UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

SUSTAINABLE CONSTRUCTION INDUSTRY IN GHANA: FOCUSING ON RECYCLE AND RE-USE POTENTIALS OF WASTE MATERIALS

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A Dissertation in the Department of CONSTRUCTION AND WOOD TECHNOLOGY EDUCATION, Faculty of TECHNICAL AND VOCATIONAL EDUCATION, submitted to the School of Graduate Studies, University of Education, Winneba in partial fulfillment of the requirements for the award of Master of Philosophy (Construction) degree.

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MAY, 2016

DECLARATION

STUDENT'S DECLARATION

I, Eric Baidoo, declare that this dissertation, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or in whole, for another degree elsewhere.

SIGNATURE ………………………………. DATE……………………………..

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of dissertation as laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: DR. WILLIAM GYADU - ASIEDU

SIGNATURE ………………………………. DATE……………………………..

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DEDICATION

This dissertation is especially dedicated to my beloved sons Erasmus Owusu-Asamoah Baidoo, Maclord Nana Kesse-Baidoo and my dear mum, Comfort Afia Owusua.

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ABSTRACT

The judicious control and management of construction waste has been a clarion call for stakeholders in the construction industry of Ghana. Construction materials reuse and recycling has not gained popularity in the Ghanaian construction industry. The study sought to examine sustainable construction practices in Ghana, focusing on recycle and reuse potentials of waste materials using Ashanti and Greater Accra Regions as the study areas. A sample size of 184 contractors were selected from the two regions using stratified sampling technique out of which 129 responded. Questionnaire and interview were used as the main data collection tools for the study. The results of the study were analysed using descriptive statistics like mean scores, relative importance index and rankings. Lack of frequent visits by EPA, AMA and KMA to construction sites have not improved compliance of environmental safety practices. Lack of expertise, resource and poor awareness creation on construction materials reuse and recycling had led to its poor practices. Materials such as wood, metals, tiles, plastics and papers were not adequately utilized on site due to some contractors poor knowledge on reuse and recycling coupled with lack of financial capacity engage in recycling. Failure of both private and public companies to venture into construction waste recycling has led to its poor practices by most contractors in the two regions. It is imperative for effective awareness creation on construction materials reuse and recycling and government must put in place policies that encourage construction firms to manage their waste effectively. The right habit should be cultivated by both workers and the public towards environmental sustainability and safety.

INTRODUCTION

CHAPTER ONE

1.1 Background of the Study

The building and construction sector is a significant consumer of raw and natural materials. It also produces wastes that contribute to the emission of greenhouse gases which are potentially damaging to the natural environment (Yalley *et al.,* 2013). Construction and post-construction activities generally consume 50% of global material resources and specifically, 70% of global timber products. In addition, 45% of all energy generated is used to heat, ventilate and light buildings and 40% of water is used for sanitation and other uses in buildings. The current population increase of 73 million per year will also place higher demands on the consumption of raw and natural materials (Yalley *et al.,* 2013). Mitigation of construction-related impacts will include implementation of a detailed erosion control plan; a plan for management and disposal of excess material; a construction staging plan; special construction techniques for river bridge construction; traffic flow management techniques; and access maintenance and/or detour plans (Yalley *et al.,* 2013). Construction activities will follow standard specifications, and noise restrictions will be incorporated in areas deemed appropriate. In addition, safety measures (e.g., fencing, signage) will be used to prevent the public from entering construction areas or from passing beneath bridge construction (when overhead activities are a concern) (Interregional Connection FEIS, 2013).

Although the construction industry plays a crucial role in economic development, it is a major exploiter of natural resources and a polluter of the environment (Ayarkwa, 2010). With growing concern about sustainability of human activities in the twenty-first century, the environmental performance of construction activities is drawing increasing attention in the world (Ayarkwa, 2010). About half of all non-renewable resources mankind consumes are used in construction, making it one of the least sustainable industries in the world (Ayarkwa, 2010). However, mankind has spent the majority of its existence trying to manipulate the natural environment to better suit its needs so today our daily lives are carried out in and on constructions of one sort or another: people live in houses, travel on roads, work and socialise in buildings of all kinds. Contemporary human civilisation depends on buildings and what it contain for its continued existence, and yet the planet cannot support the current level of resource consumption associated with them (Dixon, 2010).

The built environment and its interactions with the natural environment are complex and have a massive impact on the world around us (Dixon, 2010). Hence sustainability is a complex concept which encompasses not just energy but all the resources needed to support human activity (Ayarkwa, 2010). A large part of building sustainability is concerned with addressing the global warming that is driving by climate change; using energy conservation and techniques such as life-cycle assessment to maintain a balance between capital cost and long-term asset value (Dixon, 2010). It is also about enhancing biodiversity, creating spaces that are healthy, economically viable and sensitive to social needs. Rather than constantly battling against the natural environment, there is the need to start respecting natural systems and learning from ecological processes: creating a better balance between human need and the wider environment (Dixon, 2010).

The world is becoming increasingly conscious of the environmental implications not only of production processes but also of products discarded after use (Nermin, 2010). The recycling of waste materials as a means of tackling the solid waste problem is attracting growing public interest (Nermin, 2010). This is the problem of solid waste currently caused by construction activities and with increasing world population census, the most serious problems remain polluted environment which cause environmental damage and health problems (Nermin, 2010). As concerns grow over the amount of wastes generated in the construction industry, recycling has been identified as one of the most feasible way to overcome construction wastes. In many cases, up to 90% of construction wastes are recyclable (Saraiva *et al.,* 2012). Recycling of construction materials can be defined as the separation and recycling of recoverable waste materials generated during construction and remodeling. Packaging new material scraps and old materials and debris all constitute potentially recoverable materials. In renovation, appliances, masonry materials, doors and windows are recyclable. Nowadays, many contractors are still facing the same problem which is the waste material and wastage in construction industry that has existed for long time (Dixon, 2010; Nermin, 2010; Saraiva *et al.,* 2012).

This problem will add to the construction cost and time for all contractors. But that is common matters in construction industry so contractors always try to minimize the wastage and waste on site. Since all construction materials are getting high, recycling construction waste and wastage material is good idea because it can reduce the construction cost. In order to recycle the construction waste and wastage materials, a detailed study must be carried out (All Answers Ltd, 2014). In pursuit of sustainable development principles, which aims to rely on recycling waste came importance of research on alternatives; Salvaging materials for reuse can be both an economical and environmentally sound alternate to waste stream disposal, and it also saves energy and environmental impacts of producing new products from virgin materials that help communities to be sustainable in infrastructure renovation, construction, and maintenance (Nermin, 2010).

The construction industry has not only become a major consumer of materials; it has also become a source of pollution. Environmental integrated production and reusing and recycling is of great importance for the competitive position in the world (Hassanein & Ezeldin, 2013; Kralj, 2008). Sustainable development as a tool to continual improvement cycle and with processes of innovation leads to the need to save money in the processes via reduced resources and utility costs (Kralj, 2008). Construction industry could also cause adverse health problems in humans. It causes a lot of problem to the environment. Wastes material is one of the major problems, which is unavoidable, and always occurred in the construction industry. It happened every day and every stage as the construction project proceeds. Waste management is now no longer an option but a necessity. Recycling has been identified as one of the best options to convert the waste materials into recycled contents (Hassanein & Ezeldin, 2013). Wastages affect not only the environment but also incur extra costs to the contractors and developers. As the resources of the world are getting more limited everyday, engineers and researchers should start thinking of many ways to acquire new resources, recycle their old, or efficiently use the current (Hassanein & Ezeldin, 2013).

For recycling to be attractive from the point of the waste generator, it is necessary to have competitive cost and also provide other advantages. Transport, waste disposal and environmental fines are some factors that should be taken into account when assessing the economic viability of recycling. One must evaluate the waste according to their physicochemical characteristics, durability, performance, suitability for the user and others, always having the best possible use, if necessary, for this, the involvement of a multidisciplinary team (Saraiva *et al.,* 2012). Construction waste consists of unwanted materials produced directly or incidentally by the construction firms or industries. This includes building materials such as insulation, nails, electrical wiring, and rebar, as well as waste originating from site preparation such as dredging materials, tree stumps, and rubble. Construction waste may contain lead, asbestos, or other hazardous substances (Saraiva *et al.,* 2012).

Much construction waste is made up of materials such as bricks, concrete and wood damaged or unused for various reasons during construction. Observational research has shown that this can be as high as 10 to 15% of the materials that go into a building, a much higher percentage than the 2.5-5% usually assumed by quantity surveyors and the construction industry (Harikumar *et al*., 2014). Since considerable variability exists between construction sites, there is much opportunity for reducing this waste. Certain components of construction waste such as plasterboard are hazardous once landfilled. Plasterboard is broken down in landfill conditions releasing hydrogen sulfide, a toxic gas. There is the potential to recycle many elements of construction waste. Often roll-off containers are used to transport the waste. Rubble can be crushed and reused in construction projects. Waste wood can also be recovered and recycled (Harikumar *et al.,* 2014; Hassanein & Ezeldin, 2013).

1.2 The Problem Statement

In Ghana the construction and demolition industries generate a lot of debris that can be reused and recycled (Nermin, 2010). Most construction waste goes into landfills, increasing the burden on landfill loading and operation. Waste from sources such as solvents or chemically treated wood can result in soil and water pollution. With concerns over scarce landfills, construction waste has been identified as a potential source of waste reduction (Nermin, 2010). The wastage of the construction materials is one of the factors which reduce the contractor's profit significantly in a project. This problem has been existed in construction industry for a long time. This problem is always generated during the construction activities caused by many reasons such as human being, uploading and offloading time and etc. Besides that, during the demolishing, renovating or deconstruction buildings will produce the waste and wastage on sites.

These wastage and wastes influence contractor's profit if not handled very well. Besides that, it also may create the illegal activities on the site which are burning, burying and dumping construction or demolition waste which is illegal and may harm human health and environment (Ayarkwa, 2010; Dixon, 2010). So that to administrate the recycling concept will give benefits to the contractors or clients. It is then obvious that waste management should be implemented. Reducing, reusing and recycling appear to be profitable alternatives that will increase the lifetime of landfills and reduce exploration of natural resources (Ayarkwa, 2010; Dixon, 2010). In addition to the environmental benefits in reducing the demand on land for disposing the waste, the recycling of construction wastes can also help to conserve natural materials and to reduce the cost of waste treatment prior to disposal. The most important step for recycling of construction waste is on-site separation. The waste materials can then be sent to relevant companies which recycle construction wastes. The current state of deconstruction is severely limited by numerous factors. The mainobstacles can be categorized as costs and time, with these being interrelated (Ayarkwa, 2010; Dixon, 2010). The main opportunity factors for deconstruction are the prohibitive aspects of building materials disposal and the value of recovered materials in environmental and economic terms. Related to the economic costs/benefits of recovered materials are the quality of materials, either high-quality reuse, economically recyclable, or hazardous materials and materials and systems that become obsolete or are difficult to separate. Most construction firms have failed to make good use of recycling and reuse of materials on construction sites in Ghana (Ayarkwa, 2010; Dixon, 2010). It appears from the literature that no study has been done extensively to cover material reuse and recycling in the construction industry of Ghana and this study is expected to fill the gap.

1.3 Aim of the Study

The main aim of this study is to assess construction activities that impact mostly on the environment in Ghana as a means of identifying how these impacts could be mitigated by recycling and re-use of construction materials.

1.4 Objectives of the Study

In line with the general aim set for the study, the following objectives have been formulated:

1. To identify the challenges confronting construction firms towards materials recycling and reuse.
2. To identify the impacts of construction activities on the environment.

3. To identify which materials could be focused on for recycle and re-use to ensure sustainable construction.
4. To assess the effects of sustrainable architectural practices on construction projects.

1.5 Research Questions.

To achieve the stated objectives of the study, the following questions are posed to help elicit responses for the study:

1. What are the challenges confronting construction firms towards materials recycling and reuse?
2. What are the major impacts on the environment due to construction activities in Ghana?
3. What materials could be focused on for recycle and re-use to ensure sustainable construction?
4. What the effects of sustrainable architectural practices on construction projects?

1.6 Scope of the Study

The study is focused on the construction firms and contractors to be precise in the Kumasi and Accra Metropolis. Data were collected from contractors to identify issues on construction activities impact on the environment, material that can be resused and recycled. Since the study covers only two regions, it would be difficult in generalising its finding to cover the entire Ghana.

1.7 Significance of the Study

The study apart from its significant achievement in adding to existing knowledge to the impact of construction activities on the environment, material resuse and recycling on construction sites would serve as reference material for policy makers, contractors, clients or interested parties to assess the nature of environmental impact as a result of construction activities. The challenges facing the contractors and other stakeholders in the Kumasi Metropolis and Accra Metropolis in relation to material waste management would be addressed and this would serve as the basis for stakeholders to critically analyse where the shortfalls are and deal with them appropriately with help of issues handled in the work. It would provide greater insight to stakeholders on the ability to create a sustainable environment for posterity.

1.8 Limitations of the Study

The study encountered various difficulties during the data collection stage. It was extremely and fraustratingly difficult to get acess to some of the few companies engage construction material recycling. For instance, it was difficult in getting acess to some relevant reports on construction materials recycling and taking pictures on the various machines used for the process. Most of the workers were not prepared to offer any assistance for fear of victimisation eventhough the academic purpose of the study was adequately communicated to them.

1.9 Organisation of the Chapters

The study was divided into six chapters. The Chapter One presents the introduction of the which entails background of the study, problem statement, objectives of the study, scope of the study, significance of the study and limitations. Chapter Two presents the theoretical, conceptual and empirical related literature review of the study. The purpose of this was to gain good understanding of the related issues on the subject matter. Chapter Three includes the methodology used in carrying out the study. Thus the population, sample size, sampling technique, data sources, data collection tools and procedure and data analysis. In the Chapter Four, findings from the data gathered are presented and interpreted into meaningful information to enhance easy understanding. The results are presented in percentages, mean scores and relative importance index in the form of tables and charts. Chapter Five deals with discussion of findings emanated from the survey. The discussion highlights the major findings of the research and inferences made from them in view of findings from related previous studies. With the Chapter Six, the summary of findings, conclusions and recommendations on the study are presented.

CHAPTER TWO

LITERATURE REVIEW

2.1 Concept of Construction Recycle and Re-use potential of Waste Materials

Recycling of wastes play a vital part in any waste management strategy. This involves the reprocessing of waste into a usable raw material or product, thus enabling materials to have an extended life in addition to reducing resource utilization and avoiding disposal costs. Transportation and collection of recyclable materials incur costs resulting in an increased market price of such materials compared to virgin materials (Visvanathan & Norbu, 2006). The concept of recycling scarcity of raw materials require energy requirements for construction industries and environmental concerns forms the bane of the innovations in recycling technology today (Agbo, 2011; Lauritzen, 2005).

In all communities, it has always been common practice to reclaim valuable materials from the arising waste, e.g. metals and building materials (Agbo, 2011). After some decades in this century with an extensive "use-and-throw-away" philosophy, it has been recognized that people cannot continue this uninhibited use of natural resources and pollution of the world with waste. It is necessary to change habits and to revise former common practices within the building & construction industry, as well as within other industries, households, etc (Lauritzen, 2005).

According to estimates by Franklin Associates Ltd., approximately 80**%,** or 1,090,000 tons, of construction and demolition waste are buried in Wisconsin landfills every year (Walther & Ulder, 1993). Meanwhile, some areas of the country are recycling and reusing nearly 60% of the construction and demolition waste produced (Walther & Ulder, 1993). It is important that builders begin planning now to reduce, reuse and recycle their construction waste. Hesitant builders will find themselves losing money when landfill costs increase and the bans take effect. By acting now, builders can also begin to stimulate the markets needed to handle their waste materials (Walther & Ulder, 1993). One of the major hindrances to successful deconstruction for the reuse of building materials and components, is the difficulty in recovering items in good condition. Modern construction methods are very dependent on permanent fixing methods that allow for little else but destructive demolition. If buildings were initially designed for deconstruction, it would be possible to successfully recover much more material for reuse. This would have significant advantages both economically and environmentally (Chini, 2001).

