KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

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TOPIC: MANAGEMENT OF POLLUTION AND HAZARDS ASSOCIATED WITH ROAD CONSTRUCTION PROJECTS IN URBAN COMMUNITIES IN GHANA. (A CASE STUDY IN KUMASI)

BY

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DECLARATION

I hereby declare that this submission is my own work towards the Master of Science in Construction Management and that, to the best of my knowledge, it contains no material previously published by another person nor materials which has been accepted for the award of any other degree of any other University, except where due acknowledgement has been made in the text.

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ABSTRACT

The aim of this work was to identify the severity of pollution and or hazards on urban environment during road construction projects and the challenges the Environmental Protection Agency faces in the enforcement of pollution mitigation measures with the introduction of the Environmental Assessment Regulation,1999(LI 1652). In order to enhance economic development and improve the quality of life of people, roads are built to facilitate the movement of goods and services. The construction of these roads is however associated with environmental pollution and hazards which affects the health and well being of the people living in the urban communities. The researcher achieved the goals of this research through an interview with the EPA and administration of questionnaires to some selected urban road construction managers in the Kumasi Metropolis. The Relative Importance Index was then used to capture the weights of various factors within a specified method or strategy. This led to the following findings, firstly it was identified that the major challenge the Environmental Protection Agency (EPA) faces is the lack of adequate resources to intensify its monitoring duties on the various urban road construction sites. The study revealed that although all the seven factors of pollution considered in this work contributed to pollution during urban road construction in Ghana but the most prominent sources of pollution were noise pollution, ground movement and then pollution from dust generation. It was further identified that best mitigation measures for controlling pollution were mostly used on the sites but the frequency of its usage was not adequate enough hence the pollution of the urban environment. It is therefore recommended firstly that road construction managers develop better environmental management plan on sites. It is also recommended that issues of pollution prevention be a priority to the Government and hence allocate more resources to the Environmental Protection Agency to intensify its monitoring duties.

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CHAPTER ONE

BACKGROUND TO THE STUDY

1.1 INTRODUCTION

Time, cost and quality have been the base point for measuring construction project performance but lately environment has been considered the fourth dimension (Shen & Zhang, 1999). This is because the impact of construction activities has been estimated to be the cause of more than 25% of the world's total global warming due to the release of green house gases as the construction activities go on (Brady et al., 1993).

According to Hajibabai et al. (2001), the construction industry significantly contributes towards environmental pollution.

Moreover, it has been identified in Europe that the transportation sector in Europe is the second largest source of Green House Gas (CO_2, CO, NO_x and others) emissions (Lepert & Brillet, 2009). These are no different from the situation in China as pollution and hazards caused by urban civil construction projects have become a serious problem deteriorating the quality of air in the country thereby endangering the lives of people living in the urban communities (Li, 1998).

According to Morledge et al. (2001), the construction industry clearly is the most frequent polluter of the environment contributing to twenty two (22) percent of the total pollution within the industrial sector in the United Kingdom.

However, since the world commission on environment and development first mooted the principle to protecting the environment in 1983, governments of the world have committed

themselves to making sustainable development a keystone of their economic development policies programs (Ofori et al., 1999). The European Union following this has put forward several legislative initiatives based on "polluter pays" principle in other to enhance a sustainable environment (Mayer *et al*., 2011).

However, it has lately come to the notice that many multinational firms are moving into developing countries where a lot of markets are sprouting out (Wooldridge, 2010). This is because such countries are mainly developing countries and there is a lot of demand for all types of construction work (Jaselskis &Talukhaba, 1998). This brings to light why the environmental impact of the construction industry is probably greater in developing countries than it is in developed ones (Council for Scientific and Industrial Research (CSIR) Building and Construction Technology, 2002).

Therefore, although Road construction projects are generally intended to improve the economic and social welfare of people, it also as well poses the problem of pollution and hazards to the natural environment in urban communities.

It is for this reason why there is the need to identify the extent of pollution and hazard still associated with urban road construction even with the implementation of the Environmental Assessment Regulation, 1999(LI 1652) and recommending better management practices to curb this problem.

1.2 PROBLEM STATEMENT

Transport infrastructure development is the basis for economic growth. This is to enhance economic development and improve the quality of life of people. Along with the economic

development and improving the quality of life of people causes significant pollution and hazards to the urban communities. These impacts of the road construction pose frequently irreversible consequences to the environment (Lieplapa & Blumberga, 2012).

This is not as different from the Ghanaian urban community as the lives of residents are endangered due to pollution and hazard resulting from the road construction activities. The Daily Guide Ghana's report on the drowning of three teenagers at the Sofoline interchange project site in Kumasi attest to the negative impact road construction operations have on the urban community. The sources of these pollution and or hazards include erosion (dusts), harmful gases, noise, solid and liquid wastes, fallen objects, ground movements and others (Chen et al., 2000).

In order to reduce and prevent these pollution and hazards to safeguard the urban communities in Ghana, it is necessary to identify the severity of the pollution and hazard associated with road construction operations and propose a qualitative and quantitative approach to assess and control the problem to assist road construction project managers, Environmental Protection Agency (EPA) and other stakeholders in their duty to protect the environment as construction activities go on.

1.3 AIM OF STUDY

The aim of this work was to identify the severity of pollution and or hazards on urban communities during urban road construction projects which affect the people in the urban communities in Ghana even with the implementation of Environmental Assessment Regualtion,1999(LI 1652).

1.4 RESEARCH QUESTIONS

- How severe are pollution and or hazard on urban communities during road construction operations?
- What are the challenges the Environmental Protection Agency faces in the enforcement of the mitigation measures indicated in the Environmental Impact Statement(EIS) or the Preliminary Environmental Report(PER) by road developers in the urban communities in Ghana.
- What are the best management practices mostly used in the effective management of pollution and hazard on road construction sites in Ghana?

1.5 OBJECTIVES

- To identify the severity of pollution and or hazards on the Ghanaian urban communities during road construction operations.
- To identify the challenges of Environmental Protection Agency (EPA) in the enforcement of mitigation measures indicated in the Environmental Impact Statement or the Preliminary Environmental Report by road developers in the urban communities in Ghana.
- To identify the best practices mostly used in the effective management of pollution and hazards on road construction sites.

