training time and expense have been incurred. Job placement also needs to be regularly monitored in order to assure employee health and ability, the health service can also give valuable advice with regard to alternative employment when a worker is found to be unfit for a particular job (ILO/WHO, 1950). Several types of research have shown that maintaining a healthy and safe environment at work has many positive outcomes for the organisation such as reduction of health cost, boosting employer-employee relationships and reduction of employee turnover (Cooper, 1994; Fulmer, Gerhar & Scott, 2003; Kelloway & Day, 2005).

The findings of this study also indicate that though OHS practices are available in the ECG, there are no well-designed institutional framework and feedback mechanisms for Health and Safety practices that have been properly implemented by the concerned stakeholders. Implementation of OHS practices is either centralised to the regional safety officer or decentralised to departmental supervisors. As acknowledged by respondents, a well-designed institutional framework and feedback mechanisms for Health and Safety practices would provide the necessary avenue to report health and safety issues, proper documentation of OHS services as well as ensure a more effective collaboration between the human resource department and the OHS department. The general goal of providing a safe, secure and healthy workplace can only be achieved when there is cooperation between health and safety managers and Human Resource (HR) department. For instance, the HR department and safety manager can collaborate and implement health and safety programmes, investigate accidents, produce safety programme materials and conduct safety training for employees (Robert & John, 2004). The department supervisors and managers then ensure the maintenance of safe working conditions and a healthy workplace.

In addition, the findings revealed that majority of the employees of the ECG rate the positive effects of OHS practices in the company as either 'average' or 'below average'. Some of the respondents were of the view that managers only intervene with safety measures when something untoward happened, and that compromised the safety of employees while a few believe that OHS practices have helped to prevent accidents and promoted the well-being of employees. This implies that though OHS practices seem to have some positive impact on the success of the company, there is the need to improve how these practices are implemented to maximise their effects on the company. Investing in health and safety services has far-fetching returns for the success of the company, as creating an effective OHS practices is reported to increase employee morale and improve productivity (Australian Safety and Compensation Council, 2006).

CONCLUSION

Occupational health and safety are very crucial not only for the welfare of workers but to the overall success of the organisation. The present study indicated that the Ho Division of the ECG has a department in charge of OHS practices and some OHS practices were identified to be available within the company. These practices are in line with the ILO and WHO requirements for safety in the workplace. However, the company lacks a well-designed institutional framework for implementing these OHS practices. It was also revealed that OHS practices have some positive effects on the success of the company, but the maximum effect is not being felt. Admittedly, the present study is mainly descriptive in nature, therefore, it does not allow for conclusive inferences to be made from the collected data. It also used only one regional division of the ECG, thus, conclusions from this study may not necessarily reflect the actual state of OHS practices in all the regional divisions of the ECG. Nonetheless, the findings from this study provide very important revelations about OHS in the ECG which is a key player in the energy sector in Ghana. It may also give a hint on the state of OHS practices in Ghana and it provides a reference for future studies in the area of occupational health and safety. Considering the enormous benefits of improving OHS practices in the organisation and the impact it has on the country as a whole (see WHO 1994), it is recommended that the Regional Safety Officer must be a fully trained and certified OHS professional who will adequately educate and monitor the staff on issues concerning Occupational Health and Safety practices. Also, there should be an increased collaboration between the Regional Safety Officer and the Human Resource Manager to address issues of job placement and job suitability for all staff. In addition, there is the need for proper monitoring and surveillance of OHS diseases and injuries with particular emphasis on near misses to prevent reoccurrence. Furthermore, an institutional framework and feedback mechanisms for OHS practices must be developed and implemented to serve as a guide to management and employees of the company. Finally, periodic safety and health education/first aid training to all staff and the general public must be organised with proper monitoring and surveillance to enforce strict adherence.

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The Role of the New Technical Universities in the Improvement and Implementation of Technical Vocational Education and Training (TVET) in Ghana

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ABSTRACT

This paper addresses the relevance of Technical Vocational Education and Training (TVET) in the new technical education model in higher education being pursued under the policy of converting the polytechnics into technical universities in Ghana. It rakes up the critical challenges facing the Tertiary Education system in most African countries, and illustrates how other countries address similar challenges vis-à-vis Ghana's model for tackling her own challenges. The difficulties encountered by Polytechnics, which were established to address some of the challenges are juxtaposed against the new paradigm shift which is the conversion of polytechnics into technical universities. These are done in view of the role that the new technical universities are expected to play towards the improvement of implementation of TVET as a basis for the technological advancement of Ghana's economy. It is suggested in this paper that TVET can be used as a measure in arresting youth employment in Ghana. The paper concludes by identifying the nature and kinds of support required from key stakeholders such as the Government, industry, development partners, the technical universities and other tertiary institutions.