2.2 The Construction Sector in Ghana

The construction industry has made significant contribution to both industrial output and overall Gross Domestic Product (GDP) in Ghana over the years. With reference to available country-wide statistics, the impact of the built environment sector as a whole is much greater; including segments of the manufacturing, mining, quarrying, electricity and water sectors (Osei, 2013). The construction industry plays an essential role in the socio economic development of a country. The activities of the industry have a lot of significance to the achievement of national socio-economic development goals of providing infrastructure, sanctuary and employment (Osei, 2013). It includes hospitals, schools, townships, offices, houses and other buildings; urban infrastructure (including water supply, sewerage, drainage); highways, roads, ports, railways, airports; power systems; irrigation and agriculture systems; telecommunications etc. The construction sector holds immens potential for stimulating growth, boosting project exports and generating employment (Osei, 2013). The domestic construction sector happens to be one of the fastest growing sectors, with an impressive average growth of 7-8 per cent per annum. The foundation of a higher growth rate rests on a sound and efficient infrastructural development which makes the construction sector a key sector (Osei, 2013). The rapid expansion of infrastructure by both government and the private sector has triggered off construction activities and fuelled demand in many key sectors like cement, steel, paints and chemicals, glass, timber and earth moving equipment and machinery. The construction sector is a crucial industry having strong backward and forward growth linkages (Osei, 2013).

2.3 Sustainable Construction

Sustainable construction is defined as "the creation and responsible management of a healthy built environment based on resource efficient and ecological principles" (Zabih *et al.,* 2012). Building construction has important role in sustainable development, it is not only due to participation in national economy, but it is due to the fact that constructed environment has great influence on life quality, comfort, security, health, etc. Construction, maintenance and updating of constructed environment have potential effects on environment, and buildings consume most of unrecoverable resources and create great amount of waste, and buildings create half of the total carbon dioxide (Zabihi *et al.*, 2012). The building construction challenge is creating economical buildings that increase life quality while reducing social, economical and environmental effects. Achieving sustainability in architecture and construction is the goal emphasized more these days. There are many theoretical basics but some of them are not practical. Vernacular architecture due to some of the characteristics has many sustainability aspects, but Architecture without sustainability as a serious challenge appeared after industrial revolution (Zabihi *et al.*, 2012). The technology and its achievements are mainly considered, and architecture converts from "part of environment" to "separate from environment". So, architecture destroys environment and it would be changing and also noneconomic without adequate qualities. In result, new solutions should be proposed to benefit from technology in addition to interaction with environment. In this regard, sustainability approach presented and defined in building and architecture sector to improve these challenges (Zabihi *et al.*, 2012).

The critical issue surrounding construction activities of any kind in African countries is that construction systems have long been modelled on the experience of the developed world as argued by Taylor et al. (1994). The authors contend that it has been assumed historically that norms and systems arising from a particular set of experiences in the developed world can be readily adopted by developing countries. The authors argue that this type of thinking typified the stage of economic growth, whereby the economic emergencies of nations were hypothesized to be consistently and universally similar, thus ignoring national circumstances, value systems or current priorities. This has been proved inappropriate where principles of the developed world have been applied in Africa without modification (Adebayo, 2001). The interpretation of the meaning and definition of sustainable development and construction is therefore revisited. Whether the general presupposition in practice is accomplished and questionable when applying the meaning in the African context given the diversity of problems facing Africa as a developing continent. It is further questioned whether sustainable construction can stand alone without an understanding of the broader issues of development (Adebayo, 2001).

Construction has to support a world of continuing population growth and economic development. At the same time, construction must pay heed to the widespread social interest in environmental preservation (Kraj, 2008; Nermin, 2010). It cannot further increase its environmental impact because it is not socially and environmentally acceptable. Yet the construction industry has not done enough to reduce its environmental footprint. Concerted national and international research and educational efforts are needed to change this situation (Kraj, 2008). Construction engineering and management research should benefit from a systems perspective, and from application of standard methods and tools developed for environmentally-conscious design, construction and management by other industries such as the electronics, electromechanical products, and the automobile sectors. Traditional construction engineering and management education needs to incorporate the latest methods and tools for environmentally-conscious design, engineering and management and discuss relevant case studies (Horvath, 1999).

One of the key policies of many governments the world over is sustainable development in construction. This is due to the fact that the construction industry alone has a tremendous impact in the way the natural environment is affected by human activities whenever construction takes place, the surrounding environment will get affected (Kraj, 2008). Due to this, the emphasis has been placed on sustainable development and both the need and responsibility of citizens and companies alike to do their utmost to reduce or minimize the impact human activities can have on the surrounding environment (Patil, 2012). Buildings, infrastructure and the environment are inextricably linked. Energy, materials, water and land are all consumed in the construction and operation of buildings and infrastructure. These built structures in turn become part of our living environment, affecting our living conditions, social well-being and health (United Nations Environment Programme, 2014).

It is therefore important to explore environmentally and economically sound design and development techniques in order to design buildings and infrastructure that are sustainable, healthy and affordable, and encourage innovation in buildings and infrastructure systems and designs. The concept of sustainability in building and construction has evolved over many years. The initial focus was on how to deal with the issue of limited resources, especially energy, and on how to reduce impacts on the natural environment (Chini, 2001: United Nations Environment Programme, 2014; Patil, 2012). Emphasis was placed on technical issues such as materials, building components, construction technologies and energy related design concepts. More recently, an appreciation of the significance of non-technical issues has grown. It is now recognised that economic and social sustainability are important, as are the cultural heritage aspects of the built environment (Adebayo, 2001; Patil, 2012).

Still, sustainable construction adopts different approaches and is accorded different priorities in different countries. It is not surprising that there are widely divergent views and interpretations between countries with developed market economies and those with developing economies. Countries with mature economies are in the position of being able to devote greater attention to creating more sustainable buildings by upgrading the existing building stock through the application of new developments or the invention and use of innovative technologies for energy and material savings, while developing countries are more likely to focus on social equality and economic sustainability (United Nations Environment Programme, 2014).

2.4 Principles for Sustainable Activities

In order to understand what can be done to reduce the environmental burden of humanactivity, it has been convenient to consider the range of measures that might be taken within a smaller number of broader principles. There are potentially thousands of strategies that might be implemented in the design of a building in order to reduce the environmental burden of that building. Management of these strategies, and of conflict between them, can be better handled by addressing a few overriding aims (Chini, 2001; Dixon, 2010; Hassanein & Ezeldin, 2013). Numerous authors have proposed such broad principles for sustainable activity, and many of these relate directly to the built environment and to sustainable architecture. The writings, and the built work, of Brenda and Robert Vale illustrate a number of green architecture principles. They suggest six basic principles that could constitute sustainable architectural practice (Chini, 2001):

- *Conserving energy*, a building should be constructed so as to minimise the need for fossil fuels to run it
- *Working with climate*, buildings should be designed to work with climate and natural energy sources
- *Minimise new resources*, a building should be designed so as to minimise the use of new resources and, at the end of its useful life, to form the resources for other architecture
- *Respect for users*, a green architecture recognises the importance of all the people involved with it
- *Respect for site*, a building will touch-this-earth-lightly (Chini, 2001).
- *Holism*, all the green principles need to be embodied in a holistic approach to the built environment.

- The Royal Australian Institute of Architects. Environmental Design Guide also offers anumber of principles for achieving sustainable architecture;
- Maintain and restore biodiversity
- Minimise the consumption of resources
- Minimise pollution of air, soil and water
- Maximise health, safety and comfort of building users
- Increase awareness of environmental issues

Another author who offers a list of broad principles is Kibert. His concerns are developed from a number of issues of sustainable construction which include;

- Energy consumption, water use, land use, material selection, indoor environmental quality, exterior environmental quality
- Building design, community design, construction operations, life cycle operation, and deconstruction
- Several principles of how to achieve more environmentally responsible construction are proposed with respect to these issues;
- Minimise resource consumption
- Maximise resource reuse
- Use renewable or recyclable resources
- Protect the natural environment
- Create a healthy, non-toxic environment
- Pursue quality in creating the built environment

These lists of principles are all attempts at grouping the various strategies for achievingsustainable architecture. While these groups vary slightly, they all address issues of;

- Material use, energy use, health, and a holistic view (Chini, 2001).

Building construction and operations have significant direct and indirect impacts on theenvironment. Buildings use resources such as energy, water and raw materials, generatewaste (occupant, construction and demolition), and emit potentially harmful atmosphericemissions. Building owners, designers, and builders face a unique challenge to meetdemands for new and renovated facilities that are accessible, secure, healthy, andproductive while minimizing their impact on the environment. This requires new practices ofcreating structures and using processes that are environmentally responsible and resourceefficientthroughout a building's life-cycle from sitting to design, construction, operation,maintenance, renovation and deconstruction (Chini, 2001; Dixon, 2010; Hassanein & Ezeldin, 2013; Nermin, 2010).

The main objectives of sustainable construction activities are to avoid resource depletion of energy, water, and raw materials and prevent environmental degradation caused by facilities and infrastructure throughout their life cycle. Construction sector consumes yearly about half of all natural resources extracted in Europe and their transformation into building products has significant energy demands. Therefore the focus of today's environmental policy is on the building end-of-life scenarios and material efficiency. Here waste prevention and recycling / reuse play a key role by providing huge energy, water and material savings. These issues are also specifically addressed in the Construction Products Regulation4 (CPR 2011 as in Wahlström & Kaartinen, 2014), where health and safety aspects related to use of construction products cover the entire lifecycle, i.e. from manufacturing to construction with a safe use and sustainable handling and recycling of waste arising from renovation, maintenance and final demolition (Wahlström & Kaartinen, 2014).

2.5 Challenges facing the practice of effective construction activities

It emerged from the studies (Yalley *et al.*, 2013) that more than 50% of the stakeholders, most of who were in the building sector, had never obtained environmental permits. Their study concluded that lack of specific enforcement of the Environmental Protection Agency Act in the building construction industry and the lack of frequent visits by the EPA to building construction sites are major factors affecting effective environmental management in the Ghanaian construction industry. Since the EPA is responsible for every aspect of environmental management, this means a second look should be taken at their activities (Yalley *et al.,* 2013).

The most serious constraint of the remediation project has been the general apathy of the local people towards a progressive attitudinal and behavioural change. The low levels of education of the local people has also been a serious limitation to the success and sustained momentum of the project Horizon International, 2011). The lack of will on the part of the local people to change their behaviour and attitudes provided an impetus for high rates of re-infection of schistosomasis (bilharzias) in some communities, particularly among school children. In Ada-Foh, the follow-up studies after 14 months indicated that re-infection rate was 6%. This was attributed to the reluctance of the school children in this town to change their habits. Also, about 35% of the head pond area is still infested with aquatic weeds. This is largely due to the high re-infestation rate (6-8 weeks after clearing) of the aquatic weeds (Horizon International, 2011).

The environmental problems of the developing countries exist side-by-side with a lack of the managerial experience, financial resources, and legal and administrative systems necessary to deal with the issue through public and formal education, formulation and enforcement of "command and control" measures (legislation and regulations), as well as the devising and implementation of "economic instruments" (incentives – grants, subsidies – and taxes) (Ofori, 2012).

2.6 The Role of Environmental Management to the construction Industry

The aim of environmental management is to reduce or completely eliminate the chances of vulnerability of the environment to disaster through prevention, mitigation, preparedness or capacity building (Ofori, 1992; Adeniran, 2013). Hewitt established that vulnerability is the principal component of risk in his disaster studies. He insisted that hazard is the other main component which he regarded as merely the trigger of risk conditions while arguing that vulnerability accounts for the bulk of the propensity to suffer harm.

According to Boyce as in Adeniran (2013), this formulation is commonly used when dealing with extreme poverty. A natural disaster is the consequence of a natural hazard (e.g. volcanic eruption, earthquake, landslide, flood, cyclones, cold waves, drought, thunderstorm, heat waves, mudslides and storms) which affects human activities. Human vulnerability, exacerbated by the lack of planning or appropriate emergency management, leads to financial, environmental or human losses. In the view of Bankoff et al, the resulting loss depends on the capacity of the population to support or resist the disaster, and their resilience. The implication is that "disasters occur when hazards meet vulnerability". Therefore, a natural hazard will hence never result in a natural disaster in areas without vulnerability, e.g. strong earthquakes in uninhabited areas (Adeniran, 2013).

Resource management implies the efficient use of energy, water, materials and land, and provides for the reduction, reuse and recycling of natural resources that are used in building production. Resource management yields specific design methods through the selection of durable materials that could extend service lives of buildings components, thus reducing material consumption. Durable materials would also require less maintenance, reduce operating budgets and ultimately reduce the potential for building failure (Ofori, 2012; Ofori, 1992; Osei, 2013). The life-cycle design of a building during pre-building, building and post-building phases seek to balance environmental concerns with traditional issues that always affect decisions and choices made at the design phase. During the pre-building phase, appropriate site selection helps in the determination of the degree of resource use and the disturbance of existing and natural systems that will be required to support a development project. The use of flexible and durable designs to support future changes (cost-effectively and resource-efficiently), and the selection of sustainable materials and products that meet defined standards of compliance, contribute to sustainability. The sustainable design element of a building's life-cycle affords significant opportunities for influencing project sustainability before construction operations begin on site. During construction, proper planning and management of construction activities could be used to minimize site impact on the environment (Windapo & Rotimi, 2012).

2.7 Building materials

Building materials account for about half of all materials used and about half the solid waste generated worldwide. It has an environmental impact at every step of the building process extraction of raw materials, processing, manufacturing, transportation, construction and disposal at the end of a building's useful life. Governments worldwide have responded to the need to reduce waste with regulation and legislation that have framed a market for building materials and products derived from the construction and demolition (C&D) waste stream (Commonwealth of Australia, 2011; Windapo & Rotimi, 2012).

There are now, more than ever, clear opportunities for business and industry to invest in activities that will create profit and improve environmental outcomes by extracting valuable resources from the C&D waste stream. The built environment of the future is being constructed at the beginning of a new ecological era where governments are framing markets with regulation and legislation that respond to the challenges of environmental sustainability, and where industry must respond to the challenges of low-carbon economies and resource depletion. Businesses that are profiting and growing are adapting to these new challenges and responding with innovations that turn waste into valuable resources to supply the construction industry, which has traditionally been adverse to behavioural change (Commonwealth of Australia, 2011).

2.8 Construction Materials that can be Re-used, Recycled

A certain portion of the materials from construction and demolition projects are toxic or classified as hazardous waste. Materials generated in new construction that may require special handling include latex paint, chemical solvents and adhesives. The materials should be managed according to local regulations. Lead paint can be planed, removed, and recycled at a lead smelter or disposed of appropriately, while the remaining wood can also be reused or recycled. The age of structures involved in demolition projects ranges considerably. Many older buildings may contain materials that are no longer allowed in new construction, such as asbestos and lead-based paint. Asbestos abatement is required prior to demolition (United States Environmental Protection Agency, 2009).

2.8.1 Wood

Wood is the single largest component of residential construction waste. In Dane County wood comprises nearly 40% of residential construction waste, and for every new home built, approximately 17 cubic yards of wood waste is generated. In an age where wood fiber is becoming more valuable and the cost of raw lumber is escalating, wasting wood has become an expensive practice. Many options exist for reducing, reusing and recycling wood waste. And, because of its large volume, minimizing wood waste clearly provides one of the best ways to clamp down on disposal costs (Walther & Ulder, 1993). Wood is the harvested material most commonly used in buildings and building products. Dimensional lumber is used in framing the majority of residential buildings and many commercial structures. Wood products such as plywood, particleboard, and paper are used extensively throughout the construction industry. Until recent years, the most commonmethod of harvesting wood was clear-cutting, a process wherein all vegetation within a given area is removed for processing. Now, where clear-cutting takes place, lumber companies are required to replant the area (Kim, 1998). Reuse timbers, large dimension lumber, plywood, flooring, molding, lumber longer than 6 feet. Clean, untreated wood can be recycled, re-milled into flooring, or chipped/ground to make engineered board, boiler fuel, and mulch (United States Environmental Protection Agency, 2009).

2.8.2 Drywall/Gypsum

Drywall waste is similar to waste wood in that it comprises a large volume of residentialconstruction waste and has a lot of bulk. In addition, drywall has many reduction, reuse and recycling possibilities, and if segregated from other wastes, has great potential for reducing the overall volume of waste going to the landfill (Walther & Ulder, 1993).

2.8.3 Paper

Paper in construction waste originates almost entirely from discarded packaging. Cabinets, siding, light and door fixtures, tiles, appliances, nails, carpet, etc. usually come packaged in corrugated cardboard boxes (wavy centered board), boxboard (cereal boxtype) or brown wrapping paper. Because of its ability to protect materials from damage at a low cost, few options exist for reducing construction paper waste. The paper waste, however, has a high potential for reuse and recycling. Recycling markets for paper waste are strong in Wisconsin, and like wood and drywall, the bulk of the paper waste provides another great opportunity to reduce the volume of construction waste going to the landfill (Walther & Ulder, 1993).