1.6 SCOPE OF WORK

In order to control the pollution and hazard problem which are generated as a result of road construction in the urban communities, it is important to place the statutory bodies and stakeholders in the road construction industry in the country at the heart of the study.

According to the Ghana's 2010 Population and Housing Census Report, Ashanti region recorded a total of 4,780,280 representing 19.4% of national total of 24,658,823 making the Ashanti region the most populous region in the country followed by the Greater Accra region with 4,010,054 making 16.3% of the total population.

Therefore for the purpose of this study, road construction project managers/contractors who work on road construction projects in Kumasi the capital town of the Ashanti region will be put at the heart of the study as the size of this region could be used to identify and recommend measures to manage the road construction operations that generate pollution and hazards which affect the health and well being of people in the urban communities in Ghana.

The sources of pollution and/ hazard which were considered were dust, harmful gases, noise, solid and liquid waste, erosion, ground movement and fallen objects which were adopted from Chen et al.,2000's research on construction environment in China.

The road construction operations considered were road clearing, excavation, filling, compaction, waste disposal, piles driving, services, grading, bridges and culvert and quarrying.

These road construction operations were deduced from Chen et al., 2000's research work in China and the Environmental and Social Impact Assessment of the Awoshie – Pokuase road in Ghana.

1.7 RESEARCH METHODOLOGY

Primary data was the main source of information for the study. However, some secondary sources of data were also employed. The secondary sources of data were books, published electronic and print journals on the construction environment, the various statutory bodies and their duty to protect the environment during road construction.

Questionnaire and interview were used to collect the primary data. This method was chosen because it is a means of obtaining a large amount of information which can be measured.

The questionnaire were developed based on the review of literature on the construction industry, impact of the industry's activities on the environment, the policies, regulations and authorities set to protect the environment during road construction. The collected data were then organized and analyzed using and Microsoft Excel and the Statistical package for Social Sciences.

CHAPTER TWO

LITERATURE REVIEW

2.1 THE CONSTRUCTION INDUSTRY AND ITS ENVIRONMENT

The construction industry in Ghana, as in other parts of the world, is huge and a crucial segment in economic development. Therefore no matter what one does, there is construction, as it cuts across all sectors. Moreover, construction being among the top drivers of the Ghanaian economy, including agriculture, manufacturing and mining, its importance cannot be over emphasized, especially as the country is one of the most economically active countries in West Africa (Ghana National Commission for UNESCO n.d).

However, construction project performance has traditionally been measured in terms of time, cost and quality neglecting the environment but lately the environment, health and safety have been considered the fourth dimension of construction project performance (Shen and Zhang, 1999, Khosravi et al., 2011).

It is for this reason why the Millennium Development Goals (MDGs) adopted by the United Nations (UN) in September 2000 committed the international community to an expanded vision of development. The MDGs promote human development as the key to sustainable social and economic progress in all countries and included ensuring environmental sustainability by the year 2015 (United Nations Development Programme, 2003).

This is because the effect of construction on the environment is often irreversible (Ofori, 1992). Most of the topical issues which have implications for construction industry have so far only been discussed within the context of industrialized countries and yet to be considered seriously in developing countries (Ofori,2000).

What this implies is that all development must, while meeting the immediate needs of the present, should allow for future expansions with minimal or no negative consequence. The construction industry in Ghana is characterized by many small firms which do not have sufficient funds and credit facilities and lack appropriate technological capabilities, plant and equipment as well as key personnel to manage projects properly (Owusu-Tawiah, 1999).

This indicates that mitigating the pollution and hazards resulting from their construction activities will not be an easy task for these kinds of contractors practicing in the country and thereby endangering the lives of people in the urban communities.

2.2 DEFINITION OF THE ENVIRONMENT

The word environment refers to our surroundings the context within which we exist. All things, living or non-living, exist surrounded by other things, and therefore all have an environment (WBTP, 1997).

The Nigerian Environmental Impact Assessment Decree defines environment as the component of the earth that includes land, water and all layers of the atmosphere; all organic and inorganic matter and living organisms; and the interacting natural systems that include components of land and water. Moreover, the environment was defined as the total outer physical and biological system within which human beings and other organisms live with many interacting components (Gandu, 2005).

Human activities and our actions have consequences not only for our immediate environment, but for us as well. This is because anything we do to degrade our environment will generally affect our well-being later on (WBTP, 1997).

There is therefore a need to strike a balance between human requirement and environmental consideration in order to ensure environmental sustainability. The achievement of sustainable development goals, then sustainable construction industry activities need to be promoted both by legislation and by practitioners in the industry.

2.3 URBAN COMMUNITY

Urban communities have been defined in different ways. Urban places are now home to virtually one of every two human beings and by the middle of the twenty- first century nearly two out of every three people will be urban dwellers (UNPD, 2008).

A functionally useful definition should address demographic, geopolitical and social dimensions of such population settlements. According to the 2000 population and housing census report of Ghana, settlement areas of population of 5000 and over was considered to be urban areas. In Ghana, there are three hundred and sixty four (364) urban settlements of which fifty eight (58) of them are in the Ashanti region the most populated region in the country.

Global urbanization data are often based on self-reporting and thus are not necessarily based on criteria strictly standardized across countries. Nonetheless, available data portray a world that is becoming increasingly urban in nature, with more and larger cities in all geographic regions.

The percentage of the global population residing in urban areas has increased from 32% in 1955 to 38% in 1975 and 45% in 1995 (WHO, 1998).

The most current estimate from 2002 is 47%, with projected growth of two (2) per cent per year between 2000 and 2015, yielding approximately 65% by 2015 (UNEP, 2002). Moreover, Global

statistics indicate that a half of the world's population lives in urban areas and this figure is estimated to reach 4.7 billion in 2030 with an increasing decline in rural population (UN Commission on Human Settlement Programme (UNCHS), 2008; United Nation Population Fund (UNFPA), 2007).

2.4 THE ROAD NETWORK

Ghana's road network is about 50,000km made up of highways or trunk roads of 13,366.8km, urban roads of 4,064km and feeder roads of 32,601.8km. The trunk roads or the highways link the national and regional capitals, major cities in neighbouring countries and major production centers. Feeder roads provide access to small towns, villages and production centers, especially agricultural centers. Urban roads located within cities and major towns and described as special facilities to move people and goods in cities economically, efficiently and safely (MoT, 2007).