Keywords:

Entrepreneurship, technical education, technologies, training, research.

INTRODUCTION

The Concepts of TVET and Technical Universities

A joint document by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Labour Organization (ILO) titled "Technical and Vocational Education and Training for the Twenty-First Century defines "Technical and Vocational Education as "a comprehensive term referring to those aspects of the educational process involving, in addition to general education, the study of technologies and related sciences, and the acquisition of personal skills, attitudes, understanding and knowledge relating to occupations in various sectors of economic and social life." (UNESCO, 2002)

The document further lists some of the characteristics of a TVET system as follows:

- It is a means by which people develop talents, interests and skills leading to an occupation in various sectors or to further education;
- It allows transfers from one field to another within technical and vocational education;
- It develops the knowledge and skills that help the workforce to become more flexible and responsive to the needs of the labour market;
- It provides scientific knowledge, technical versatility and cluster of competencies; and
- Develops, among others, capabilities for decision-making necessary for active and intelligent participation, teamwork and leadership at work.

A Report of the Technical Committee on conversion of the Polytechnic in Ghana to Technical Universities published by the NCTE (2014) also identifies the following characteristics of technical universities. They:

- Provide education and training for the world of work: students are trained to acquire high-level employable skills for the world of work: students are trained to acquire high-level employable skills for wage or self- employment;
- Have strong links with industry and business;
- Support existing and emerging productive sectors of the economy with technical expertise and R&D;
- Are focused on practical research activities, including industry and market-driven joint research projects;
- Provide skills training at all levels: certificate, diploma, degree and postgraduate degree levels;
- Are autonomous or semi-autonomous in their governance and management practices;
- Offer courses and programmes covering a wide range of economic activities;
- Place emphasis on innovation and application of new technologies, including ICT;
- Have well-trained faculty imbued with both academic and professional experience;
- Admit capable students into science and technology based programmes;
- Possess top grade teaching and learning facilities;
- Engage in consultancy and contract management activities;
- Encourage staff and student mobility;
- Provide skills training from the middle level to the highest level possible.

As is evident from the characteristics of TVET and Technical Universities listed above, both concepts set out to develop the knowledge and

skills that should help the workforce to become more flexible and responsive to the needs of the labour market and help to integrate workplace-based learning and training into the TVET curriculum. A joint message from UNESCO and ILO in a preface to the joint document referred to above emphasises the importance to be accorded TVET and Technical Universities as follows:

> Providing all individuals with learning opportunities throughout their lives in an ambitious but necessary undertaking. All-inclusive lifelong learning system calls for the mobilisation of increased public and private resources for education and training and for providing individuals and enterprises with the incentives to invest in meeting their learning and skills development needs (UNESCO, 2002)

Human Resource Challenges in Sub-Saharan Africa (SSA)

A report by British Council (2014) highlights some of the human resource challenges facing Sub-Saharan Africa (SSA). It cites one of the major challenges facing the region as the lack of adequate jobs for its growing population. It cites a World Bank report which estimates that as many as 11 million young people in Sub-Sahara Africa would be joining the job market every year for the next decade. The British Council report further points to the booming higher education in SSA, noting that between 2000 and 2010, enrollment more than doubled, and increased from 203 million to 5.2 million. It is important to note that SSA has significant a youthful population. In 2010, for example, the population in the 18-23 age group in SSA was 101million, and it is projected to grow by more than 50% by 2030 (British Council, 2014). Such developments have implications for quality of education which is already under threat. The evidence available suggests that there are already 50 percent more students per lecturer in SSA than the global average (British Council, 2014). In a situation like this too few graduates particularly in TVET, gain the skills they need to find work.

Graduate Unemployment in Sub-Saharan Africa

The challenge of graduate unemployment in SSA is real and African countries must prepare themselves to address it if they are to avoid a time bomb sooner or later.