2.8.4 Metals

Most metals in residential construction waste can be recycled. Wisconsin has many scrap dealers that accept metal waste. Although most sub-contractors already recycle or reuse high valued metals such as copper, solder and brass, some lower valued metals such as steel and aluminum still end up in the landfill. In Dane County, many metal items found products, such as metal hinges and drawer runners, were landfilled because they were affixed to construction materials that were damaged before installation (Walther & Ulder, 1993). Recycle metals found at a construction, demolition, or renovation sites. Common metals include steel, aluminium, and copper. Local metal scrap yards or recyclers that accept metal materials are typically accessible. Metals are melted down and reformed into metal products. Markets are well established for metals (United States Environmental Protection Agency, 2009).

2.8.5 Plastics

Plastic waste from residential construction sites comes in many forms. When mixed together, the plastics are practically impossible to recycle due to incompatible polymers and chemical additives. If a builder wishes to recycle plastic wastes, great care must be taken to prepare and separate the many different types of plastic. In general, most builders do not have the time or employees to handle this waste material for recycling. In 1995, however, foam polystyrene packaging, and anything which constitutes a "plastic container" was banned from landfills in Wisconsin (Walther & Ulder, 1993).

2.8.6 Asphalt Shingles

Companies across the country are starting to recycle this material into pot-hole filler and new pavement. Government of US encouraged suppliers of new asphalt shingles to invest in an operation to facilitate the use of unused or discarded shingles (Walther & Ulder, 1993).

2.8.7 Asphalt Paving

Asphalt is crushed and recycled back into new asphalt. Markets for recycled asphalt paving include aggregate for new asphalt hot mixes and sub-base for paved road (United States Environmental Protection Agency, 2009).

2.8.8 Masonry,Tile, Concrete, Rock, and Dirt

Many builders leave small amounts of soil, rock and masonry on construction sites, or use it as driveway underlay. Large quantities of these materials separated from other construction debris, may be accepted at local landfills as "clean fill" (largely inert soils and clays used for covering daily deposits of waste). Have a landfill operator examine any large amounts of these materials for approval as clean fill. Material landfilled as daily cover usually has lower tipping or disposal fees than regular landfilled waste (Walther & Ulder, 1993). Clay and adobe soil must also be mined. They are usually found in shallow surface deposits, and manufacturing is often done nearby, reducing extraction and transportation costs. With the exception of adobe, bricks and tiles must be fired to be useful building materials. The firing process exposes the formed clay to high, prolonged heat, producing a hard, waterproof, permanent brick or tile. The firing process can take hours or even days and requires a large amount of energy. Glazed bricks and tiles are fired twice: first to make the shape permanent and then to melt and adhere the glazed finish, which usually contains glass. The end product has much embodied energy but is also very long-lasting. Even without firing, properly maintained adobe bricks can last 350 years or more (Kim, 1998). Concrete is commonly recycled. It is crushed, the reinforcement bar is removed, and the material is screened for size. Market outlets for recycled concrete include road base, general fill, pavement aggregate, and drainage media (United States Environmental Protection Agency, 2009).

2.8.9 Lunch Refuse

It is not uncommon to find lunch refuse in residential construction waste. Lunch refuse can include many recyclables such as glass and plastic drink bottles, aluminum soda cans, and steel food cans. The recyclables may need to be sorted out of the bags or the recycling center may sort the materials. Workers could also be required to take all lunch refuse with them, and encouraged to make their own arrangements for recycling it (Walther & Ulder, 1993).

2.8.10 Limestone

Limestone is perhaps the most prevalent building material obtained through mining. It is used as a cladding material and plays an important role in the production of a wide range of building products. Concrete and plaster are obvious examples of products that rely on limestone; less obvious is the use of limestone in steel and glass production. An abundant natural resource, limestone is found throughoutthe world. In the U.S., the states of Pennsylvania, Illinois, Florida, and Ohio are the largest producers. The mining of this sedimentary rock generally takes place in open-pit quarries. Pit-mining requires the use of heavy equipment to move the topsoil, vegetation, and overlaying rock (collectively referredto as “overburden”). Large blocks of stone are removed from the rock bed by controlled drilling and explosions. These blocks may be cut into smaller units for use as structural masonry or veneer material. Most limestone is crushed at the quarry, then converted to lime, by burning, at another location.The burning of limestone creates sulfide emissions, a major contributor to acid rain. Limestone (primarily calcium carbonate) is converted to quicklime (calcium oxide) through prolonged exposure to high heat. This removes water and carbon from the stone and releases carbon dioxide into the atmosphere. The quicklime is then crushed and screened. Before it can be used in plaster or cement, it must be mixed with water and then dried. The hydrated lime then becomes an ingredient in concrete, plaster, and mortar (Kim, 1998).

2.9 Waste

Generally, construction and demolition waste (C&D) is defined as the waste that arises from construction, renovation and demolition activities (Kofoworola & Gheewala, 2009 as cited in Lu & Yuan, 2011). It may also include surplus and damaged products and materials arising in the course of construction work or used temporarily during the process of on-site activities (Roche & Hegarty, 2006). Fatta *et al.* (2003) reported that C&D waste, depending on their origins, can be classified into four categories, namely, excavation, road planning and maintenance, demolition, and worksite waste materials. In Hong Kong, "C&D waste is, arising from various construction activities including land excavation or formation, civil and building construction, site clearance, demolition activities, roadwork, and building renovation" (Shen *et al.*, 2004; Poon *et al.*, 2004a; Hao *et al.,* 2007).

It is noticed that C&D waste as an integral term is increasingly used in literature. Whilst from the landfill's perspective it makes sense to use this term to stand for all solid wastes to be dealt with, C&D waste is not a rigid concept to indicate their specific origins. The two waste streams are considerably different in terms of their volumes. Bossink and Brouwers (1996) reported that the annual volumes of construction waste and demolition waste in Germany were estimated at 30 million tons and 14 millions tons respectively. The U.S. Environmental Protection Agency (EPA) (2002) mentioned that the majority of C&D waste is from demolition (48%) and renovation (44%). An investigation in China revealed that construction practitioners viewed that construction waste is "negligible" therefore main waste management efforts should be focused on demolition waste (Li, 2006). Research has also interpreted C&D waste by its composition. The European Waste Catalogue (EWC) provides a comprehensive classification of C&D waste in line with its compositions. According to it, C&D waste is classified into eight categories including (1) concrete, bricks, tiles and ceramics; (2) wood, glass and plastic; (3) bituminous mixtures, coal tar and tarred products; etc. In Hong Kong, C&D waste is normally in the form of building debris, rubbles, earth, concrete, steel, timber, and mixed site clearance materials (Shen et al., 2004; Poon *et al.,* 2004a; Hao *et al.,* 2007; Lu &Yuan, 2011).

Although C&D waste is often included as one of the forms of municipal solid waste (MSW), the C&D waste is considered being heterogeneous by comparing it with the general MSW (e.g. household waste) or other industrial solid wastes (ISW) (e.g.hospital waste and computer waste). For example, normally the majority of C&D waste can be reused or recycled (Tam, 2008a). Unlike household waste, C&D waste is generated by a limited few of contractors thus it might be easier to manage. It is reported that in some developing countries, informal sector is involved in the general MSW and ISW while for C&D waste the main involvers are contractors or specialist subcontractors (Khalil & Khan, 2009; Yuan, 2008; Lu & Yuan, 2011). While research and practice often "borrow" theories and concepts (e.g. waste hierarchy, polluter pays principle) from the general waste management, the heterogeneity of C&D waste should beconsidered in the future study. In addition, more research to compare the characteristics of C&D waste and other wastes is envisaged. So far, there is a lack of consensus about the definitions of C&D waste in literature. Different perspectives on these wastes, actually, imply different waste management philosophies. In Japan, C&D waste is considered as construction *by-product* ratherthan*waste* therefore considerable efforts were given to reuse or recycle it (Nitivattananon & Borongan, 2007). In Hong Kong, the C&D waste is divided into two major categories: inert materials and non-inert waste. Over 80% of C&D materials including debris, rubble, earth and concrete are inert which could be used for land reclamation and site formation (EPD, 1998). The remaining is non-inert C&D waste (e.g. bamboo, timber, vegetation, packaging waste and other organic materials) which is disposed of at landfills (Lu &Yuan, 2011).

Construction wastes have become the major source of solid wastes in Hong Kong whereconstruction and demolition activities generate thousands of tonnes of solid wastes every year.The increasing generation of construction wastes has caused significant impacts to theenvironment and aroused growing public concern in the local community. Thus, theminimization of construction wastes has become a pressing issue (Shen *et al*., 2002). Construction waste is becoming a serious environmental problem in many large cities in the world. In Malaysia, the construction industry generates lots of construction waste which caused significant impacts on the environment and aroused growing public concern in the local community. Thus, the minimisation of construction wastes has become a pressing issue (Begum *et al*., 2006).

Every time someone builds or remodels a home, waste is created. Thus, every builder has become the manager of a bonafide waste stream. According to the Wisconsin Department of Natural Resources (DNR), construction waste is defined in conjunction with demolition waste as: solid waste resulting from the construction, demolition or razing of buildings, roads and other structures. Demolition and construction material typically consists of concrete, bricks, bituminous concrete, wood, glass, masonry, roofing, siding, and plaster, alone or in combinations. It does not include asbestos, waste paints, solvents, sealers, adhesives or similar materials (Walther & Ulder, 1993).

Waste is an environmental, economic, social, and political challenge to the EU, as well as to global society, due the fact that waste volumes continue to grow (European Commission, 2005). For example, the European Commission reports that huge amounts of waste are generated in the activities such as manufacturing (360 Mt/a), or construction (900 Mt/a), having a significant impact on the environment, contributing to the climate change and losses ofmaterial (European Commission, 2010). Thus, in 2008 the European Council adopted a revised framework for waste management in the EU, with an objective to encourage recycling and reuse of waste, in order to reduce landfill, environmental impact, and dependence on imported raw materials (as cited in Koletnik *et al.,* 2012).

Ghana has neither methods nor laws dealing with hazardous waste disposal. The Environmental and Social Impact Assessment (ESIA) notes that a Draft Hazardous Waste Control bill was before the Cabinet for consideration. Currently, hazardous wastes are disposed-of in landfills. At any mine site, there is great potential for future problems caused by sub-standardwaste disposal. The ESIA evidences that Newmont is aware of potential problemsassociated with toxic and hazardous waste disposal, but the ESIA does not sufficientlycommit to methods and monitoring that are needed to avoid future liability and humanhealth or environmental degradation. It is considered best practice in the United Statesand elsewhere to require up-front methods and protections rather than facing sizeablecleanup costs after problems occur (Levit & Chambers, 2005). Particularly because of the vast spectrum and quantity of toxics proposed for mine use, Newmont should commit to disposal of all chemicals to United States. standards (notably Toxic Substances Control Act (TSCA), Resource Conservation Recovery Act (RCRA), Clean Air Act (CAA) and Clean Water Act (CWA)), and all disposal facilities should meet Comprehensive Environmental Response Compensation and Liability Act(CERCLA) disposal requirements. This will ensure that disposal will not cause contamination after the mine is reclaimed. That Ghana is considering but has not yet implemented hazardous materials laws should not excuse Newmont from treating hazardous materials in Ghana as seriously as Newmont treats hazardous materials in the U.S. Further, Newmont should commit to complying with future Ghanaian laws and regulations that are passed after the mine is active, and not attempt to seek .grandfather exclusion from implementation (Levit & Chambers, 2005).

2.9.1 Waste management (WM): a multidisciplinary effort

The research on C&D WM representing in the 115 articles can be understood by putting them into a "C&D WM Spectrum" ranging from "hard" construction technologies through to "soft" WM measures. Technology, at one end of this spectrum, is often on the front line as the approaches for managing C&D waste. For example, low waste technologies (e.g. prefabrication instead of in-situ; and use of steel formwork and falsework instead of timber ones) are introduced to reduce the C&D waste generation. When waste is inevitably generated, new technologies are developed to reuse and recycle it if possible, such as the use of recycled aggregates for different concrete applications (Poon & Chan, 2007). Standing at the other endof this spectrum is management. Various managerial measures are developed to manage C&D waste based on the view that C&D WM is also a behavioral and social process (e.g. promoting best WM practices). With the assistant of a process description approach, Shen *et al.* (2004) examined the waste handling process during construction, and a WM mapping model incorporating the good operations was developed. Other research is falling between the two extremes by examining both technical and managerial aspects of a C&D WM effort. For example, Jallion and Poon (2008) examined the technical, managerial, and marketing aspects of prefabrication technology in Hong Kong.

Lots of research indicates that changing project stakeholders' wasteful behavior can make a significant contribution to the effective management of C&D waste (Lingard *et al.,* 2001; Teo & Loosemore, 2001; Begum *et al.,* 2009). Research also shows that the awareness of practitioners significantly contributes to the reduction of C&D waste (McDonald & Smithers, 1998). The C&D WM is a multidisciplinary effort needing coordinated input from different disciplines. Any waste management strategy should be considered in the framework of administrative, financial, legal, planning and engineering functions. This has been increasingly acknowledged in both waste management research and practice. Through a critical review of the existing literature, it is noticed that research on C&D WM mainly focused on the "hard" technologies while paid scant attention to the "soft" measures or the combined approaches of the "soft" and "hard" measures. For example, how to reduce waste generation through promoting practitioner's environmental awareness by training? How to integrate the ISO 14000 and a company's processes to truly improve WM performance? How to measure the attitudes of the stakeholders involved toward C&D WM? (Lu & Yuan, 2011).

2.9.2 Reduction of Construction Waste

Minimal construction waste during installation reduces the need for landfill space and also provides cost savings. Concrete, for example, has traditionally been pre-mixed with water and delivered to the site. This excess is usually disposed of in a landfill or on-site. In contrast, concrete mixed on-site, as needed, eliminates waste, and offers better quality control. Designing floor intervals to coincide with the standard lengths of lumber or steel framing members also reduces waste. Taking advantage of the standard sizes of building materials in the design phase reduces waste produced by trimming materials to fit, as well as the labor cost for installation (Kim, 1998).

2.9.3 Demolition

The complete removal of a building. Generally, after extracting easily removable materials for reuse or recycling, workers complete the demolition with heavy equipment. Additional recyclables are often sorted from the rubble generated during these demolition activities. In order to be recycled, materials must be separated from contaminants (e.g., trash, nails, broken glass) (United States Environmental Protection Agency, 2009).

2.9.4 New Construction

Putting together all or part of a structure. Most construction site debris is generated from packaging and when raw materials are cut or sized. Workers can save large scraps for use in other projects. Durable packaging and unused materials can be returned to suppliers. Smaller scraps and non-durable packaging can be source separated when produced and recycled (United States Environmental Protection Agency, 2009).

2.9.5 Renovation

Partial removal of a building's interior and/or exterior followed by construction. Contractors can adapt the same recovery techniques as above for renovation projects (United States Environmental Protection Agency, 2009).

2.9.6 Re-use

Many materials can be salvaged from demolition and renovation sites and sold, donated, stored for later use, or reused on the current project. Typical materials suitable for reuse include plumbing fixtures, doors, cabinets, windows, carpet, brick, light fixtures, ceiling and floor tiles, wood, HVAC equipment, and decorative items (including fireplaces and stonework) (United States Environmental Protection Agency, 2009). To extend the life of an item by using it again, repairing it, modifying it or creating new uses for it**.** Construction materials require great amounts of energy and resources to produce. By landfilling the materials that did not "fit", the energy and resources contained in those left-over materials are lost. Moreover, reusing materials may improve efficiency. The result of this greater efficiency lowers disposal costs and decreases the quantity of materials that need to be purchased per job site (Walther & Ulder, 1993).

A study by Begum *et al.* (2012) demonstrates that construction materials contribute to the generation of large quantities of the construction waste.Waste minimisation is common in the project site where 73% of the waste material is reused and recycled. Waste minimisation is economically feasible and also plays an important role for the improvement of environmental management. The net benefit of reusing and recycling of waste materials is estimated at 2.5% of the total project budget. Thus, the construction industry can save money by implementing waste minimisation practices on the site (Begum *et al.,* 2012).