2.5 AWARENESS OF PROTECTING THE ENVIRONMENT

According to Dunlap and Scarce (1991), it is generally assumed that companies, particularly those belonging to manufacturing industries, have the greatest impact on the natural environment. Moreover public administrations, especially city councils also contribute significantly to the amount of pollution through the use of vehicles carrying out of activities such as building of houses and construction of roads which in the long run affect the environment and hence have been considered as silent destroyers (Taylor et al., 1994).

These problems and the more associated with developing the environment has created a global awareness to protect the environment and hence gingered governments all over the world

including Ghana to take concrete steps towards the protection, management and enhancement of the environment (EPA, 1994).

The consciousness of protecting the environment can be traced as far back as the pre-biblical periods. However, Pickering and Owen (1997) were the first to give concrete meaning to it at the United Nations Conference on the Human Environment held at Stockholm, Sweden in June 1972. The next summit was held in Brazil "Rio Conference" or the "Earth Summit" of 1992. Pickering and Owen (1997) further stressed that, the earth summit offered world leaders the rare opportunity of building consensus on managing the planet. The major outcome of the Conference on the Human Environment held at Stockholm, Sweden in June 1972 conference was the 27 point principle that was adopted by all the 171 countries.

However, agenda 21 notes that the construction industry is vital to the achievement of national socio-economic development goals but it can also damage the environment by degrading fragile eco-zones, using harmful materials, consuming excessive energy and increasing air pollution (United Nations, 1993).

Despite its perfect objectives to address the global ecological issues, the ambitious Agenda 21 action plan proposed for different countries to adopt, became unpopular due to its comprehensive list of activities which were not only difficult to follow but also to achieve.

Consequently, considering that the Agenda 21 was too broad to act upon, the 2002 World Summit on Sustainable Development (WSSD) raised the need for multisectoral actions to encourage regional, national and local agendas to take the leading role.

Alongside with the local agendas, an action plan for Sustainable Building and Construction (SBC) named Agenda 21 for Sustainable Construction in Developing Countries (A21SCDC) was

adopted in 2002 aiming to provide a guide in addressing environmental issues related to the construction industry (Du Plessis et al., 2002).

Moreover, Atkinson, 1999 suggests that environmental assessment, environmental audits and management systems may be used more strategically to prevent pollution at source. Nitz and Holland, 2000 also suggest that improved environmental management must be looked into in the country.

The government of Ghana since the Stockholm conference established agencies to manage its environment. The purpose of environmental management according to the EPA, 2002 is to identify human activities that may threaten and affect the quality of the environment, implement mitigation measures at the appropriate time to manage these effects, ensure that anticipated effects are maintained within the levels predicted, manage anticipated effects before they become a problem and, optimize environmental protection.

2.6 THE ENVIRONMENTAL PROTECTION AGENCY- GHANA

In 1974, the Government of Ghana established the Environmental Protection Council (EPC) by NRC Decree 239. The EPC was primarily an advisory and research organization and it was expected to co-ordinate the activities of other bodies concerned with environmental matters.

It had no power to enforce measures for improving the environment or preventing damage to it. It served as a meeting point for the bodies that actually exercised power with regard to the various sectors of the environment and so facilitated the co-ordination of environmental programmes and activities in the country (EPC, 1991).

The members of the EPC included ministries of health, agriculture, foreign affairs, lands and natural resources, industries, science and technology, local government, finance, economic planning, works and housing. The Council also maintained networks through its expert committees on education, natural ecosystems, toxic chemicals, human settlements, etc.

However, long before the establishment of the EPC, many legal enactments existed in the country and empowered various official bodies which actually exercised executing powers with regard to environmental care and protection. These powers were however widely scattered among the bodies involved and no one of them could be said to have enjoyed exclusive control of the whole of the environment or even of significant portions of it.

However, the Environmental Protection Agency Act (Act 490) transformed the Environmental Protection Council into an Agency having inter alia, regulatory and enforcement roles in 1994. The EPA is given full mandate and responsibilities for regulating the environment and ensuring the implementation of Government policies (EPA, 1996).

Environmental Assessment (EA) or EIA has been an important environmental prevention, planning and management tool in Ghana since the 1980s, in ensuring sound and sustainable investments and developments.

The EPA Act 490 (1994) and the Environmental Assessment Regulations, 1999 (LI 1652) are the main legal basis for Environmental Assessment application in Ghana. Its key objectives are firstly ensuring that the implementation of environmental policy and planning are integrated and consistent with the country's desire for effective, long-term maintenance of environmental quality; providing technical assistance to the District Assemblies to enable them meet their responsibilities for managing the local environment; working in partnership with stakeholders;

guiding development with the aim of preventing, reducing and as far as possible eliminating pollution and nuisances; initiating and pursuing formal and non-formal environmental education programmes; collecting, collating and disseminating information and promoting and supporting research programmes needed to ensure sound environmental management and use of environmental and natural resources; applying the legal processes in a fair, equitable and efficient manner to ensure responsible environmental behaviour in the country; and continuously improving EPA's performance to meet changing environmental trends and community aspirations (EPA, 1996).

2.6.1 ENVIRONMENTAL ASSESSMENT REGULATION 1999(LI 1652)

Under the section 28 of the Environmental Protection Agency Act, 1994(Act 490) the environmental assessment regulation were made to help control the adverse effect all undertakings might have on the Ghanaian environment. This environmental regulation requires every developer yet to commence any development (regulation one) or who has an existing undertaking (regulation two) which has adverse effect on the environment to obtain an environmental permit from the Environmental Protection Agency.

2.6.2 STEPS TO OBTAIN AN ENVIRONMENTAL PERMIT AND CERTIFICATE

According to the Environmental Assessment Regulation, 1999 a person required under either regulation one or two to obtain a permit has to do so through an application in a format determined by the Environmental Protection Agency. The submitted application by the developer goes through an initial assessment screening which then comes out with a screening

report by the Agency. In the screening report, it will be stated whether the application is approved, objected to, requires the submission of a preliminary environmental report (PER) or requires the submission of an environmental impact statement (EIS).