According to the British Council (2014) report, the graduate unemployment rate for Nigeria is 23.1 percent. It is 5.9 percent for South Africa but high for those with diploma or certificate level qualifications. Unemployment specifically for university graduates were not available for Ghana and Kenya. However, across the 25-29 age group as a whole, the unemployment rate is 41.6 percent in Ghana and 15.7 percent in Kenya. It is further estimated that it takes a university graduate five years to secure a job in Kenya. In South Africa, the Centre for Higher Education Transformation (CHET) has introduced a term, *Not in Education, Employment or Training* (NEET) and shocked the world with the revelation that there were million youth in that category in South Africa.

It may be revealing to work out our own NEET in Ghana to find out how many of our youth belong to this category. It could be a staggering and frightening figure. I now turn to how some other countries have attempted to address this problem by differentiating and diversifying

their educational system.

The Concept of Differentiation and Diversification in Selected Countries

The concept of differentiation as applied to the education sector in the Netherlands puts institutions into different categories each with specific focus, mission and mandate and made to keep to their respective missions. The Dutch higher education system has two distinct types of study programmes: the profession-oriented and research-oriented programmes. The latter is provided by the research universities while the former is provided by the applied science universities. In 2006, there were 41 universities of applied science and only 14 research universities in the Netherlands with enrollment in the former constituting almost two-thirds of all students in higher education. Even more significant are the characteristics of the system operated by the universities of applied science. For instance, according to HBO (2006), there is close alignment to professional practice (described as the most important value added). Thus, many applied science universities were actually founded by the business sector, which explains the kind of partnership and collaboration between them. Again, all programmes have committees with representation from educational institutions and regional business associations which work together to ensure the relevance of the programmes provided. Moreover, there is an agreement at the national level between the Netherlands Association of Universities of Applied Sciences (HBO-road) and the employers organisations to ensure alignment between national networks of educational programmes (education) and organisations representing branches of industry in the same field (the field of work). Furthermore, attachment and internship programmes are not taken lightly as students of the universities of applied science are made to familiarise themselves with their future professional practice during the course of their four-year programmes.

Approximately 25% of a student's study consists of a practical component in a placement or graduation assignment. A study may also be available on a cooperative education basis, as part of which study and work may be seamlessly intertwined during the course of the programme. The structure of the system is based on the principle that the interaction between the applied science universities and the business sector is the best guarantee for the labour force which knows what the business sector wants. In 2004, 90% of the students of universities of applied sciences who graduated found work within three months. The benefit to business is the contribution in knowledge and innovation that the students and their teachers bring. Although, sociocultural differences may not allow the same situation to happen in Ghana to the same extent, the nature and structure of the universities of applied sciences and the kind of collaboration that exist between them have lessons for Ghana if differentiation should have meaning and applicability.

There are also lessons to be learnt from the higher education system in the United States of America, which offers a differentiated higher education system with the community colleges at the base. In the middle of the structure are the land grant colleges and the state universities established to deal with the problems of agriculture, mechanical arts and the trade, which were identified at the Boston Convention in 1848 literally by the whole of the US. The land grant colleges which became the great state universities were tasked to study and assist in finding solutions to the problems facing

America. At that time, the most important industry in America was agriculture, and, therefore, it was only natural that agriculture would be the focus of their endeavours.

The land grant colleges trained extension officers who were sent to the field to assist the farmers to identify their problems and find solutions to them. Such was their contribution that at some point it was estimated that 50% of the agricultural produce of America was attributed to the work of the land grant colleges (Bowden, 1977). At the top of the US differentiated higher education system are the research universities such a Harvard, Yale, Princeton, etc. many of which are private. Also, the study of mechanical arts and trade were taken seriously. In 1989 there were 12,300 post-secondary institutions in America. Out of these there were 2,070 four year colleges and 8,956 vocational and technical institutions, emphasising the importance attached to TVET (Department of Education and Science, 1989). More than half of the population of America enter higher education at some time in their lives and many of the students work while studying.

Unlike the British higher education system which frowned on TVET and career-focused education, the American system promoted it (Bowden, 1977). The American commitment to open access to higher education and career-focused and skills-oriented education was the reason for the establishment of community colleges which together enrolled close to a third of all American students in postsecondary education. It is at the colleges where students are equipped with the knowledge and skills in applied and vocational courses in a range of fields that lead directly to employment such as restaurant management, metal work and automobile mechanics. The students are further trained in general education so that those who wish to transfer to other universities can do so.