2.9.7 Re cycle

To collect and reprocess manufactured materials for reuse either in the same form or as part of a different product.If you can't reduce or reuse certain construction waste materials, recycle them. Recycling construction waste can provide many valuable raw materials to manufacturers of new products (Walther & Ulder, 1993). Materials can either be recycled onsite into new construction or offsite at a C&D processor. Typical materials recycled from building sites include metal, lumber, asphalt, pavement (from parking lots), concrete, roofing materials, corrugated cardboard and wallboard (United States Environmental Protection Agency, 2009).

2.10 Recycling Hierarchy in the Built Environment

While the field of industrial design has addressed some of the issues of reuse and recycling through the theories of industrial ecology, the field of architecture and building design has not (Chini, 2001). Most writers in the field of environmentally sustainable architecture have noted the environmental advantages of reuse and recycling, and there are many excellent examples of built work where materials and components have been reused. Despite this there has been until recently a lack of critical analysis of the possible effects that reuse and recycling might have on the built environment, and in particular a lack of debate on the implications of a hierarchy of end-of-life scenarios (Chini, 2001).

The scenarios of reuse, repair, and reconditioning are placed in the product level since they are concerned with product components or subassemblies. The scenario of recycling is placed in the material level since it is concerned with base materials. In adapting this model to the built environment, and in an attempt to accommodate the theory of time related building layers, this two level approach is then prefaced by a third level, the systems level.

- *Systems level: Adaptable building which can change to suit changing requirement*
- *Product level: The products (or layers) of the building are designed to allow upgrading, repair and replacement. The replaced products can then enter the replenishing loop.*
- *Material level: When a product has been stripped back its constituent materials these can undergo recycling* (Chini, 2001).

Exactly how the theory of time related building layers relates to the hierarchy of end-of-life scenarios in this model is not explained. The model does however recognise a hierarchy in which some options are environmentally preferable to others, such as product level reuse being a more .efficient use of resources. than material level recycling.

Guequierre and Krstinssons model is also simplified by grouping the product scaledscenarios together. This results in a model with the four scenarios of; *repair of products*,*recycling of materials*, *incineration*, and *landfill*. Since the model has been devised as anassessment tool for existing buildings, there is no consideration of a scenario for wholebuilding reuse as a system. Kibert and Chini write on the topic of deconstruction as a means to reducing the environmental burden of the built environment. They propose an explicit waste management hierarchy that includes the levels of landfill, burning, composting, recycling, reuse, and reduction. In this hierarchy the level of recycling is further broken down in to downcycling, recycling and upcycling, in which each is slightly more environmentally advantageous than the previous. The level of reuse is similarly broken into the reuse of materials and the more advantageous reuse of components or products. The previously unmentioned level of reduction is an important waste management strategy with profound environmental benefits, but in the context of this study it has little bearing on recycling of building materials and components, other than to suggest a general reduction in material usage. On the separate topic of buildability, not related to recycling, there is one interesting piece of research that identifies a hierarch in building assembly. Moore builds an assembly process hierarchy based on Furguson.sbuildability hierarch. This hierarchy consists of materials, components, subassemblies and final assemblies (buildings). Though this hierarchy is concerned with levels of assembly and production in an effort to determine better buildability, it is still relevant to deconstruction and recycling (Chini, 2001).

2.11 Construction recycling/reuse best practices

The other major driver is a growing market in recycled materials and reusable fixtures. The construction industry uses more materials by weight than any other industry in the United States producing 325 million tons of recoverable construction and demolition materials. Approximately 8,000 lbs of waste are thrown into the landfill during the construction of a 2,000 square foot home. That is a lot of construction dollars that will either be lost to landfill tipping fees or gained by successfully selling this material for recycling or reuse (Roth, 2012).

Planing for making money by recycling and reusing construction material

1. Think first.

Demolition by sledge hammer will cost money. The first step to making money through recycling/reuse is to survey what is in the building and develop an inventory of materials that can be sold to recycling companies or can be reused. Then use the web and your phone to figure out who will pay for what in terms of reusable and recyclable material in the building industry. Also work with the architect on what can be recaptured for reuse in the new construction. This homework before the demolition crew arrives can increase a project's margins and bid competitiveness. Many companies now target diverting at least 50 percent of their construction landfill waste and best-in-class operations like the St. Croix Habitat for Humanity Eco-Village target 90 percent landfill diversion (Roth, 2012).

2. Create a lay down area

What one plan to sell from the demolition process requires a lay down area just like new materials. And it should be similarly organized with designated areas and containers for the sorting of materials and fixtures. This will make it easier to count and take pictures of materials and fixtures, which will make them easier to sell. If lay down area is the big mental container supplied by the waste management company, then one might as well go to the ATM and get some cash to throw in there too, since the more stuff you pitch in the dumpster the more of your potential profits go with it to the landfill (Roth, 2012).

3. Create crew buy-in

Managing waste requires the engagement of all of your trades people. If one expect them to handle your demolition materials and fixtures like the dollars they represent, then one have to train them, set performance expectations and motivate them (Roth, 2012).

4. **Measure/report**

If one does not measure how workers are doing on materials capture, then the odds are they would not do it. Keep track of what is being done. Having a lay down area makes this much easier. Make sure to report the results to the crew (Roth, 2012).

5. Keep it local

The best place to recycle and reuse demolition material is on job site. This is an increasingly attractive path for cost mitigation and for the potential aesthetics often conveyed through the repurposing of bricks, woods and refurbished fixtures.

2.12 Ghana's Environmental Protection Act of 1994 (Act 490)

The Environmental Protection Act, 1994 maps the mandate, functions, structure and funding of the EPA. The mandate of the EPA includes formulating environmental policy and making recommendations for the protection of the environment. The EPA is responsible for ensuring compliance with EIA procedures in the planning and implementation of development projects, including compliance with respect to existing projects. This requires that any project likely to have potentially adverse effects on the environment be subjected to an EIA (Dickson, 2011).

The EPA is responsible under section 2(f) of EPA Act 1994 for the issuance of environmental permits and pollution abatement notices for controlling waste discharges, emissions, deposits or other sources of pollutants. They also issue notices in the form of directives, procedures or warnings for the purpose of controlling noise in the environment (Dickson, 2011).

Under section 2(h) it is the EPA function "to prescribe standards and guidelines relating to air, water, land and other forms of environmental pollution including the discharge of wastes and the control of toxic substances" Under section 12 (1) "The Agency may by notice in writing require any person responsible for any undertaking which in the opinion of the Agency has or is likely to have adverse effect on the environment to submit to the Agency in respect of the undertaking an environmental impact assessment containing such information within such period as shall be specified in the notice". Also, under Section 15(1), The EPA working through Environment Protection Inspectors (EPIs) referred to in the Act as "Inspectors" have power to enter and inspect at any reasonable time premises for the purpose of ensuring compliance with environmental law. These sweeping powers taken together imply that the EPA at least in theory can generally manage or control environmental risks resulting from E&P activities (Dickson, 2011).

Regulation 6 of the Environmental Assessment Regulation, 1999 LI 1652 , Schedule 1 Part 1 (Undertaking Requiring Registration and Environmental Permit) requires that an Environmental Permit to be obtained for crude oil and natural gas activities in Ghana - this includes crude oil or petroleum production facilities as well as natural gas facilities. Further, Appendix 2, of the EPA's "Environmental Assessment in Ghana, A Guide" requires registration with the Agency of all undertakings such as "Mining (including milling), quarry and oil wells". This means activities related to oil exploration and production (crude oil, petroleum or natural gas) are caught by the provision (Dickson, 2011).

2.13 Environmental Management System in the Construction Industry

The Environmental Management Act (EMA) provides a more flexible authorization framework, increases enforcement options and uses modern environmental management tools to protect human health and the quality of water, land and air in Ghana. EMA also enables the use of administrative penalties, informational orders and economic instruments to assist in achieving compliance (Yalley *et al.*, 2013). The Environmental Management Act, Ghana requires by law that, any activities taken under Agriculture, Energy, Forestry and wildlife, General construction and services, Health, Manufacturing industry, Mining, Tourism and Transportation sectors conduct Environmental Assessment. Also any undertaking approved for development, by the EPA is required to submit an Annual Environmental Report (AER), Environmental Management Plans (EMPs) and Environmental Impact Statements (EISs).

Management of any undertaking in the above mentioned sectors is required to conduct periodic, systematic and objective evaluation to assess the environmental effectiveness of the operational and management systems of that undertaking. The management of the undertaking may appoint an independent expert to conduct the audit in order to be fully informed of the true status of the environmental management programme in place. However, the EPA is charged with the responsibility to conduct its own audit termed

"Compliance Audit", to verify and inform itself about the compliance status of an undertaking (Yalley *et al.,* 2013).

The widespread introduction of formal environmental management systems into the practices of businesses that affect the environment offers a unique opportunity to observe both the processes, the environmental and economic consequences of these initiatives, andto compare similarities and differences across different firms, sectors, sizes, and other characteristics. From a public policy perspective, environmental management systems offer an unusual opportunity to look at the achievement of environmental and economic objectives through the eyes of the businesses whose actions are critical to those outcomes, rather than merely through the perspective of government agencies. At the same time, environmental management systems should also shed light directly on environmental policy questions such as the practical issues involved in improving regulatory compliance, environmental performance, and cost effectiveness in monitoring, reporting, and other issues (Famiyeh, 2005).

Environmental Management System (EMS) has recently been advocated for most economic sectors. Construction, one of the pollution generators creating destruction to the environment, is by no means exempted from EMS. However, in implementing EMS, the greatest obstacle found is the lack of objective performance evaluation criteria. To overcome this, Environmental Performance Assessment (EPA) is introduced to assess environmental performance, which however is not popularly adopted in the construction industry. Therefore, EPA can help improving and predicting environmental performance of an organization (Tam & Le, 2007).

2.14 Impacts of Recycle and Re-use of Potential Waste Materials on the environment as a Result of Constructional Activities

Recycling not only provides economic benefits but also offers environmental benefits by reducing reliance on virgin materials. Such programs can reduce pollution, save energy, mitigate global climate change, and reduce pressures on biodiversity. Reusing items delays or sometimes avoid that item's entry in the waste collection and disposal system. Source reduction coupled with reuse can help reduce waste handling and disposal costs, by avoiding the cost of recycling, municipal composting, land filling and combustion (Visvanathan & Norbu, 2006).

A study by Koletnik *et al.* (2012) has evaluated the environmental performance of the repair/maintenance of public road service at the Nigrad company, Slovenia, using a life cycle approach. The results suggest that the service provided has the most significant environmental impacts on human toxicity (HT), followed by acidification potential (AP), and global warming potential (GWP). The main contributor to all the impacts is a process of road construction, followed bywaste processing, and demolition of a road. In order to reduce overall environmental impacts, various improvement options for the road construction as well as for the waste processing can be considered, such as re-usage and re-construction of materials that can be integrated into road systems, remanufacturing of excavation materials (e.g. gravel), and re-usage of old asphalts. Another possibility to reduce the environmental impacts of the serviceprovided by the company could be establishment of an efficient system of waste management, assurance of control and inventory, evidence of subjects in a “construction waste supply chain” (Koletnik *et al.*, 2012).

2.15 Policies and Strategies to enhance Construction waste Recycling and Re-use

Construction waste must be considered as a specific individual type of waste associated with the building and construction industry. It is important that the management and handling of waste is carried out by the industry itself. Generally, the building and construction industry is relatively conservative, and changes in normal procedures often take time and need long-term policies and strategies (Lauritzen, 2005). One of the most important barriers is the many different interests in building waste. Usually it is the environmental politicians, departments and public offices who prepare the policies and issues concerning waste recycling and reduction, whereas the building and construction industry is controlled by laws, departments and offices concerned with housing, construction and public works. To co-ordinate the interests of all parties, particularly with respect to the implementation of cleaner technologies in industry, it is necessary that longterm policies and strategies should first have been prepared and implemented. Danish experience in this field has led to the recommendation that long-term strategies, e.g. for 10 years with respect to achieving goals for the recycling of C&D waste, should be adopted. These must then be continuously revised in accordance with the political situation, and followed up by adequate legislation and regulation at all levels - national, regional and local (Lauritzen, 2005).

In order to achieve the maximum benefit of recycling a management system must be established on a project basis in relation to a specific construction project, e.g. urban development master plan, or on a permanent basis in relation to long-term municipal and construction waste management system. The Integrated Resource Management System comprising environmentally and economically balanced management of the following elements:

- Demolition (selective demolition)
- Recycling, reuse recovery
- Handling of hazardous C&D waste materials and non-recyclable materials
- Transportation
- Substituting (saving) natural resources

A presumption of the success of the Integrated Resource Management System is that an effective co-operation between all stakeholders/decision makers has been established in order to avoid conflict of interests. Conflicts between recycling companies and raw materials companies, for example, could prevent all initiatives towards recycling in general. The Integrated Resource Management can be implemented according to normal routines of project management in the construction industry, e.g.:

- Final Report. Descriptive document about the development and findings of the specific work packages and the project in general.
- National policies (legal and fiscal instruments)
- Regional strategies (control of C&D streams, stationary or mobile recycling plants)
- Concepts (high versus low value recycling)
- Feasibility studies (specific proposals for recycling)
- Computer optimisation (e.g. waste-resource streams and economic models)
- Master planning
- Design
- Supervision
- Quality & environmental management

The opportunities for recycling and integrated resource management depend on the size and the time frame of the project. In bigger projects, such as

- development of old industry sites, hospitals, airports, etc.
- reconstruction after disasters and wars
- urban renewal and development of cities

recycling of concrete and other building materials must be considered careful (Lauritzen, 2005).

Government should formulate and implement policy for management of waste from construction and other industries. It should clearly set out goals for recycling of waste as a means of reducing pollution and conserving valuable resources. The present framework for disposal of waste needs to be strengthened and improved. In this approach, all the demolition and construction wastes have to be accounted in terms of re-use, recycling and disposal. Such an elaborate system can be developed and implemented in two steps. In the short term, requirement of applying for permission for demolition process with mandatory requirement to provide details of the projected quantities, types and disposal routes can be introduced. In the long term, along with permission for demolition, commitment of segregation of constituents of waste and recycling should be submitted (TIFAC, 2009).

The waste from Construction Industry can be used in this plant for making recycled aggregates. Charges should be imposed on disposal of construction waste to landfill site. This is to induce the builders/ owners to divert the waste to recycling. Municipal Corporation Authorities of Metropolitan Cities should take up this work under guidance of agency, which has put up the pilot plant. If necessary, assistance from foreign consultants/ experts may also be taken (TIFAC, 2009).

CHAPTER THREE

METHODOLOGY

3.1 Introduction

Chapter three of this study presents methods and strategies used for the survey. This includes the research design, population, sample size, sampling techniques, and sources of data, data collection tools and procedure, pilot study and data analysis.

3.2 Research Design

The research design refers to the overall strategy that one chooses to integrate the different components of the study in a coherent and logical way, thereby, ensuring that one will effectively address the research problem; it constitutes the blueprint for the collection, measurement, and analysis of data. A research problem determines the type of design one can use, not the other way around (De Vaus, 2001 as in University of California, 2013). The researcher employed triangulation technique to deal with issues understudy. The triangulation made it possible for the researcher to use more than one method to collect data on the same topic understudy. The mixed approach that consists of both quantitative and qualitative techniques were employed in handling the study.

The purpose was not to cross-validate data but bring detail understanding of issues under scrutiny. The researcher randomly selected contractors of the construction industry in two regions, namely Ashanti and Greater Accra. Additionally, key officials of Architects Registration Council of Ghana (ARCG) and the Environmental Protection Agency (EPA) were interviewed. This was because officials of EPA are the most suitable source of information since they are the enforcers and monitors of environmental protection act (Yalley *et al.,* 2013). Also, the Architects are to respond on issues related to design environment and sustainable construction in the country. Administered questionnaires, observations and interviews were used in the data gathering. The data comprised primary data generated as a result of the administered questionnaires, interviews and the observations on site. The quantitative and qualitative analysis are centred on the primary data collected. The secondary source include reports on causes and effects of construction activities on the environment and materials reuse and recycling. The data were analysed by using Statistical Package for Social Sciences. The researcher adopted several comprehensive methods to collect data and analyse them in an appropriate way so that it can be easily communicated. Ethical issues concerning the construction firms selected for the sample size were strictly adhered.