A preliminary environmental report will be required from the developer where there is the need for the detailed adverse effects the undertaking. If the assessment of the preliminary environmental report proves that the undertaking has a significant adverse environmental impact then an environmental impact statement will be required from the developer.

Moreover, before the developer presents an environmental impact statement, a scoping report will have to be submitted to the Agency.

The scoping report shall set out the extent of environmental impact assessment to be carried out by the developer not forgetting a draft of terms of reference which shall indicate the essential issues to be addressed in the environmental impact statement. The draft of terms of reference in the scoping report may include;

- Proposal to mitigate any potential negative socio- economic, cultural and public health impacts on the environment.
- Proposals to be developed to monitor predictable environmental impact and proposed mitigating measures.
- Contingency plans existing or to be evolved to address any unpredictable negative environmental impact and proposed mitigating measures.

Upon the approval of the scoping report by the Agency, the developer shall be required to submit the environmental impact statement based on the scoping report which was accepted by the Agency.

The environmental permit is granted to the developer after the environmental impact statement is approved by the Agency.

The Agency will in addition to the permit award the developer an environmental certificate within twenty four months from commencement of the undertaking.

An environmental certificate may be issued subject to such conditions as the Agency shall determine except that no such certificate shall be issued unless the person responsible has submitted to the Agency confirmation of actual commencement of operations ,acquisition of other permits and approval where applicable, compliance with the mitigation commitments indicated in the environmental impact statement or preliminary environment report and lastly has submitted to the Agency its first annual environmental report to the Agency.

2.7 POLLUTION AND ITS HAZARDS RESULTING FROM ROAD CONSTRUCTION

Construction pollution and hazard have received much attention over the past years. The impact of the activities of the road construction industry is very severe and hence there have been many researches done related to pollution and hazard control in construction, for instance a study on noise pollution, air pollution, solid and liquid waste from construction sites was conducted in early 1970s (Jones; 1973 *cited in* Heng et al. n.d).

Road construction activities while meeting societal needs of development, impact the environment before, during and after the creation of the construction products and these impacts have adverse effects on the environment. Some of the negative effects of road construction activities are pollution and hazards which include land misuse (erosion, desertification), destruction of natural resources and vegetation, change in direction of flow of underground

water, loss of wild life and their habitat, air and noise pollution, waste or effluent discharges, on-site wastage, health and safety impairment, generation of solid and gaseous wastes and resource depletion (Gandu, 2005; Kolawole & Anigbogu, 2005; Owoyale, 2005).

Pollution is the release of any substance that can harm people or animals, plants, soil, water or air; for example, an oil spill, silty water getting into a river or smoke into the air(U.K. EPA;2010).

Pollution control in road construction projects is the control of all human activities that have either significant or small negative impact on the environment during the whole construction process (Griffith, et al. 2000 *cited* Heng *et al*. n/d).

The impact of the construction industry on the environment has been recognized the world over. The harm caused by road construction activities may be classified according to their pollution effects such as dust, noise, solid and liquid waste, soil erosion and ground movement, fallen objects etc. (Chen et al., 2000).

2.7.1 DUST

Road dust is often seen to be a non significant hazard by many practitioners. However models developed by the United States Environmental Protection Agency and calibrated in various countries has shown that millions of tons of dust are generated on our unsealed road ways per year and its effect on the urban environment is higher on developing countries like Ghana (Jones et al., 2008).

Dust generation may result from several road construction operations which may include vehicle and equipment traffic on paved and unpaved roads, earthmoving vehicles and equipment during construction, wind erosion from disturbed and exposed soils, including stockpiles, materials

handling, conveyance and transport within site boundaries including the material site and main access road outside the Project boundary (BP Wind Energy, 2013).

It is necessary to manage dust evolved on road construction sites thereby put the lives of both the road operators and the urban environment in danger.

2.7.2 HARMFUL GASES

Road construction also generates harmful gases into the urban environment. Anair, 2006 however identified in his research on the impact of construction equipment on the environment that harmful emissions are generated as a result of the use of road construction equipment.

These emissions are harmful to the health and well-being of people in the communities where the construction takes place. These damages come in the form of premature death, increased hospital admissions for respiratory and cardiovascular diseases, asthma attacks, and lost productivity through school absences and missed work days and hence the impact of several pollutants that come from the use of road construction equipment should be carefully looked at.

There are also a number of indirect impacts on human health and safety resulting from road building (USAID, 2003) as the emission of a higher concentration of particulate matter (PM10, PM2.5 and smaller) which is associated with the increase of respiratory tract and cardiovascular diseases and mortality rate. These particulate matter are twenty five (25) times smaller than the width of a human hair and can penetrate deeply into the lungs, causing or worsening a variety of respiratory and cardiovascular illnesses and even leading in some cases to premature death (Dahl *et al*., 2006; O'Donoghue et al., 2007; Kupiainen & Pirjola, 2011, Pope 2002, Krewski 2000, Samet 2000).

Moreover, smog-forming pollutants also have great adverse effect on the environment. Nitrogen Oxides (NO_x) and hydrocarbons react in the presence of sunlight to form ozone (smog), which can damage the respiratory tract, reduce lung function, exacerbate asthma, aggravate chronic lung diseases, and also cause premature death (White 1994, Koren 1995, Thurston 2001, Bell, 2005 cited in Lieplapa & Blumberga, 2012).

2.7.3 SOLID AND LIQUID WASTE

Road construction generates both liquid and solid waste that may have adverse effect on the land and the water bodies (Teixeira, 2005).

Road construction project may generate waste during the construction phase. The source of waste may include the following;

- Regulated waste including hydrocarbon waste such as waste oil, oily water, oily sludge, grease, coolant, oil rags, oil filters, drums, detergents, solvents, batteries, tyres, paints and resins.
- General waste including food waste, packaging and food containers.
- Recyclable waste including paper, cardboard, plastics, glass and aluminium cans.
- Wood waste including timber, pallets, and off-cuts.
- Sewage effluent and sludge (BHP Billiton Mitsubishi Alliance, n.d).