The Canadian system of higher education is described as diverse, vibrant and dynamic because it offers a mix of opportunities in a variety of educational settings. In addition to universities, Canada's post-secondary system in 1989 included 175 community colleges that respond to the training needs of business, industry and public service, as well as the educational needs of vocationally oriented secondary school graduates. In 1995, I had the opportunity to experience the Canadian system at the Okanagan University College which combines practical vocational programmes with some theoretical underpinnings.

In Thailand, TVET is making significant progress in training skilled and semi-skilled technicians as well as technologists for the labour market. There are more than 800 public and private institutions providing TVET to about one million students in formal programmes. According to Boonplyathud and Choomnoom (2002), the mission of TVET in Thailand is to implement the following:

- Quality/Standard/Efficiency/Demand-driven technical education
- Opportunity/Continuation/ Articulation/Variety
- Youth/Adult training in technical education
- Cooperation/Mutual Benefit/ Partnership
- Modern/International Standard/ Technology/ICT/Indigenous Knowledge
- Workplace learning/On-the-job training/ Practical Experience/ Enjoyable learning

In Africa, Kenya offers a recent example of a technical university to focus on work related disciplines.

I now turn to Ghana's model of addressing the human resource challenge, emphasising what I term "the missing link in Ghana's educational systems".

Ghana's Model of TVET

Ghana's model of TVET at the tertiary level began with the upgrading of five technical institutes as polytechnics-Accra, Takoradi, Kumasi, Tamale and Ho. Cape Coast was established as a Polytechnic from the inception under the Polytechnics Law of 1992, PNDC 321. Sunyani, Koforidua, Wa and Bolgatanga were later added to the list to ensure that there was a Polytechnic in each of the ten administrative regions of Ghana.

The conversion of technical institutes into Polytechnics was largely to ensure that there was progression for students who opted for the TVET stream. The upgrading of polytechnics to tertiary status did not address the problem of deficit in skills training in TVET. Part of the problem was that the decision to elevate the Polytechnics was implemented in haste. The minimum resources necessary for the upgrading had not been met. Recruitment and training of the requisite staff and the provision of facilities and improvement of existing ones were not done before the upgrading exercise. The polytechnics received just about 28% of their assessed financial requirements (Effah and Adu, 1998). Although this figure increased to about 50% in 2000, given the magnitude of the requirements of the polytechnics, it was far below what was required to enable them to meet their objectives (Effah, 2003).

Although the mandate of the Polytechnics is to focus on the application of science and technology; the applied arts and skills training; encourage the study of technical subjects at the tertiary level; and provide opportunity for research and development, polytechnics currently enroll only about 30% of their students in science and technology programmes. As at the 2013/2014 academic year, the total enrollment in public and private universities was 208,117. This was about four times more than that of the polytechnics, whose enrollment stood at 54,897. This is a situation of an inverted pyramid, where the base is smaller than the top. With regard to the quality of staff, particularly faculty, one could confidently say that owing to interventions such as the Teaching and Learning Innovation Fund (TALIF) sponsored by the World Bank as well as UFFIC by the Government of Netherlands, the quality of staff has significantly improved with many staff acquiring the masters and a few doctorate degrees. This improvement notwithstanding, most of the teachers lack the necessary professional and industry experience which is a major requirement in similar systems like that of Germany (NCTE 2014). Collaboration with industry in terms of governance, internship and attachments is not structured, and that accounts for the deficit in skills training among most graduates of polytechnics, thus limiting employment opportunities, particularly in business and industry.

Polytechnics have also had a fair share of industrial actions and agitations that have tendered to dent their image and slow down progress. In 2005 when I was invited by the Sunyani Polytechnic to present a paper at their first lecture series, I spoke on the topic "A decade of Polytechnic Education in Ghana: An Assessment of Achievements and Failures". I

used the opportunity to share with participants' information I had worked out in terms of industrial actions and agitations. In the previous year 2004 alone, out of the 32 weeks devoted to academic work, 27 had been taken up by industrial action; 16 weeks by students, 5weeks by the Polytechnic Teachers Association of Ghana (POTAG) and another 6 weeks by the Teachers and Educational Workers Union (TEWU). In more recent times agitations have taken a different form, characterised by the writing of anonymous letters, court actions, intimidation and various other kinds of unrest, sometimes at acrimonious proportions. These actions retard progress and cannot be carried into the new technical universities poised to make a difference and to bridge the gap between TVET institutions and the world of work.