3.3 Population

According to Castillo (2009), all individuals or objects within a certain population usually have a common, binding characteristic or trait. A research population is also known as a well-defined collection of individuals or objects known to have similar characteristics. The targeted population for the study consists of contractors, architects personnel from Environmental Protection Agency (EPA) in the Ashanti and Greater Accra Regions. They included the Association of Building and Civil Engineering Contractors of Ghana (ABCECG) in the two regions (460) and the Architects Registration Council of Ghana (ARCG). The Association of Building and Civil Engineering Contractors of Ghana, hold a total membership of 1500 contractors in the country (ABCECG, 2013). The selected two regions host many of the reputable construction companies operating in the country. The major cities in these regions are their administrative capitals, and for that matter, Kumasi has been chosen for Ashanti region and Accra for the Greater Accra region. These cities were chosen based on their geographical locations, population, commercial, and construction activities booming in these cities.

3.4 Sampling Technique

Sampling can be defined as the process of selecting representative units of a population for the study in research investigation. The objective of the sampling is to provide a practical means of enabling the data collection and processing (Al-Shorafa, 2009). There are two types of sampling techniques namely; probability sampling and non-probability sampling (Sekaran, 2000). These two types of sampling techniques are applied to both the qualitative and quantitative aspects of this research. In probability sampling, there is an opportunity or chance for every element of the population that is being selected and non-probability sampling, there is no such predetermined opportunity for being selected as an object in the sample. Without any doubt, a sample should represent all properties of the population. Stratified sampling technique was adopted in selecting the number of contractors from the two regions. In the first place, the total number of registered contractors in Ghana was ascertained been 1500. A total of 460 contractors representing that of Ashanti and Greater Accra Regions were also ascertained and the participants were selected randomly based on Nwana (1992) formular for dertermining sample size.

3.5 Sample Size

Whilst the qualitative (the interview) aspect of the study is applied to personnel of EPA and ARCG, with the application of snow ball sampling due to the nature of their job. The survey questionnaire was meant for the contractors in two regions randomly selected, with the sample size of contractors determined by the Nwana (1992) sample size calculation which states that to achive a credible sample size, 40% of participants can be used for population in few hundreds, 20% for more hundreds, 10% for few thounsand and 5% for many thousands. Hence the number of questionnaire items administered was determined and constituted 184 out of which 129 responded.

3.6 Source of Data

Data was gathered for this study from two crucial sources being both primary data and secondary sources. With regards to the primary data, responses gathered from the interviews conducted, questionnaires and personal observations serve its basis. The secondary data were captured from reports on materials re-use and recycle by the various construction firms and the EPA.

3.7 Data Collection tools and Procedure

Questionnaires, structured interviews and observation were used to gather data for the study. The interviews were devised through the literature review having in mind the nature and characteristics of the population.

3.7.1 Questionnaire

Survey questionnaires was used for the gathering of data. It was prepared for contractors who are members of Association of Building and Civil Engineering Contractors in Ghana. One hundred and eighty four (184) questionnaire were distributed to contractors. As said earlier, the questions are such that it contains elements to unravel construction activities impact on the environment, construction materials reuse and recycling and their impact on sustainable environment in the construction industry in Ghana. Details of the questionnaire are presented in (Appendix A).

3.7.2 Interview Schedule

The researcher used structured type of interview to collect data from officials from EPA and ARCG. This was used because most of these officers in this groupings scarcely stay in their various offices, attending meetings and travelling across the length and breadth of the country. This would not make it easy for them to answer questionnaires, but interview was suitable. The second factor is the unreliability of retrieving questionnaires if asked to administer due to the busy schedule of their office work.

3.7.3 Pilot-Test of Questionnaires

A pilot-test of survey questionnaire of this research is deemed important. The test is conducted to obtain feedback from practitioners in the industry. The pilot-test served largely to; 1) test the relevance of the constructs in Ghanaian construction context, 2) identify further constructs not captured from the secondary source (literature review), 3) to test the clarity and relevance of the questions, 4) modify the look and feel of the questionnaires and 5) to explore ways of improving the questionnaires appeal and response rate. The questionnaires were pre-tested by five Mphil. students, Construction option. Response revealed the need to improve the clarity of a few questions. Part of the feedback received from the pre-test was the need to add "Neutral" or "Not sure" to the four point rating system to five point rating scale. This was to avoid any guesses from the participants who might not be clear about the question or not having the background knowledge of some particular constraints.

3.7.4 Pilot-Test of Structured Interview Material

In like manner, the survey questionnaires were effectively dealt with to ensure its validity and reliability, the same test on questionnaires covered and affected structured interview as well. It's all because the interview is a subset of the actual questionnaires, and most of the areas covered in the interview are taken from the questionnaires. For that matter, there is no need repeating a test on the interview items.

3.8 Validity and Reliability

This part presents tests of reliability of questionnaire according to the pilot study. One of the most commonly used indicators of internal consistency is Cronbach's alpha coefficient. According to Hair et al. (2010) and Straubs et al. (2004), the Cronbach alpha coefficient of a scale should be 0.7 or above. In the current study, the Cronbach alpha coefficient was 0.978, indicating that the research instrument has high reliability, graded excellent. The reliability of an instrument is the level of consistency which measures the attribute it is supposed to be measuring (Polit & Hunger, 1985). The less variation an instrument produces in repeated measurements of an attribute, the higher its reliability. Reliability can be equated with the stability, consistency, or dependability of a measuring instrument. The test is repeated to the same sample of people on two times and then compares the scores obtained by computing a reliability coefficient (Polit& Hunger, 1985). Chronbach's coefficient alpha (George and Mallery, 2003) is designed as a measure of internal consistency, and asked, do all items within the instrument measure the same thing? The normal range of Chronbach's coefficient alpha value is between0.0 and + 1.0. The closer the Alpha to 1, the greater the internal consistency of items in the instrument being assumed. As the number of items (variables) in the scale increases, the value becomes large. Also, if the inter correlation between items is large, the corresponding will also be large. Since the alpha value is inflated by a large number of variables then there is no set interpretation as to what is an acceptable alpha value. A rule of thumb that applies to most situations is:

$0.9 \leq \propto \leq 1.0$ = Excellent

$0.8 \leq \propto 0.9$ = Good

$0.7 \leq \propto 0.8$ = Acceptable

$0.6 \leq \propto 0.7$ = Questionable

$0.5 \leq \propto 0.6$ = Poor

$0.0 \leq \propto 0.5$ = Unacceptable.

3.9 Data analysis

In the case of this study, the use of descriptive statistics that concerns the presentation of facts as they are without necessarily going beyond its existence was adopted. In view of this, the results obtained were presented per the outcome without any other additions or omissions. This facilitated the discussion of the study. To ensure effective, accurate, consistency and reliable results, data were thoroughly checked for possible errors and corrected before making the final presentation of the findings in the form of tables, graphs and charts.

CHAPTER FOUR

PRESENTATION OF RESULTS

4.0 Introduction

The Chapter Four of this study deals with the presentation of results from the collected data. The results were made possible due to the use of SPSS. It contains demographic characteristics of respondents of the study and critical issues the study sought to achieve which include challenges facing the practice of effective construction activities; construction materials that can be re-used and recycled, sustainable construction architectural practices; placing the scenario of re-use, recycle and repair in levels; planning by recycling and reusing construction materials, management of waste from construction industry; impact of construction activities on the environment; impact of recycle and re-use of potential waste materials on the environment as a result of construction activities and construction recycling /reuse best practices. The results were presented using descriptive statistics in the form of Percentages, Mean scores, Relative Importance Index (RII) and Ranking.

4.1 Demographic Characteristics of the Respondents

From the study, respondents' demographic characteristics include their gender, age, educational background, nationality and number of years served in the construction industry (Ghana). It was found that out of 184 contractors selected for the study, 129 responded to the questionnaires. This gives a response rate of 70%.

4.1.1 Gender of Respondents

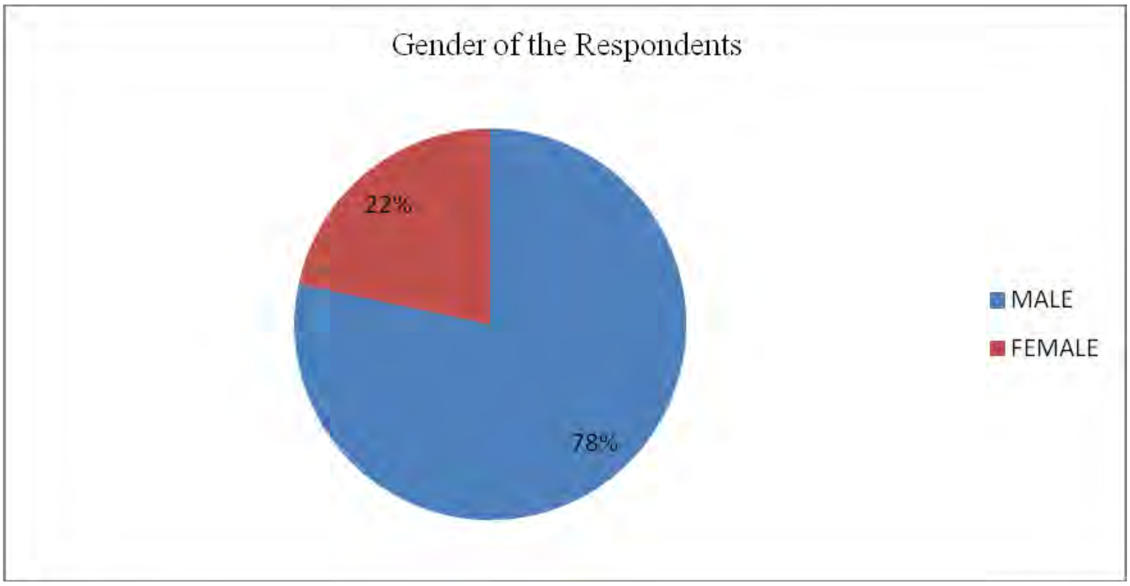

Figure 4.1: Gender characteristic of the respondents

Source: Field survey, 2004.

The construction industry is dominated by both opposite sex in its activities depending on the nature of work one does. From the results, it was presented in Figure 4.1 that male contractors accounted for 78% whiles female contractors composed of 22%. The results shows that there are more registered male contractors in both Ashanti and Greater Accra regions than females.

4.1.2 Age of Respondents

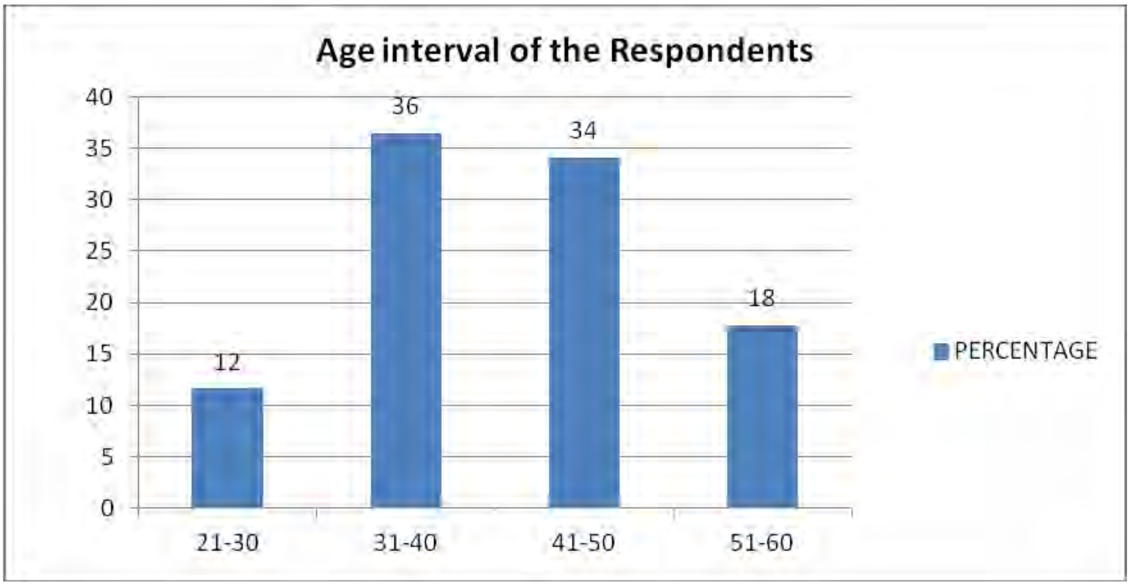

Figure 4.2: Status of the respondents

Source: Field survey, 2004.

The study probed further to know the age interval of contractors who responded to the study. The responses indicate majority of contractors are within 31-40years and constituted 36%. This was followed by contractors at the age of 41-50years who obtained 34% as well as those within the ages of 51-60years and 21-30years who represented 18% and 12% respectively. The results imply that majority of contractors who responded to the study were in their youthful ages.

4.1.3 Number of Years served in the construction firms

Figure 4.3: Respondents years served in the Construction Industry

Source: Field survey, 2004.

Ascertaining the number of years contractors have served in the construction industry was crucial to the study in the quest to know their level of experience on their job and its impact on relevant issues such as materials reuse and recycle in construction firms. It was evidenced in Figure 4.3 that majority of contractors who responded to the questionnaires had served for 11-15years and constituted 35%. It was found that 21% of contractors had been in the industry for 16-20years. This was followed by some contractors (20%) who emphasised that they have served for 6-10years. Moreover, 15% were found to have been in the industry for 21-25years. Some of the contractors (9%) indicated they have served for 1-5years. The result implies that majority of contractors of the study had some considerable high level of experience in the industry and are conversant with the purpose of the study.

4.1.4 Educational background of Respondents

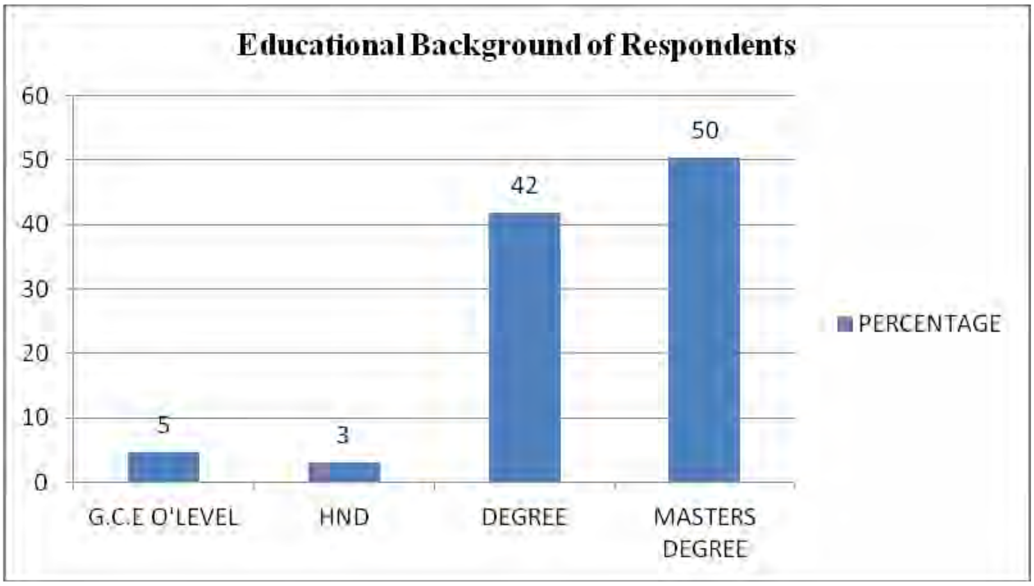

Figure 4.4: Educational background of the respondents

Source: Field survey, 2004.

It was appropriate to know the educational background of contractors who responded to the study. As shown in Figure 4.4, majority of contractors were masters' degree holders with 50% been half of the totality of the entire sample who responded to the study. Second to this was those with bachelor's degree from various academic disciplines who constituted 42% . It was also shown that 5% and 3% held G.C.E O' level and HND respectively. This gives an indication that majority of the respondents had attained higher level of formal education.