Direct release of construction waste into the sewage system is inconvenient and forbidden in some countries because it may damage pipes and treatment plants. This is because Paints, solvents, oils and run off water from construction sites could mostly be harmful to the urban environment. The costs which would be incurred in repairing these damaged infrastructures are high, and disruption also causes severe inconvenience and must therefore be strongly avoided (Esin and Cosgun, 2007).

2.7.4 EROSION

According to Israelsen *et al*. 1980, urban road construction projects come along with extensive land disturbance which comes as a result of removing vegetation and reshaping topography. These road construction activities make the soil easily prone to erosion. The top soil carried away by erosion may become airborne and create dust problem or be carried by water into natural waterways and pollute them (Goodland & Irwin, 1975).

2.7.5 NOISE

Harris (1991) defined sound as a physical disturbance in a medium that is capable of being detected by the human ear. However, not every sound can be considered noise. The Canadian Transportation Research Board (1999) defined noise as any sound that has the potential to annoy or disturb humans, or cause adverse psychological or physiological effects on humans (Gilchrist et al, 2002).

Noise generated at road construction sites may affect the right to silence, comfort and health of residents and the visiting population and may thereby affect normal activities of nearby schools, hospitals and other services (Teixeira, 2005; Choi, 1997).

2.7.6 GROUND MOVEMENT

On road constructions sites, the operation of machines and heavy equipment generate ground movement which has significant impact on the urban environment. These operations can give rise to high levels of ground vibrations. The magnitude of the nuisance created by vibrations depends on the nature of soils transmitting the vibration and the distance to the nearest building. A British study has found that nuisance from ground vibration and building damage is likely to occur if the operation is conducted at distances less than 50 metres (Martin, 1980).

2.7.7 FALLEN OBJECTS

Road construction also poses the hazard of people in the urban environment and the workers on site been exposed to risk of been injured by fallen objects. The fallen object may include the following; solid-state waste-building material waste, building material package, mud / building material waste, construction water and bitumen, scaffold and board, model plate, building material etc.(Chen et al, 2000).

2.8 ENVIRONMENTAL MANAGEMENT

According to the British Standard 77502 and ISO 14000 series, in other to efficiently manage the environment during construction activities, it is necessary to adopt an environmental management system. The environmental management system establishes quality systems to ensure consistently high environment outcomes for the project as a whole. In other to control pollution and /hazards during road construction the following are some management practices that could be adopted.

2.8.1 MANAGEMENT OF EROSION

The following measures may be taken to minimize erosion. Firstly, land clearance should be kept to a minimum in other to minimize erosion. Moreover, clearing of areas with soils which are prone to erosion, steep slopes which are prone to water and wind erosion should be avoided wherever possible. Again, revegetate and mulch progressively as each section of works is completed. The interval between clearing and revegetation should be kept to an absolute minimum. Adding to the above, road construction activities should be properly coordinated, if more than one contractor is working on a site, so that there are no delays in construction

activities resulting in disturbed land remaining unstabilised (EPA, 1996). These management practices are summarized below;

- Land clearance should be kept to a minimum.
- One should avoid wherever possible clearing areas of highly erodible soils and steep slopes which are prone to water and wind erosion.
- There should be revegetation and mulching progressively as each section of work is completed. The interval between clearing and revegetation should be kept to an absolute minimum.
- One should coordinate work schedules, if more than one contractor is working on a site, so that there are no delays in construction activities resulting in disturbed land remaining unstabilised.
- Construction activities should be programmed so that the area of exposed soil is minimized during times of the year when the potential for erosion is high, for example during rainy season when intense rainstorms are common.
- The site should be stabilized, installed and erosion controls maintained so that they remain effective during any pause in construction and this becomes particularly important if a project stops during the wetter months.
- Vehicles should be kept to well-defined haul roads.
- Haul roads should be kept off sloping terrain wherever practical.
- The slope should be designed of a cut to minimize the angle of incline.
- The cut surface should be cultivated in other to increase infiltration of rainfall and decrease the velocity of water across the slope during rain and therefore reduce erosion.

2.8.2 MANAGEMENT OF DUST

According to the Australian Environmental Protection Agency (1996) soil erosion contributes to dust generation however the following are additional measures, not mentioned in the sections of managing erosion. However according to EPA, (1996), Stäubli and Kropf, 2004, Jones et al., 2008; the following measures could be used to manage dust evolvement during road construction,

- Firstly, dust generation should be prevented in preference to applying dust suppression measures.
- One must ensure in the project schedule that the area of cleared land is minimized during the drier months of the year, when dust generation is at its greatest.
- As much as possible the cleared roads should be watered with the frequency of watering dependent on the weather conditions and the erodibility of the soil.
- However, additives could be used in the water to increase its dust suppression properties but the chemical should have no adverse environmental impact on adjacent water bodies.
- Moreover, the project manager should ensure that smooth surfaces are deep ripped and left rough and cloddy to reduce the wind velocity at the soil surface.
- Wind fences should be constructed if it is appropriate for the site.
- As a contingency measure, in areas that do not have access to a reticulated water supply, the project manager should make sure that water stored on-site should never be less than 2,000 litres per hectare of disturbed land surface.
- Moreover the project manager should ensure that wherever watering is used to suppress dust it does not create contaminated run-off that will contaminate surface waters.

- The number of stockpiles, the area of stockpiling and the time stockpiles are expose in the environment should be minimized.
- The stockpiles for road building should be located away from drainage lines, at least 10 metres away from natural waterways and where they will be least susceptible to wind erosion.
- The stockpiles and batters on road construction site should be designed to ensure that the slopes are not steeper than 2:1 (horizontal/vertical).
- Stockpiles and batters that will remain bare for more than 28 days should be stabilized by covering with mulch or anchored fabrics or seeding with sterile grass.
- Sediment controls should be established by the manager around unstabilised stockpiles and batters.

2.8.3 MANAGEMENT OF HARMFUL GASES

There are three potential sources of air pollution on urban road construction sites. They are exhaust gases from vehicles and machinery and exhaust material from chippers. The exhaust gases from vehicles and machinery on the construction site can be controlled by ensuring that all vehicles and machinery are fitted with appropriate emission control equipment, maintained frequently and serviced to the manufacturers' specifications. Finally, Smoke from internal combustion engines should not be visible for more than ten seconds (EPA, 1996).