Cataloguing achievement of some Polytechnics, I listed for Tamale Polytechnic, the design and manufacturing of a rubbish dump, a domestic waste separator and shea butter extraction and cashew shelling machines, among others. For Ho Polytechnic I cited the Catering Unit which had developed over 17 new recipes for the hospitality industry. Ho had also just developed it Strategic Plan.

Regrettably, these impressive beginnings have suffered stunted growth. You can imagine where Ho Polytechnic would have been if this impressive start had continued. These days, fruit juices of all kinds are beginning to surface on the local market. How much share of this fruit juice market can you annexe at Ho to become the one-stop centre for all advisory services in the fruit juice industry? This is only one example that polytechnics and technical universities can set themselves up for.

Arguably, owing to a number of circumstances, some inherited at birth, and others acquired, the performance of polytechnics in terms of their mandate of providing programmes in applied science and technology with significant industry-content, skills training, and research and development (R&D) has been less than satisfactory. It is also true to say that the conditions of service for staff of the polytechnics have not helped the situation. Has a case been made for the conversion of polytechnics into technical universities? I think there is a strong case but this has to be accompanied with a number of provisions.

Which Way, Technical Universities?

I have titled the last segment of my Lecture, "Which Way, Technical Universities?", to discuss their role in the provision of quality and relevant TVET in Ghana. This section is organised around governance, financing, quality and relevance, R&D, and the roles of the private sector (industry) and Government.

I echo the point that has been made several times over, namely, that education is the foundation of economic growth, a necessary step towards economic and social development. No system of education is complete without TVET which is one critical avenue for creating opportunities for the child to escape poverty, to move upward on the social ladder and contribute meaningfully to the socio-economic development of the country. Among the stigmas linked to polytechnic education in its current form is the lack of progression. Until the recent opportunity to study up to the B. Tech level in some programmes, the impression had been created that students of polytechnics could not train beyond the HND without shifting to other disciplines.

Polytechnics have, therefore, become unattractive to many candidates seeking tertiary education beyond the HND. Polytechnic education is good for the country. Like the community colleges in the USA, polytechnic education in Ghana will also serve as the feeder in providing technical and career-oriented programmes to the technical universities so as to provide opportunities for all categories of students who are TVET inclined to progress to the highest level possible without shifting focus. And, as has been demonstrated, the country would benefit by creating more opportunities for students to go through the TVET stream.

Governance and Funding of Technical Universities

Effective technical universities require effective governance and management systems. For instance, how much power the governance system has on the decision-making process, how vision and goals are turned into management systems, and how governance and management systems are implemented have implications for the effective functioning of the technical universities. For, as it is said, 'the fish rots from the head'. An ineffective governing council will kill initiative and dampen morale and half progress in the institution.

The councils of the technical universities must have sufficient autonomy to run the affairs of the institutions. They must have a good mix of relevant educational background, industry experience, diversity, professional expertise, and fund raising skills. They should not limit their activities to the council chamber or boardroom. They must evaluate their vice chancellors and assess their own performances. The Councils must act on advice, particularly where they lack the ability to deal with specific issues.

Appropriate orientation should be given to both council members and the leadership of the technical universities to orient them on their new roles and responsibilities. Staff development must be pursued vigorously to improve quality.

Quality and Relevance

Every successful citizen must meet three criteria- knowledge, appropriate skills and the right attitudes; and technical universities must provide these in adequate doses. In other words, TVET at the technical university level must not shift focus to mere academic qualifications. It must combine theory and practice, skills development and entrepreneurship such that graduates of technical universities can create their own jobs or meet the standards set by the labour market. Every student whatever the course being pursued must have a project and a business model to be nurtured to completion to coincide with graduation. In order for these to be implemented, two things must happen. First, we need to establish in the technical universities business incubation centres where students would nurture their businesses. These centres would provide inclined business services such as legal, business development plans, tax regimes and other business advisory services where professionals and industrialists hired on either retainer or consultancy basis would assist the students to nurture and develop their business models to maturity throughout the entire duration of their programmes.

Councils and the leadership of the technical universities should muster support from all stakeholders, particularly the internal constituencies ensuring that they do not turn their backs to any of them. They should embrace and address all agitations and conflicts and try to address them early before they get

out of hand. They should set good examples by providing information using the approved channels of communication. They should be open and transparent in their dealings with the university community. Second, there is the urgent need to reorganise and restructure attachment and internship programmes. It is impossible to release the total of about 50,000 students pursuing TVET programmes during one long vacation to industry. In this regard the technical universities should be advised to restructure the attachment and internship programmes year round to permit the release of the students in smaller numbers to industry. The semester system should make such a scheme possible. Again, the term industry should not be limited to the large scale enterprises. The small and medium scale businesses are available to offer attachment programmes. Some incentive packages should be worked out to make attachments and practical training attractive to industry.