4.1.5 Nationality of Respondents

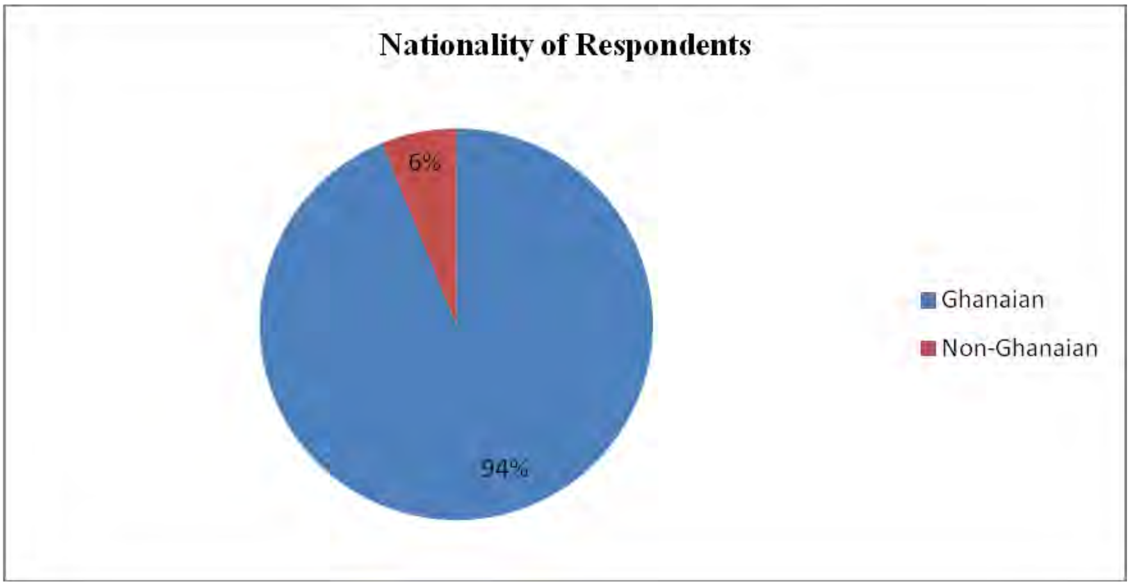

Figure 4.5:Nationality of the respondents

Source: Field survey, 2004.

In the quest to ascertain the demographic characteristics of the respondents, the nationality of them were ascertained. The results from Figure 4.5 shows that 94% of the contractors were Ghanaians and 6% been Non-Ghanaians.

4.2 Challenges facing the practice of construction activities by firms towards materials recycling and reuse

Table 4.1: Challenges facing the practice of construction activities towards materials recycling and reuse in Ashanti and Greater Accra Regions

Statement	1	2	3	4	5	∑W	Mean	RII	Ranking
Lack of specific enforcement of the Environmental Protection Agency Act in the construction industry	22	13	2	50	42	464	3.57	0.071	2nd
Lack of frequent visits by the EPA to building construction sites	9	7	4	64	45	516	4.00	0.062	5th
General apathy of the local people towards a progressive attitudinal and behavioural change	19	23	3	37	47	457	3.54	0.075	1st
The low levels of education of the local people	25	20	3	29	52	450	3.48	0.067	3rd
Lack of managerial experience	9	15	2	43	60	517	4.01	0.066	4th
Poor communication among teams	20	7	5	39	58	495	3.83	0.066	4th

Source: Field survey, 2014

Key: Where X= Weighted Mean, 5= Strongly Agree, 4=Agree, 3=Not sure, 2= Disagree, 1=Strongly disagree. Where 1-1.5= Strongly disagree, 1.6-2.5=Disagree, 2.6-3.5=Agree and 3.5-4.0= Strongly agree and RII= Relative Importance Index

As evidenced in Table 4.1, the respondents enumerated their views on challenges facing the practices of effective construction activities. It was indicated by majority of respondents that lack of managerial experience on the part of contractors, supervisors and consultants in the construction firms in relation to judicious use of materials on site. This assertion was supported with a mean score of 4.01.

In addition to this, lack of frequent visits by the EPA to building construction sites (mean=4.00) was found to be another challenging factor that hinder progress of construction firms. It was stressed by majority of respondents that poor communication among teams does not improve activities of construction firms (mean=3.83). Poor communication among parties does not ensure sustained harmonious relations among employees on site and that of management. Some respondents indicated lack of specific enforcement of the Environmental Protection Agency Act in construction firms' activities has increased the rate of poor practices among firms (mean= 3.57). This is because when checks and controls are not effectively put in place to monitor the activities of construction firms, they sometimes operate with less environmental sustainability measures. One of the overwhelming issues that confronts construction firms in their operations were indicated by sections of respondents to be general apathy of the local people towards a progressive attitudinal and behavioural change (mean= 3.54). This was followed by assertion that the low levels of education of the local people contributes to enormous challenges confronting the firms.

4.3 Construction materials that can be Re-used, Recycled

Table 4.2: Construction materials that can be Re-used, Recycled in Ashanti and Greater Accra Regions

Factor	1	2	3	4	5	Mean	∑W	RII	Ranking
Metal	16	20	3	45	45	3.64	470	0.080	1st
Limestone	12	19	4	27	67	3.91	505	0.058	7th
Asphalt Paving	10	14	2	35	68	4.06	524	0.059	6th
Wood	22	12	4	48	43	3.60	465	0.075	3rd
Asphalt Shingles	18	25	3	54	29	3.39	441	0.063	5th
Plastic	9	21	2	40	57	3.89	502	0.068	4th
Tile, Concrete, Rock and Dirt	26	15	5	37	46	3.48	449	0.075	3rd
Lunch Refuse	58	34	8	25	4	2.09	270	0.036	8th
Paper	31	10	3	44	41	3.41	441	0.077	2nd

Source: Field survey, 2014

The researcher probed further to ascertain the views of the respondents in connection to materials which can be recycled and reused. As established in Table 4.2, it was clear that metals were indicated as the most material which be easily recycled and reused on site (RII=0.080). Next to metals was paper (RII=0.077). Wood was also indicated to be the third material that can easily be recycled and reused and this was backed by RII of 0.075. Others include materials such as plastic (RII=0.068), Asphalt Shingles (RII=0.063), Tile, Concrete, Rock and Dirt (RII=0.075) and limestone (RII=0.058). However, it was evidenced that majority of the respondents rejected the claim that lunch refuse can be recycled and reused.

4.4 Sustainable architectural practices

Table 4.3: Sustainable architectural practices in Ashanti and Greater Accra Regions

Factor	1	2	3	4	Mean	∑W	RII	Ranking
Minimise pollution of air, soil and water	8	33	42	46	2.97	384	0.064	1st
Maximise health, safety and comfort of building users	32	21	44	32	2.58	334	0.058	3rd
Minimise new resources	45	19	28	37	2.44	315	0.054	4th
Respect for users	22	16	36	55	2.96	382	0.053	5th
Pursue quality in creating the built environment	18	25	47	39	2.82	365	0.060	2nd
Maintain and restore biodiversity	11	20	64	34	2.93	379	0.045	8th
Minimise the consumption of resources	41	37	31	26	2.41	312	0.058	3rd
Conserving energy	9	13	45	62	3.24	418	0.052	6th
Working with climate	11	23	41	54	3.06	376	0.053	5th
Increase awareness of environmental issues	20	15	50	44	2.91	376	0.058	3rd
Respect for site and users	10	19	38	62	3.17	410	0.051	7th

Source: Field survey, 2014

Where X= Weighted Mean, 4= Very important, 3=Important, 2= Quite important, 1=Not Important. Where 1-1.5= Not Important, 1.6-2.5=Quite important, 2.6-3.5=Important and 3.5-4.0= Very important

It was shown in Table 4.3 that ways of ensuring sustainable architectural practices among construction firms in Ashanti and Greater Accra Regions. The results indicate minimisation of air pollution, soil and water was a key factor in sustaining the environment (RII=0.064). Next to this is by pursuing quality in creating the built environment (RII=0.060). Majority of respondents agreed on the need to maximise health, safety and comfort of building users (RII=0.058). Having respect for users and site were overwhelmingly agreed by vast number of respondents (RII=0.051). Awareness creations on the need to protect the environment as well as maintaining biodiversity were essential in sustaining architectural practices in the two regions. Some of respondents agreed that minimising the consumption of resources and new resources are crucial to sustaining architectural practices in the construction industry.

4.5 Planning by recycling and reusing construction materials

Table 4.4: Planning by recycling and reusing construction materials in Ashanti and Greater Accra Regions

Statement	1	2	3	4	Mean	∑W	RII	Ranking
Keep track of what is being done	33	16	46	34	2.62	339	0.0190	3rd
Managing waste requires the engagement of all of your trades people	12	32	61	24	2.56	355	0.0150	5th
What one plan to sell from the demolition process requires a lay down area just like new materials	43	27	39	20	1.96	294	0.0194	2nd
The best place to recycle and reuse demolition material is on job site	17	25	55	32	2.79	360	0.0169	4th
Survey what is in the building and develop an inventory of materials that can be sold to recycling companies or can be reused	52	38	30	9	1.96	254	0.0218	1st

Source: Field survey, 2014

As evidenced in Table 4.4, the opinions of respondents in relation to planning by recycling and reusing construction materials in Ashanti and Greater Accra Regions are presented. The results show that to plan effectively, construction firms survey what is in the building and develop an inventory of materials that can be sold to recycling companies or can be reused (RII=0.0218). Moreover, emphasis should be placed on construction firms plan to sell from the demolition process requires a lay down area just like new materials (RII=0.0194). In ensuring proper planning of recycling by construction firms, keeping track of what is done is essential to promoting good outcome. Some of respondents asserted that managing waste entails engaging all trades people and the best place to recycle materials should be done on site.

4.6 Management of waste from construction industry

Table 4.5: Management of waste from construction industry in Ashanti and Greater Accra Regions

Factor	1	2	3	4	Mean	∑W	RII	Ranking
Re-use of materials salvaged in good condition during demolition	13	18	60	38	2.95	381	0.0194	1st
All metal items are sent for re-melting through scrap dealers	22	31	51	25	2.61	337	0.0170	2nd
Disposal of other items to low lying	38	54	29	8	2.05	265	0.0164	3rd

Source: Field survey, 2014

`The respondents were probed further to know how management of waste from construction industry should be done. Responses shown in Table 4.5 indicate most respondents were content with assertion that re-use of materials salvaged in good condition during demolition was needed in ensuring effective management of waste (RII=0.0194). Melting of metals through scrap dealers was found to be a common practice in the quest to ensure waste management control by constructions but majority of respondents were not in tune with the issue of disposal of other items to low lying (RII=0.0164).

4.7 Impacts on the Environment due to Construction Activities in Ghana

Table 4.6: Impacts on the Environment due to Construction Activities in Ashanti and Greater Accra Regions

Statement	1	2	3	4	5	Mean	∑W	RII	Ranking
Ecosystem and soil degradation	8	10	2	58	51	4.03	521	0.0158	5th
Nuisances (e.g. noise, airborne dust, vibrations, traffic)	15	19	4	45	46	4.01	475	0.0160	3rd
Health risks	6	11	2	56	54	4.09	528	0.0171	2nd
Risks of accidents may arise during construction activities.	21	14	4	39	51	3.65	472	0.0143	7th
Pollution (soil, water, air) and human health sensitivities may arise, depending on the building's operational activities	10	18	3	50	48	3.83	495	0.0159	4th
Increased runoff and flooding	36	25	2	42	24	2.94	380	0.0175	1st
Land use conflicts are a growing threat to the environment in Ghana	31	27	3	44	24	3.02	390	0.0151	6th

Source: Field survey, 2014

Table 4.6 presents the impact on environment due to construction activities. The study revealed that the activities of construction firms lead to health risks (RII= 0.0171). It was also revealed that construction activities leads to pollution (soil, water, air) and human health sensitivities may arise, depending on the building's operational activities (RII= 0.0159). Construction activities were found to have led to risks of accidents (RII= 0.0143). The study also found that operational activities of construction firms have increased runoff and flooding (RII= 0.0151) and majority of them also agreed that noise, airborne dust, vibrations, traffic arises out of construction activities.

4.8 Impacts of Recycle and Re-Use of Potential Waste Materials on the Environment as aresult of Constructional Activities

Table 4.7: Impacts of Recycle and Re-Use of Potential Waste Materials on the Environment as aresult of Constructional Activities

Statement	1	2	3	4	5	Mean	∑W	RII	Ranking
Recycling not only provides economic benefits but also offers environmental benefits by reducing reliance on virgin materials.	8	14	2	56	49	3.96	511	0.0161	1st
Such programs can reduce pollution, save energy, mitigate global climate change, and reduce pressures on biodiversity.	12	19	4	61	33	3.65	471	0.0149	2nd
Reusing items delays or sometimes avoid that item's entry in the waste collection and disposal system	20	24	9	46	30	3.32	567	0.0136	3rd
Reuse can help reduce waste handling and disposal costs	18	21	4	38	48	3.59	464	0.0149	2nd
Waste minimisation is economically feasible and also plays an important role for the improvement of environmental management.	6	13	2	58	50	4.03	520	0.0161	1st
Economic instruments for minimisingconstructionwaste can be used to raise revenue for environmental policy, encourage prevention efforts, serve to discourage the least desirable disposal practices	19	6	6	47	51	3.81	492	0.0149	2nd

Source: Field survey, 2014

The results presented in Table 4.7 shows that recycling not only provides economic benefits but also offers environmental benefits by reducing reliance on virgin materials (RII= 0.0161). Majority of respondents agreed that waste minimisation is economically feasible and also plays an important role for the improvement of environmental management (RII= 0.0161). Moreover, it was agreed by number of respondents on assertion that economic instruments for minimising construction waste can be used to raise revenue for environmental policy, encourage prevention efforts, serve to discourage the least desirable disposal practices (RII= 0.0149). Recycling not only provides economic benefits but also offers environmental benefits by reducing reliance on virgin materials (3.96) and such programs can reduce pollution, save energy, mitigate global climate change, and reduce pressures on biodiversity (RII=0.0161).

CHAPTER FIVE

DISCUSSION OF RESULTS

5.1 Inroduction

Chapter five of this study presents discussion of results. The discussions are done in accordance with objectives of the study. The findings are compared to earlier works conducted by other authors to ascertain whether results support or reject earlier outcomes or assertions.

5.2 Gender of Respondents

The results indicate that construction firms in both Kumasi and Greater Accra have attracted more males than females based on the responses had on gender. Contractors selected for the study were mostly males but there was no significant determinant factor which suggests that being a contractor was influenced by a person's gender. It appears that it depends on interest developed in the profession or work and that is purely on personal choices and capability.

5.3 Age of Respondents

The response in Figure 4.2 imply majority of contractors who responded to the study were in their youthful ages. Moreover, there was no correlation between a person's age and being a contractor. Therefore emphasis cannot be placed on the assertion that a contractor who has not attained certain ages cannot handled issues with materials recycle and reuse in construction firms.

5.4 Number of years contractors have served in the construction industry

The results as shown in Figure 4.3 portrays majority of respondents (71%) have had enough experience as being contractors and therefore may be conversant and familiar with material recycle and reuse in the construction industry. Contrary to earlier findings on gender and age of respondents, it was found that most contractors who have had enough experience on the job were quite familiar and conversant with issues of recycle and reuse of materials. Thus it was stressed by majority of respondents that experience was much needed in understanding how and what materials can be recycled and reused by construction firms even though there may be few exceptions.

5.5 Educational background of respondents

From Figure 4.4, it appears majority of contractors who took part in the study had attained various degrees. Even though the results indicate majority of contractors of the study had attained high level of education, there was no scientific proof to emphasis been a contractor can be influenced by ones educational background. This is because, contractors are sometimes given contracts based on favouritism, political affiliations and other nepotism that have been silent in Ghanaian culture but plays key roles in the award of contracts to people even though people do not talk about it boldly in these context.

5.6 Nationality of Respondents

The results in Figure 4.5 suggests majority of contractors who responded to the study are Ghanaians. Again, there was no correlation between a person's nationality and the conception of material recycle and reuse in the construction industry.

5.7 Challenges facing the practice of construction activities towards materials recycling and reuse

It was presented in Table 4.1 challenges facing practice of effective construction activities in both Ashanti and Greater Accra Regions. As evidenced in the results, majority of contractors indicated lack of managerial experience of contractors, consultants, management and supervisors on construction projects have led to the deterioration of effective implementation of good construction practices. In experienced managerial capability of key stakeholders in the construction industry do not yield fruitful and greater efficiency in the system. Poor managerial practices by stakeholders such as contractors, consultants and supervisors do not ensure increase in the performance of workers and productivity as a whole. In view of this, poor management practices cannot enhance the quality of material recycling and reuse due to the assertion that requisite technical knowhow may be lacked on the part of management and supervisors. Ofori (2012) in his submission reiterated that, one of the problems related to environmental management has to do with lack of managerial expertise and experience by stakeholders in the construction industry of Ghana.