2.8.4 MANAGEMENT OF NOISE AND GROUND MOVEMENT

According to Martin, 1980, there are no strong laws controlling the noise from urban road construction sites and recommends that there is a need to control this pollution in the urban environment.

The EPA Act 490, 1994 of Ghana thereby recommends that environmental impact assessment should be provided on how to control noise and vibration involved in urban road construction.

Therefore according to EPA (1996), to control noise and vibration on road constructions the following suggested measures could be applied,

- Firstly, appropriate mufflers should be fitted on earth-moving and other vehicles on the site to enclose noisy equipment.
- Moreover, noise attenuation screens should be provided where appropriate. Again, where an activity is likely to cause a noise nuisance to nearby residents, the operating hours should be restricted to between the hours of 7 am and 6 pm weekdays and 7 am to 1 pm Saturday, except where, for practical reasons, the activity is unavoidable.
- Moreover, the noise on road construction site should not be above background levels inside any adjacent residence between 10 pm and 7 am. Local residents should be informed when unavoidable out-of-hours work will occur. Furthermore, a study should be conducted on the impact of ground vibration from construction activities, where these operations occur within 50 metres of a building and appropriate action should be taken and finally minimize air vibrations as much as possible.

2.8.5 MANAGEMENT OF SOLID AND LIQUID WASTE

Urban road construction comes along with so much waste that affects the environment and so when choosing between waste controls measures, the following hierarchy for waste management is preferred, firstly waste avoidance, then reduction in reuse and finally recycling.

Adhering to these control measures means that waste treatment and waste disposal options can be reduced. Urban road construction sites should pursue this hierarchy and seek out waste

reduction opportunities. Therefore to identify opportunities it is necessary to consider all aspects of the project and the wastes it generates. Waste can be minimized by using improved technology, recycling or reusing on-site, or by making purchasing decisions that favour recycled products. Wherever possible, performance measures and targets for reduction reuse and recycling options should be included in the environmental management plan (EPA, 1996).

The following is a summary of management of solid and liquid waste on road construction site;

- Waste control measures may include obtaining construction materials, paints, lubricants and other liquids in reusable packaging or containers.
- Noise barriers used should be made from recycled materials,
- Contaminated water from sediment dams should be used for dust suppression and irrigating adjacent vegetated land,
- Waste concrete from demolition activities should be sent to a concrete recycler instead of landfill,
- All contaminated material uncovered on a construction site should be excavated and disposed of in an environmentally responsible manner (EPA, 1996, Chen et al., 2000).

2.8.6 MANAGEMENT OF FALLEN OBJECTS

The fallen object may result from the following; solid-state waste-building material waste, building material package, mud / building material waste, construction water and bitumen, scaffold and board, model plate, building material etc. Therefore recycling waste, improving technology on site, applying good safety control and recovery measures could help to manage fallen objects on road construction site (Chen et al., 2000).

2.8.7 SUMMARY OF CHAPTER

It is clear that in order to effectively control pollution and hazards during urban road construction; a good environmental plan is needed. This is to say road construction project managers should firstly develop their environmental management on how and when to combat the predicted environmental impact the project might have on the community. However, there should always be contingency plans existing or to be evolved to control any unpredicted negative environmental impacts.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter discusses the research method employed in the study together with justification of the choice. The method include the research design, the sources of data, the population of the study, the sampling technique and sample size, data collection and data analysis techniques that were used in the study.

This thesis attempts to contribute towards the effective management of pollution and or hazards in the environment during road construction in urban communities which will eventually be useful to road construction project managers, the Environmental Protection Agency and the environment of urban communities in Ghana. For this purpose it first attempts to critically review literature to identify and describe the generally accepted road construction and environmental management procedures.

3.1.1 RESEARCH DESIGN

According to Saunders et al. (2009), research design is the blue print of the study and entails the overall plan of the research as to how the research questions would be answered. There are three different general categories of research designs to choose from when conducting a research. These are exploratory, descriptive and explanatory research. The design of the research depends on the aim of the study and the current knowledge about the subject (Aaker et al., 2010).

An exploratory study is a valuable means of "finding what is happening to seek new insights, to ask questions and to assess phenomena in a new light" (Saunders et al., 2009, p. 139) or to actually determine the nature of the phenomenon(Saunders et al., 2009, pp. 139-140).

This study adopted an exploratory type of research design. The exploratory approach was an attempt to identify the severity of pollution associated with road construction operations, the challenges the Environmental Protection Agency (EPA) faces in the enforcement of the mitigation measures stated in the Environmental Impact statement of urban road construction projects in Ghana. This also helped in the identification of the mostly used best management practices on urban road construction sites in managing pollution and hazard.

There are five different strategies used when collecting data; archival analysis, case study, experiment, history and survey (Yin, 1994). The choice of strategy used to collect the data depends on the purpose of the study (Bryman & Bell, 2011). When making the decision on which one to use, three different factors should be considered; how the research question is formulated, if it requires control over the behavioral events and if the study focuses in contemporary events (Yin, 1994). According to Yin (2003), the most important condition for differentiating among the various research strategies is to identify the type of research question being asked. The importance of adopting a particular research strategy lies in its ability to help the researcher answer the research questions and meet the set objectives (Yin, 2003).

However, since this study seeks to find out about the severity of pollution and hazards associated with road construction operations even with the implementation of the Environmental Assessment Regulation, 1999, the mostly used management practices in controlling pollution and hazard and the challenges the EPA faces in the enforcement of the mitigation measures

stated in the environment impact statement of various road construction projects, the researcher identified the case study strategy as a good tool to use to help achieve the goals of this research.

This conforms well to the literature which states that, a case study is useful to answer questions like 'why?' and 'how?'(Yin, 2009). A case study is an empirical inquiry that investigates a contemporary phenomenon in-depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident' (Yin, 2009, p 18). The case study method helps the researcher to make direct observations and collect data in natural settings, compared to relying on 'derived' data (Yin, 2003).

In order to gain a clear understanding of the context of this research, a case study was used.

The urban area used in this research was Kumasi, the regional capital of the Ashanti region based on its high number of population. In this research both quantitative and qualitative data were analyzed. This was to quantify the severity of pollution and or hazards associated with the road construction operations which have great environmental impact on the urban communities, the mostly used best management practices for controlling the various sources of pollution and the challenges the EPA faces in enforcing pollution and hazard mitigation measures.