Research and Development

The Technical Universities should pay attention to Research and Development. A recent international study by the Netherland Development Assistance Research Council concluded that universities in developing countries are not fully geared towards solving development related problems. The study shows the lack of connection between research and development priorities. This is partly due to inadequate spending on R&D. For example, while Asia accounted for 31.5% of world expenditure on R&D in 2002, Africa accounted for only 0.6%. It is not surprising that Africa is experiencing rising levels of poverty, failing GDP and even political upheavals (Zakri, 2006).

In the area of agriculture, can our technical universities and the polytechnics manufacture special hoes that would be much friendlier to farmers and much more suitable to the agricultural land? When will mechanical engineering departments in our tertiary institutions envision and work towards the manufacture of local equipment and implements for our local industry? What creativity and innovation can our institutions come up with to address some of our local and peculiar challenges? Such are the challenges that our technical universities would be required to address if they are to be effective. But this cannot be achieved without the support and cooperation of all stakeholders which is my last subject.

Role of Stakeholders

All stakeholders have a responsibility towards making the emerging technical universities vibrant partners in the economic development of the country, particularly in addressing graduate unemployment among the youth, in reducing poverty and raising the standard of living of the people.

By far, it is the Government that has the biggest responsibility to set up the technical universities and to set them up well. This time around we should try to avoid the situation which befell the polytechnics where they were established without adequate preparations. In spite of the achievements that polytechnics have chalked over the years, they have not been well-resourced with the human, physical and academic infrastructure to operate on the same scale as their counterparts in South Africa, Germany and the Netherlands.

Governments across the globe, especially in China and India, are pouring unprecedented

sums into building and improving their universities and spending million more selling them abroad (Vencat, 2007). Our technical universities should be treated the same way. This is why I support a phased approach to the conversion of polytechnics into technical universities, a few at a time, to ensure that they are properly equipped for a sustained take-off. Abortive take-offs are expensive and have disastrous consequences.

Other Stakeholders

There are many other stakeholders that stand to benefit from well-functioning technical universities. Industry is one such stakeholder which stands to benefit from the skill-trained and knowledgeable graduates to help turn industry around as happened in France and Germany. Industry has to open up and partner with the technical universities, particularly in the area of curriculum design, practical attachments and internships. Both teachers and students should bring into the university the problems facing industry, study them, and find relevant solutions.

The technical universities would benefit from technological know-how, modern trends and equipment which industry is best suited to acquire because of the capital outlay involved. The technical universities need to reposition and apply themselves seriously to the work ahead of them. Staff and students should spend time dreaming, being creative and innovative. They should spend less time on agitations that only make the institutions ungovernable. Conditions of service for staff must be improved to stem the current brain drain: or, is it brain attraction to the traditional universities? Donor support is welcome but it must be demand-driven to allow flexibility in addressing local and peculiar problems and challenges.

Marginson et.al. (2002) have referred to universities as "Glonacal" institutions where "Glonacal" represents the three dimensions of global, national and local. Every university must meet the three criteria. The new technical universities must address local challenges; they must promote national aspirations and also become competitive within the global intellectual community.

CONCLUSION

This paper has tried to hoist the argument for identifying TVET as the training model that could help eradicate the challenges Ghana has faced for decades with the churning out of graduates, most of whom do not possess employable skills. Although, it is not possible to exhaust in one paper all the benefits, challenges, and the measures towards improving the implementation of TVET through technical universities, the major arguments that support the value and relevance of TVET have been established. This paper has registered the position that it is evident that the establishment of the technical universities is timely and the motivation behind it and its goals are legitimate, logical, genuine and beneficial. However, these would be best served if the conversion process is rolled out in phases, a few at a time. It is of critical significance to identify with the position that they have to be well resourced and positioned to train people in TVET to the highest level possible.

As the conversion is hailed today, the process and each technical university would be assessed in future by the extent to which they have been positioned to address industry-related problems and become institutions that train people to create jobs and to become entrepreneurs who can transform the economic fortunes of individuals, households and the nation.

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