It was overwhelmingly agreed by majority of contractors that lack of frequent visits by EPA to building construction sites have been a major problem hindering the quest to achieve environmental sustainability in Greater Accra and Kumasi respectively. It has been acknowledged by several stakeholders in the construction industry that degradation of environment due to construction activities have been prominent due to the habit of EPA not performing its role effectively in responding to environmental related issues. Officials from EPA who are mandated to enforce laws governing environmental protection do not carry out their mandate effectively. Some blame their inability to execute their duties adequately on failure by government to resource them properly to carry out their talks. Lack of logistics and financial constraints do not facilitate activities of the agency. In some cases, the employees in these sectors are very few to undertake operational activities and this is compounded with issues of lack of expertise on the part of employees of EPA and in some cases poor training given to them to enhance their skills and capability in executing their mandate. In a related study by Yalley et al. (2013), the authors concluded that lack of frequent visits by the EPA to building construction sites was among factors hindering environmental management in Ghanaian construction industry.

Effective communication is essential to the success of any firm since effective utilisation of information is crucial to the development of firms in achieving their goals and objectives. In the absence of good communication channels in firms, it makes dissemination of information very difficult and workers tend to feed on rumours which are mostly dangerous to firm successes. Poor communication among teams at the workplace are usually brought as a result of hostility. Lack of harmonious relationships among employees and their superiors yield bad interpersonal relations. Majority of contractors who responded to the study affirmed that poor communication among team and all workers in general affect the performance and productivity of construction firms. Employees and management as well as contractors need peaceful working atmosphere to operate effectively.

Poor communication are caused by conflicts and it jeopardises the congenial atmosphere within which activities are conducted on site. Poor communication delays sharing of appropriate and need information among workers for enhancing continuity and progress of firms activities. It has the potential of misinforming employees on right approaches towards work. It does not promote greater respect and cordialism among employees and that of their superiors. It undermines progress of construction activities and halts improvement and innovative capacity of workers towards work due to misunderstanding.

In responding to the issue of lack of specific enforcement of the EPA act in the construction industry, majority of contractors agreed on this assertion. Once again, it could be emphasised that failure by state agencies such as EPA mandated to ensure proper management of environment as a result of construction activities have continuously failed in achieving their objectives. Lack of adequate enforcement of specific acts governing environmental management sustainability has contributed to construction firms flouting the laws and imputatively operating illegally and unconsciously towards the environment. Most construction firms have not done much in ensuring their activities do not have some repercussions on lives of dwellers in societies. For instance, some construction firms do not cover or refill holes created in the course of their activities. Some of these practices does not inure to the benefit of society. The study found that some contractors have not cultivated the habit of maintaining and promoting environmental sustainability by way of minimizing and preventing pollution. It was not surprising Yalley et al (2013) concluded on the ascertain that lack of specific enforcement of EPA Act has affected the growth and sustainability of environmental management during construction projects.

The results further indicate majority of contractors who responded buttressed the view that general apathy of the local people towards a progressive attitudinal and behavioural change was a big challenge to construction firms. The unchanging habit and perpetual syndrome where it becomes difficult for people to depart from their negative attitude and behaviour towards positive construction activities is of major concern to all stakeholders in the industry. Precisely, some workers and community members have not made it a point to change their negative habit in ensuring sustainable environment creation. In some cases, lack of will by some persons to control their actions towards ensuring better environment to enhance livelihoods of posterity is completely absent. It was affirmed by some contractors that some employees and community members deliberately engage in activities tantamount to environmental degradation even though the people may be well conversant with repercussions likely to cause in the end. This posture and position of some individuals in their ambition to achieve personal gains do not care much about what happens to the environment. This finding supports the work of Horizon International (2011) which stressed on the fact that lack of will local people to change their behaviour and attitudes has not helped in promoting effective and efficient environmental management.

Moreover, it was revealed from the findings that low levels of education of the local people have contributed to poor concern for environmental management sustainability. The study found low educational levels on the need to maintain and sustain the environment despite their activities. Some contractors threw light on the assertion that lack of adequate education on environmental sustainability on the part of local people have made it extremely and fraustingly difficult for proper measures to be put in place by these people in the course of activities. This issue was hugely highlighted in the findings of Horizon International (2011) who insisted that the most serious constraint of remediation project has been low level of education of the local people. Low levels of education on the need to maintain the environment has not enhanced the activities of construction firms since the local people themselves destroys the environment by their activities before used by construction firms.

5.8 Construction materials that can be recycled and reused

As can be seen from Table 4.2, much premium was placed on metals as materials that can be easily recycled and used in Ghanaian context so far as our technological advancement of recycling is taken into consideration. Majority of contractors were of the opinion that metals were easily recycled and re-used. They cited Kumasi Magazine as a typical place where metals are recycled for various purposes. For instance, iron rods used for one thing could be melted and used for an entirely different purposes based on the specific action of construction firms. Paper was considered as the second most appropriate materials from the list which could be recycled and used on construction projects. In united states, local metal scrap dealers accept construction metal materials, melt them and make reformation to suit other metal products (United states Environmental protection agency, 2009). This attitude and practice have ensured continuous and easy accessibility of construction materials in the country.

In Greater Accra and Kumasi where the survey was conducted; paper was commonly used as means of packaging most materials such as files, cabinets, nails, cement, glass to mention a few. When these materials are removed, the discarded papers are usually wasted and disposed of without taking advantage of possible recycle and reuse. This has been immensely tagged or attributed to lack of high recycle technological advancement capacity of companies in the two regions the study was undertaken. Walther and Ulder (1993) stressed paper waste had great momentum of being potentially recycled and reused. The study revealed asphalt paving had adequate and immense potential of being recycled and reused. This was indicated by some contractors of not been prominent in Ghana but can be recycled and used especially with the construction of road networks.

Wood was one of the most prominent construction materials easily to come across on construction sites. Waste from wood used on project can be recycled and used. For instance the remains of facial board, plywood and paper can be recycled into forming chipped engineered board and much. The issue of plastic was welcomed by vast section of contractors who responded to the study. It was further emphasised that the country is of late witnessing some progress in plastic waste recycling across major cities such as Accra Kumasi, Takoradi and Tamale. These have been quite some efforts by private firms to recycle plastic waste. The study found lunch refuse to be major materials which can be recycled appropriately when due diligence and careful approach towards its collection and separation on site. Such materials usually constitute food steel food can, glass and plastic drink bottles. Even though these can be recycled for better use on construction projects, the fundamental problem with this lies on lack of needed technology to recycle them. This means that the idea is available but what is most lacking is the capital and physical logistics to undertake such activities to promote effective recycling and reuse of materials on construction sites.

5.9 Sustainable architectural practices in Ashanti and Greater Accra Region

As can be found in Table 4.3, one of the key factors which ensures sustainable architectural practices in both Greater Accra and Kumasi was to minimise pollution of air, soil and water. Emphasis was laid on this premise that quality of life depends largely on water, air and soil is essential in ensuring healthy being. In view of this construction firms which captures and use pollution control mechanism in their activities adds to developing the environment and building a healthy life for its workers and the society at large. Ayarkwa (2010) indicated construction industry exploits largely natural resources and pollutes the environment.

Since the built environmental cannot be effective without quality assurance in its work, it is incumbent on contractors and major stakeholders to enhance the quality of projects executed. In view of this, the type and quality of raw material used for projects should be highly considered coupled with right quantities. High quality materials in their right proportions used for projects sustains the lifespan of it whilst poor ones easily deteriorates the lifespan of projects and question value for money principle expected on projects.

The responses further show ways of sustainable architectural practices include maximisation of health safety and comfort of building users. The provision of adequate health and safety tools and equipments on site for workers is essential to enhancing good architectural safety. Availability of gloves, googles, helmet, jacket, boots and portable water on site to wokers ensures adequate protection of workers against possible accidents, injuries and good health. Hassanein (2013) stressed that construction activities cause health problems and in view of this recycling has been identified as best option to convert material waste into other worth materials.

The respondents (majority) alluded that increase in awareness creation of environmental issues is a right step in cultivating positive habits in educating the public on the need to maintain healthy environment through effective sustainable construction practices and is key to positive environmental management. Well informed public on environmental safety measures are likely to practice good construction activities devoid of degrading the environment. Awareness creation on environmental issues is a pre-requisite for sustainable construction activities in Greater Accra and Kumasi. Respect for users and site is also needed in the quest of achieving sustainable architectural development on site.

Having respect for site enable contractors to use appropriate measures and mechanism to achieve their purposes. It pushes and guide designers and contractors to adopt appropriate methods of construction plus ensuring safety environmental for workers and the society at large. This trend calls for effective restoration of biodiversity. Contractors and other stakeholders become successful when they execute projects by targeting the right climatic conditions fit for such exercises. For instance, it is usually not safe for heavy construction activities to take place during heavy rainfalls. Conserving energy is of immense importance to all stakeholders in the construction industry. Energy conversation saves cost and reduces overall expenditure on projects.

5.10 Planning by recycling and reusing construction materials

The respondents were probed further to ascertain their views on ways of planning by recycling and reusing construction materials. As evidenced in Table 4.5, to ensure proper planning its most appropriate for firms to survey what is in the building and develop on inventory of materials that can be sold to recycling companies or can be reused. Knowing materials which can be recycled and reused is crucial to facilitating easy separation of good materials from chuffs. Realisation of materials can be converted to other purposes was an ideal factor in pursing the journey of sustainable recycling and reusing by construction firms.

In addition to this, it was affirmed by majority of contractors who responded to the study that construction firms plain to sell from demolition process may require a well laid down area just like new materials. The waste should be properly identified, separated and counted if possible to enable construction firms know actual amount they are sell out or recycle. This indeed strengthens the level at which proper arrangements are done to ensure accurate and secure recycling contracts between construction firms and recycling companies. Well establishes waste materials on clear sites enhance accuracy in determining appropriate prices for waste materials.

Another important factor the study found during the survey was the issue of keeping track of what is being done. Proper keeping of track on activities or progress of work on site informs contractors and key stakeholders on state of materials and the need to recycle or reuse them if possible. Proper records on state of materials on site is crucial to ascertaining the type and kind that ought to be recycled and reused. However, majority of contractors rejected and disagreed on assertions that managing waste requires the engagement of all stakeholders in the construction industry and the best place to recycle and demonstration material should be in job site. For majority of them, recycle companies could be far from construction firms want to recycle their materials and yet it can still yield better results so far as appropriate measures are put in place.

5.11 Management of waste from construction firms

The responses from Table 4.6 throws high light on the issue issue that materials found to be in good shape or condition during demolition are reused. Most contractors who affirmed this were of the view that, in most cases when demolition exercises are carried out for several reasons, materials found out from demolition which deems fit for other purposes are kept and reused. For instance, bricks, wood, wire, pipes and metals especially, iron rods to mention a few. Quite a number of respondents were in support of the assertion that metal items are sent for re-melting through scrap dealers. Some contractors from Kumasi indicated usually metals of such sort are sent to Suame-Magazene where re-melting in various forms are carried out.

5.12 Impacts on the Environment due to construction activities

Table 4.7 presented issues relating to impacts on the environment due to construction activities. The results show. Construction activities such as road; and buildings had potential health risks on humans. Workers of construction firms are equally liable and prone to health risks as well as visitors. Some contractors were of the view that construction activities usually generates dust and pollutes water bodies. The dust for example was found to have caused several respiratory disorders in some workers and other related illness. This trend usually happen heavily when construction firms do not put in place effective pollution control mechanisms to contain and maintain the ripple effects of such pollutants. It was emphasised by Kralj (2008) that the construction industry has been a major consumer of materials and source of pollutions to the environment with its related health risks.

Construction activities have caused several soil and ecosystem degradation. Through the execution of projects, lands and soil are depredated from their natural state to suit the artificial standard clients and firms sets to achieve. The disturbance of this natural phenomenon on soil and land have caused the environment to lose its quality and nutrients suitable for other purposes. There have been instances according to the respondents that construction activities have led to accidents of various kinds on site. Uncovered pits have caused several injuries to some workers and visitors to some construction sites. In some extreme cases, accidents have resulted to the death of some affected victims on sites.

5.13 Impacts of Recycle and reuse of potential waste materials on the environment as a result of construction activities

Majority of waste minimisation as a result of recycle and reuse of construction materials was economically feasible and also plays an important role for the improvement of environmental management on site and dumping areas in society likely to cause havoc in terms of disease outbreaks and poor sanitation. Through effective recycling and reusing of waste materials, the possibility of having the burden to incur more cost on disposal is minimised. Waste collection has been found to be tedious and cumbersome in nature especially when dumping sites are far away from sites. The operation cost involved in dealing with such issues are usually high and uneconomically compared to that of recycling and reuse of materials.

In a similar study conducted by Visvanathan and Norbu (2006), emphasis was placed or the assertion that reuse help in waste reductions and disposal cost. It was stressed by majority of contractors and responded that in most cases, it was extremely cost effective to recycle waste materials than to prove or purchase new ones entirely. This reduces material burden cost on construction firms that sometimes frustrate contractors and clients in completing construction projects on time.

Moreover, waste handling management techniques which comes with personnel and cost in terms of salaries, training and development issues related to it can be minimised. Expertism is required in handling waste on construction site and this is usually accompanied with a cost. These are highly avoided when waste materials are recycle and reused by construction firms Construction firms generates much waste as a result of their activities and in view of this recycling and reuse has been mostly preferred. Nermin (2010) stated as concerns grow over the amount of wastes generated in the construction industry, recycling has been identified as one of the most feasible way to overcome construction wastes.

Recycling and reuse of waste materials on construction sites reduce pollution and pressure on biodervisily. Recycling ensures that waste materials are well categorised and placed in their respective types or kinds. This prevents waste materials to be scattered on site which has the potential of aiding pollution either water, air and soil. Some materials such as oil coal and cement has the potential of deteriorating the rich nutrient of soil on site. This affects the growth of plants on site when construction activities are completed. By eliminating these waste through recycling and reuse, it reliefs the risks of degrading the soil. Moreover, the likely of some materials getting into water bodies to contaminant them is also reduced. This ensures safe health for workers and visitors on site as well as society to general.

CHAPTER SIX

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

In the chapter six of this study, summary of key findings are presented in addition to conclusions drawn on the findings. Suggestions to improve recycling and material reuse among construction firms was found in this part. Suggestions for future studies is contained in this section.

6.2 Summary of Findings

The contractors who responded to the study in revealing the challenges they encounter in practicing effective construction activities in Ashanti and Greater Accra Regions agreed in the assertion that lack of specific enforcement of EPA ACT in the construction industry has caused severe damage to good practices. The failure of employees of EPA, KMA and AMA to enforce environmental safety laws have led to some construction firms practicing without recourse to the standards set. If laws are not adequately enforced, institutions and people easily get away with their wrong doings.

Lack of frequent visits by the EPA, AMA and KMA to construction sites has not improve the situation to ensure compliance of environmental safety and sustainability laws. The lack of frequent visits was attributed to lack of adequate funds to undertake such operations. For instance, inadequate vehicles and other logistics needed to carry out monitoring exercises affectively on site was questionable. This has not enhanced their activities and thereby affect their performance. The general apathy of the local people towards a progressive attitudinal and behavioural change was been a canker to development of construction sector in ensuring good environmental management. The study found that some workers and commonly members do no not mind taking the law into their own hands and executing their tasks contrary to the safety of the environment. Some are aware of the negative practices but they just continue during without any remorse. In addition to these, the study found low levels of education of the local people. Lack of managerial experience on the part of contractors have not helped in building effective idea of recycling and reuse of construction materials. Lack of the needed expertise to handled waste management was an issue with some contractors in the construction industry.

Some of the materials that can be recycled and reused were wood, paper, metals, plastics, concrete, rock and shingles. The problem lies with the easy accessibility of companies that can recycle them. The few ones normally found in Kumasi and Accra were into recycling metals, plastics and wood (see Appendix C). Major architectural practices sustainable in Accra and Kumasi were found to be having respect for users and site, maintain and restore biodiversity, minimise the consumption of resources, minimise pollution of air, soil and water, maximise health safety and conformant of building users, increase awareness of environmental issues, pursue quality in creating the built environment and conserving energy.

In order to ensure effective planning by recycling and reusing construction materials, it is appropriate to survey what is in the building and develop an inventory of materials that can be sold to recycling companies or can be reused. What out to be sold from waste materials requires a lay down area. Track must be kept on what is being done.

The activities of construction firms were found to have causal damaged to ecosystem and soil degradation, nuisances such as nose, airborne dust, vibration and traffic health risk, risks of accident, pollution (soil, water, air), increased run off and flooding and land use conflicts.