Quantitative research is described by the terms 'empiricism' (Leach, 1990) and 'positivism' (Duffy, 1985). It is derived from the scientific method used in the physical sciences (Cormack, 1991, Cassell &Symon, 1994). However, using quantitative method through the case study made it possible for us to interpret and get a deeper knowledge on the severity of pollution associated with road construction operations on the urban environment and the best measures mostly used to control the pollution and its related hazards on the road construction sites and beyond.

A qualitative method was also used to come out with why there is still pollution even with the implementation of the Environmental assessment regulation, 1999(LI 1652) on the part of the Environmental Protection Agency. In the view of the researcher, analyzing data through these methods made it easier to present a discussion and conclusion on the study.

3.1.2 POPULATION OF THE STUDY

A research population refers to a well defined collection of individuals with similar or binding characteristics or traits (Castillo, 2009). Hence to collect data from all the members of a population is considered impractical (Aaker 2010; Bryman & Bell, 2011).

Even if there is enough time and financial means to do so, the odds are that the respondents will not provide sufficient data, particularly with a large population such as the whole Ghanaian population. In fact it will in many cases result in a less accurate study, because of the difficulty to maintain control over the data collection (Aaker, 2010).

To solve this problem, the choice was to narrow down the population of this study to road construction managers of Kumasi in the Ashanti region that work with the Department of Urban Roads in Kumasi.

3.1.3 SAMPLING TECHNIQUE AND SAMPLE SIZE

The sample size is basically a subset of the entire population. It is representative of the population from which it is drawn and can be used to conduct research study to derive findings that apply to the population (Castillo, 2009).

However in this research a census population sampling was used as its size was manageable. The sample size consists of 41 road construction companies who majorly work hand in hand

with the Department of Urban Roads in Kumasi. The respondents chosen were skilled personnel from these construction firms who were majorly civil engineers, geodetic engineers and the like with varying experiences in the road construction industry. The sampling technique used to identify these road construction managers from these road construction firms was purposive because of the need to select those who have key information so as to minimize the tendency of rejection.

3.1.4 DATA COLLECTION

There are two fundamental categories or types of data: primary data and secondary data. According to Crowther and Lancaster (2008), primary data does not exist until or unless it is generated through the research process and is often collected through techniques such as interviewing, observing, surveys etc.

On the contrary, secondary data is information that already existed in some form but not necessarily collected for the particular research at hand.

Field Survey was done to study the prevalent pollution and its related hazards of the environment in urban communities during road construction. This survey was done to have first hand information, essential to be aware of the problems encountered by urban communities during road construction projects.

A questionnaire was prepared in two parts. The first part seeks to come out with the extent of pollution and hazard associated with road construction even with the implementation of the Environmental Assessment Regulation, 1999.

The second part of the questionnaire also seeks to identify the usage levels of the best management practices in the effective management pollution on the urban road construction sites

and beyond. Both first and second questionnaire consists of 7 factors each which were identified from the literature review.

The questionnaire was sent to the project managers who were actively associated with the urban road construction activities under the Department of Urban Roads in Kumasi and possessing sufficient experience in the field.

The respondents were asked to rank in their opinion regarding the extent of pollution that comes with the various road construction operations in part one. In part two the respondents were asked to assess the level of usage of best pollution controlling practices on a scale of 1 to 5 depending upon its effect and level of usage, 5 being the highest and 1 the lowest.

The respondents are road construction mangers and only experts in the organizations were approached for answering the questionnaire. This was done to preserve the quality of the opinions gathered in the survey. Throughout the questionnaires, the concept of importance is interpreted in a generic way and is comparable to preference, dominance, and similar relationships.

To ensure consistency throughout by the respondents, the definition of the factors had been provided in the questionnaire.

The questionnaires were designed in a manner that will help in the preservation of integrity and consistency in the data. To secure good quality data, a brief presentation with regard to the objective and methodology of the study was made to every respondent individually.

The respondents were specifically reminded of the importance of observing consistency in their answers when point wise comparison was made.

They were made to understand that their responses should not be biased toward any particular road construction project whether it was highly successful or highly disastrous in managing pollution and its related hazards**.** Information from reports of Department of Urban Road - Kumasi was also used. Delivery-and-collection method of questionnaire administration was used for the road construction managers of the construction organization. The questionnaires were partly adopted from the research work on environmental management of urban construction projects in China by Chen et al., 2000.

3.1.5 DATA ANALYSIS

The researcher employs the use of Statistical Package for Social Sciences (SPSS) and Microsoft Excel for the organization of the data, presentation, description and analysis. The Relative Importance Index was then used to capture the weights of various factors within a specified method. RII = Sum of weights (W1 + W2 + W3 + ……+ Wn) / A x N where W = weights given to each factor by the respondents and will ranges from 1 to 5 where '1' is less significant and '5' is extremely significant. A = highest weight (i.e. 5 in this case), and N = total number of respondents.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.1 INTRODUCTION

This chapter deals with the analysis and discussion of this research to identify the severity of pollution and hazard associated with road construction operations in the Ghanaian urban environment and the challenges the Environmental Protection Agency faces in the enforcement of the mitigation measures stated in the Environmental Impact Statement or Preliminary Environmental Report of various urban road construction projects. The research also seeks to identify the best management practices mostly used in the effective management of pollution and or hazards on urban road construction sites in Ghana.

This chapter presents the results of the analysis and discussions in the form of texts, figures and tables. This chapter is organized as follows; Background information of Respondents, Sources of pollution and hazard on construction activities, Methods of managing pollution and hazards, best practices mostly used for controlling pollution and hazards and then a summary of knowledge of various issues pertaining to road construction.

4.2 BACKGROUND INFORMATION

This section presents background information of data collected on 41 respondents in the road construction industry who hold various positions in their respective organizations with various academic qualifications and several years of experience managing road construction projects.

Table 1 shows the summary of information on the positions that individual respondents hold in their respective institutions. Up to 75.6% (31) individuals were either Engineers or Assistant

Engineers, majority of who are Engineers. The remaining 24% (10) held other positions in their institutions.