6.3 Conclusions

Controlling and managing waste has been major concern to construction firms in the course of their activities. There have been poor awareness creation on the need to recycle material waste on site by construction firms. This failure has been partly due to lack of adequate recycling companies in the two major cities in Ghana. The trend has led to most construction firms disposing waste materials which could be have been recycled and reused. State institutions such as EPA, KMA and AMA has not done well in enforcing laws on environmental sustainability taken into consideration construction projects. Materials that can be easily recycled and reused by construction firms were wood, metals, plastics, concrete, rock and plastics even though the companies in Ghana capable of recycling was out of number of unsatisfactory looking at the number of construction firms in Accra and Kumasi. Recycling of construction materials has not been effective in the Ghana context due to low education and companies to manage waste. In view of these it is appropriate to state that failure on the part of both public and private companies to venture into waste management has contributed to the lower concentration of recycling in Accra and Kumasi.

6.4 Recommendations

The study recommend the following based on the findings

- ❖ EPA must be proactive in its activities as well as that of KMA and AMA. The government should ensure that these state institutions are well equipped with necessary resources be it logistics or finances. Adequate provisions should be made on sustaining the activities of the said institutions. Adequate logistics and finance would promote patrols on construction site to monitor their activities to confirm to set standards. This would help reduce pollution to the environment and degradation as well due to construction activities.
- ❖ Adequate and effective enforcement of by-laws governing environmental management should be major concern to all stakeholders mandated to carry out such tasks. When construction firms are queried and sanctioned for flouting environmental safety laws, it would send signals for potential culprits to desist from degrading the environment. This would help sustain the quality and improvement in managing the environment. Appropriate punitive measures should be instituted to ensure that construction firms do not conduct their activities to the detriment of the environment.
- ❖ The right habit should be cultivated by both workers and the public towards environmental sustainability and safety. Workers on site should ensure that their activities do not yield negative impact onto the environment. A careful approach in handling their takes assigned to them should be maintained. his would promote the quality and sustainability of the environment despite their operations. Community or the public should play their roles effectively towards ensuring a better environment by avoiding negative practices that has the possibility of harming the environment.

- Effective awareness creation should be done on the need for materials recycling and reuse by construction firms. This would help reduce waste collection and disposal with its associated cost. When contractors are well educated on the need to recycle and reuse waste materials on site, it would serve as an economical tool to enhance saving cost on materials on projects.
- There should be frequent visits by mandated officials of EPA, KMA and AMA on construction sites to ascertain whether their activities conform to set standards.
- Government is expected to bring out policies where construction firms effectively manage their waste. This can be done to ensure clear policies on recycling of waste materials on site. Clear formulated and implemented policy on this have the potential of installing the habit of recycling in construction firms.
- The government should collaborate with private sector to create and build more recycling companies to ensure easy accessibility. Materials from these recycling companies should be affordable to attract high patronage.
- Construction firms should be efficient in collection of waste as a result of their activities. This would ensure proper waste control and management.

6.5 Suggestions for Future Studies

This study was focused on only two regions and it is expected that future studies concentrate on assessing the impact of construction materials recycling and reuse on costs of projects in Ghana.

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APPENDIX A

UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION – KUMASI CAMPUS

DEPARTMENT OF DESIGN ADN TECHNOLOGY EDUCATION

QUESTIONNAIRE FOR EXAMINING SUSTAINABLE CONSTRUCTION INDUSTRY IN GHANA: FOCUSING ON RECYCLE AND RE-USE POTENTIALS OF WASTE MATERIALS

This questionnaire is prepared by a final year Master of Philosophy (Construction Management) student to solicit information for the writing of thesis for the award of Master of Philosophy Degree from UEW-K.

Please your confidentiality is assured, so feel free to express your views.

Thank you for your participation in this survey.

SECTION A

PERSONAL-DATA

Please read and tick [√] the appropriate box

1. Gender

   [ ] [1] Male

   [ ] [2]Female

2. Age

   [ ] [1] 20- 30

   [ ] [2] 31-41

   [ ] [3] 50-60

   [ ] [4] 60+

others (specify)…………………………..

3. Level of education (highest certificate)

   [ ] [1] Basic

   [ ] [2] Senior High School

   [ ] [3] Higher National Diploma

   [ ] [4] Degree (First)

   [ ] [5] Post- Graduate

   [ ] [6] Doctorate

   [ ] [7] Illiterate

   Others (specify)………………………………………

4. Nationality

   [ ] [1] Ghanaian

   [ ] [2] Non Ghanaian

5. Type of job on site

[ ] [1] Management

[ ] [2] Supervisor/Foremen

[ ] [3] Artisan

[ ] [4] Permanent employee

[ ] [5] Contractor

[ ] [6] Engineer

[ ] [7] Architect

[ ] [8] Casual worker

Others (specify)……………………………………..

6.For how many years have you been in active business?

[ ] [1] Less than 3years

[ ] [2]3-5years

[ ] [3] above 5years

SECTION B

Challenges facing the Practice of Effective Construction Activities

Please tick [√] to indicate your level of agreement or disagreement in the following statement

NO	Statement	Strongly disagree [1]	Disagree [2]	Agree [3]	Strongly agree [4]
1	lack of specific enforcement of the Environmental Protection Agency Act in the construction				
2	lack of frequent visits by the EPA to building construction sites				
3	General apathy of the local people towards a progressive attitudinal and behavioural change.				
4	The low levels of education of the local people				
5	lack of the managerial experience				
6	The lack of will on the part of the local people to change their behaviour and attitudes				
7	Others (specify)				

Construction Materials that can be Re-used, Recycled

Please tick [√] to indicate your level of agreement or disagreement in the following statement

NO	Item	Strongly disagree [1]	Disagree [2]	Agree [3]	Strongly agree [4]
1	Wood				
2	Drywall/Gypsum				
3	Paper				
4	Metals				
5	Plastics				
6	Asphalt Shingles				
7	Asphalt Paving				
8	Masonry,Tile, Concrete, Rock, and Dirt				
9	Lunch Refuse				
10	Limestone				
11	Others(specify)				

Sustainable architectural practices

On the scale of importance provided, kindly rate the level importance of the following factors to Sustainable architectural practice

No.	STATEMENT	RESPONSES			
		Not Important	Quite Important	Important	Very Important
1	Conserving energy				
2	Working with climate				
3	Minimise new resources				
4	Respect for users				
5	Respect for site				
6	Holism				
7	Maintain and restore biodiversity				
8	Minimise the consumption of resources				
9	Minimise pollution of air, soil and water				
10	Maximise health, safety and comfort of building users				
11	Increase awareness of environmental issues				
12	Pursue quality in creating the built environment				
13	Use renewable or recyclable resources				
14	Others (specify)				

Planning by recycling and reusing construction material

On the scale of importance provided, kindly rate the level importance of the following factors to Planning by recycling and reusing construction material

No.	STATEMENT	RESPONSES			
		Not Important	Quite Important	Important	Very Important
1	Survey what is in the building and develop an inventory of materials that can be sold to recycling companies or can be reused				
2	What you plan to sell from the demolition process requires a lay down area just like new materials				
3	Managing waste requires the engagement of all of your trades people				
4	Keep track of what is being done				
5	The best place to recycle and reuse demolition material is on your job site				

Management of waste from construction industry

On the scale of importance provided, kindly rate the level importance of the following factors to management of waste from construction industry

No.	STATEMENT	RESPONSES			
		Not Important	Quite Important	Important	Very Important
1	Re-use of materials salvaged in good condition during demolition				
2	All metal items are sent for re-				

	melting through scrap dealers				
3	Disposal of other items to low lying sites				

Impacts on the Environment due to Construction Activities in Ghana

Please tick [√] to indicate your level of agreement or disagreement in the following statement

No.	Item	Strongly disagree [1]	Disagree [2]	Agree [3]	Strongly agree [4]
1	Ecosystem and soil degradation				
2	Nuisances (e.g. noise, airborne dust, vibrations, traffic)				
3	health risks				
4	Risks of accidents may arise during construction activities.				
5	Pollution (soil, water, air) and human health sensitivities may arise, depending on the building's operational activities				
6	Increased runoff and flooding				
7	Land use conflicts are a growing threat to the environment in many countries				
8	Others (specify)				

Impacts of Recycle and Re-Use of Potential Waste Materials on the Environment as a Result of Constructional Activities

Please tick [√] to indicate your level of agreement or disagreement in the following statement

No.	Statement	Strongly disagree [1]	Disagree [2]	Agree [3]	Strongly agree [4]
1	Recycling not only provides economic benefits but also offers environmental benefits by reducing reliance on virgin materials.				
2	Such programs can reduce pollution, save energy, mitigate global climate change, and reduce pressures on biodiversity.				
3	Reusing items delays or sometimes avoid that item's entry in the waste collection and disposal system				
4	reuse can help reduce waste handling and disposal costs				
5	waste minimisation is economically feasible and also plays an important role for the improvement of environmental management.				
	economic instruments for minimising construction waste can be used to raise revenue for environmental policy, encourage prevention efforts, serve to discourage the least desirable disposal practices				
	Others (specify)				

Construction recycling/reuse best practices

Please tick [√] to indicate your level of agreement or disagreement in the following statement.

No.	Statement	Strongly disagree [1]	Disagree [2]	Not sure [3]	Agree [4]	Strongly agree [5]
1	survey what is in the building and develop an inventory of materials that can be sold to recycling companies or can be reused					
2	work with the architect on what can be recaptured for reuse in the new construction.					
3	planning to sell from the demolition process requires a lay down area just like new materials					
4	managing waste requires the engagement of all of your trades people					
5	Keep track of what is being done. Having a lay down area makes this much easier					
6	Make sure to report the results to your crew					
7	The best place to recycle and reuse demolition material is on your job site.					
8	Others (specify)					

Policies and Strategies that can be adopted so that Construction waste can be Recycled and Re-used

Please tick [√] to indicate your level of agreement or disagreement in the following statement

No.	Statement	Strongly disagree [1]	Disagree [2]	Agree [3]	Strongly agree [4]
1	recommendation that long-term strategies, e.g. for 10 years with respect to achieving goals for the recycling of C&D waste, should be adopted				
2	handling of hazardous C&D waste materials and non-recyclable materials				
3	Government should formulate and implement policy for Management of waste from Construction and other Industries.				
4	It should clearly set out goals for recycling of Waste as a means of reducing pollution and conserving valuable resources				
5	Put up facility for recycling of construction and demolition waste adjacent to their landfill sites.				
	Others (specify)				

APPENDIX B

INTERVIEW GUIDE FOR EPA OFFICIALS

1. What is your educational background?..
2. How long have worked in the construction industry?..............................
3. Do you visit construction sites to enforce EPA laws? Yes [ ] No [ ]
4. How often do you carry out site visit on sustainable practices by construction firms………………………………………………………………….
5. What are some of the challenges to your work?....................................
6. What are the impact of construction activities on the environment?..........
7. Are you able to achieve your objectives? Yes [ ] No [ ]
8. If Yes, how?.................

   If No, why?..................
9. In your view, what do you think can be done to improve sustainable environment due to construction activities?

APPENDIX C

RECYCLING SITES, EQUIPMENTS AND MATERIALS

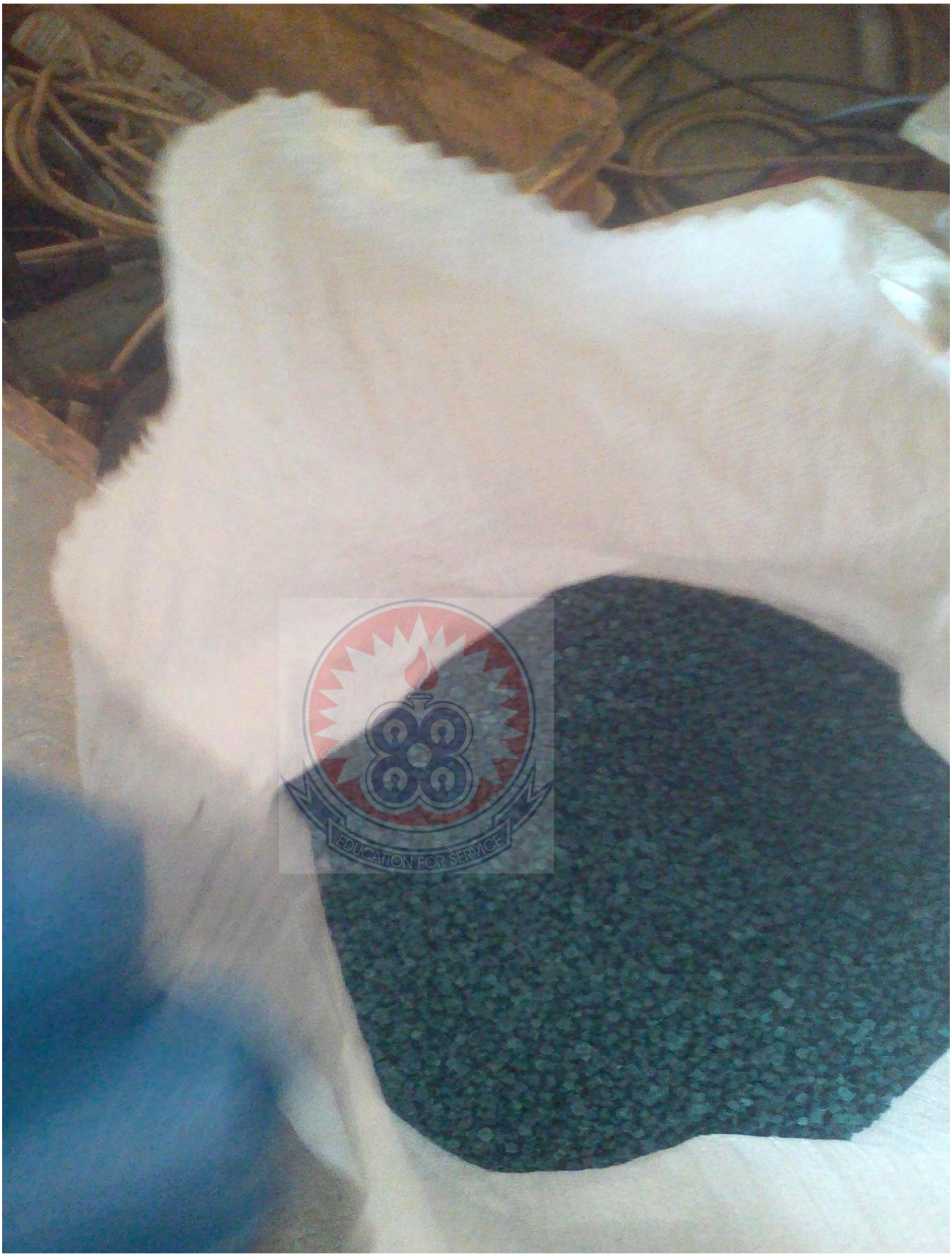
Metal Waste on Site

Waste Iron Rods on Site

Waste Iron Rods to be Recycled

Packed Plastics

Crushed Plastics for Recycling



Chemicals used for Recycling

Water Tanks as Coolant

Machine for Recycling Plastics

Cooling System for Recycling Plastics

APPENDIX D

College of Technology Education, Kumasi
UNIVERSITY OF EDUCATION, WINNEBA
P. O. Box 1277, Kumasi - Ghana Tel:03220 53607,50331,53616 Fax03220 50039
Department of Design & Technology Education

Our Ref....UEW/KC/CWT/A.15......

Your Ref...

Date...............June 13, 2014..........

TO WHOM IT MAY CONCERN

Dear Sir,

LETTER OF INTRODUCTION

The bearer of this letter **Eric Baidoo** (Index no. 8121760031) is a student pursuing Master of Philosophy (M.Phil) degree (Construction Option) at the College of Technology Education, Kumasi of the University of Education, Winneba.

He currently needs to visit your establishment to collect data to assist him to write his final thesis in partial fulfillment for the award of an M. Phil degree.

His thesis topic is *"Sustainable Construction Industry in Ghana: Focussing on the choice of materials, Recycle and Re-use potentials"*.

We wish to state that any data that will be obtained from your establishment shall be treated as confidential and used for academic purpose only.

We should be grateful if he is offered the needed assistance.

Thank you.

Yours sincerely,

Stephen J. Mitchual
(Head of Department)
Construction & Wood Technology Education

E-mail:uewk@ksi.uew.edu.gh