Table 1: Position of Respondents in their Institutions

	Frequency	Percentage	Cumulative Percent
Assistant Engineer	13	31.7	31.7
Engineer	18	43.9	75.6
Others	10	24.4	100.0
Total	41	100.0	

Most of the respondents held BSc. Civil Engineering degrees representing 43.9% and a significant 41.5% holding other degrees as academic qualification. There were a few individuals representing 14.6% who were holding either BSc. Geodetic Engineering or HND Civil Engineering. This information is summarized in Table 2.

Table 2: Academic Qualification of Respondents

	Frequency	Percentage	Cumulative Percent
BSc. Civil Engineering	18	43.9	43.9
BSc. Geodetic Engineering	3	7.3	51.2
HND Civil Engineering	3	7.3	58.5
Others	17	41.5	100.0
Total	41	100.0	

Table 3: Working Experience of Respondents

	Frequency	Percentage	Cumulative Percent
Less than 1 year	15	36.6	36.6
1-3 years	3	7.3	43.9
4-6 years	16	39.0	82.9
More than 6 years	7	17.1	100.0
Total	41	100.0	

Table. 3 shows a summary of the data collected on the working experience of the respondents in this research. Up to 43.9% of the respondents have worked for less than 4 years. Most of the respondents have been working for between 4-6 years representing 39.0%. This is shown in the table above.

This implies that over almost 64% of the respondents in this research have been in the industry and have worked for more than a year and are either Engineers or Assistant Engineers with various academic degrees in Engineering. The respondents therefore have the know-how and experience to make judgments on issues relating to road construction and its related pollution effects. The next sections are responses summarized and analyzed on pollution via road construction.

4.2 SOURCES OF ROAD CONSTRUCTION RELATED POLLUTION

This section presents data collected on levels of pollution and hazards from various sources such as dust, harmful gases, noise, etc. during specified road construction activities.

Respondents were asked to rank their responses on a likert scale of 1-5 where 1 – very low and

5 – Very high as an indication of how serious the specified sources of pollution and hazards are during the given road construction activity. The responses are ranked using the Relative Importance Index (RII).

Table 4 shows the mean, standard deviation and relative importance indices for the responses gathered for this research for the activities of road clearing and excavation. The forms of

pollution and hazards are ranked based on the RIIs that is calculated using the data. Road clearing generally produces dust, noise, erosion and ground movement extremely.

The process of excavation on the other hand was observed to produce erosion, dust, harmful gases and ground movement in order of severity according to the data collected.

Table 4: Road Clearing and Excavation

	Road Clearing				**Excavation**			
Factor	Mean	SD	RII	Rank	Mean	SD	RII	Rank
Dust	4.1	9.3	82.0	**1**	3.7	6.4	74.1	**2**
Harmful Gases	2.5	6.7	49.3	**7**	3.7	4.9	73.2	**3**
Noise	3.7	8.7	74.1	**2**	3.2	10.4	63.4	**5**
Solid and Liquid Waste	3.1	9.1	62.9	**5**	3.0	6.7	59.5	**6**
Erosion	3.7	10.1	74.1	**3**	4.1	7.6	81.5	**1**
Ground Movement	3.2	7.3	63.9	**4**	3.6	5.5	72.7	**4**
Fallen Objects	2.9	5.3	58.5	**6**	2.4	7.7	47.3	**7**

There was a similar trend of pollution and hazards for the construction activity of filling as was observed for road clearing except the magnitude of the collective responses given by the RIIs were lower. Compaction also had an extremely high response for harmful gases with erosion being the next in terms of severity. This information is shown in Table 5.

Table 5: Filling and Compaction

	Filling				**Compaction**			
Factor	Mean	SD	RII	Rank	Mean	SD	RII	Rank
Dust	3.3	5.5	66.8	**1**	2.2	5.8	46.8	**5**
Harmful Gases	2.7	5.0	54.1	**5**	3.1	4.1	80.0	**1**
Noise	3.0	8.7	61.0	**2**	3.5	7.8	50.2	**4**
Solid and Liquid Waste	2.1	7.8	42.9	**7**	2.3	8.9	45.9	**6**
Erosion	2.2	8.2	44.4	**6**	2.5	6.9	69.3	**2**
Ground Movement	2.7	9.2	54.6	**4**	4.0	7.0	62.0	**3**
Fallen Objects	2.9	4.6	57.1	**3**	2.3	4.8	43.4	**7**

As expected solid and liquid waste were the highest ranked forms of pollution for Waste Disposal and Service activities as shown in Table 6 and Table 7 respectively.

Table 6: Waste Disposal and Piles Driving

	Waste Disposal				**Piles driving**			
Factor	Mean	SD	RII	Rank	Mean	SD	RII	Rank
Dust	2.6	6.6	52.2	**6**	2.6	4.4	52.2	**6**
Harmful Gases	3.1	7.3	62.0	**3**	2.7	6.0	53.2	**5**
Noise	3.0	9.5	59.0	**4**	3.7	5.4	73.2	**1**
Solid and Liquid Waste	3.6	5.6	72.2	**1**	3.0	4.8	59.0	**3**
Erosion	2.6	6.6	52.7	**5**	2.5	4.3	50.7	**7**
Ground Movement	2.4	6.8	48.3	**7**	3.6	4.6	72.7	**2**
Fallen Objects	3.3	6.9	65.4	**2**	2.9	5.8	57.6	**4**

Piles Driving gave off noise and ground movement strongly high and then also some significant levels of solid and liquid waste as shown in Table 6 above. The grading activity was responded as giving off dust but the responses for all the other forms of pollution and hazards were generally low with the RIIs ranging from 41.0 to 54.1. This information is summarized in Table 7.

Table 7: Services and Grading

	Services				**Grading**			
Factor	Mean	SD	RII	Rank	Mean	SD	RII	Rank
Dust	2.5	8.5	49.8	**2**	2.7	2.3	54.1	**1**
Harmful Gases	1.7	11.5	34.1	**7**	2.2	6.6	44.9	**6**
Noise	2.5	9.6	49.8	**3**	2.6	10.2	51.7	**3**
Solid and Liquid Waste	2.6	7.7	52.2	**1**	2.6	3.8	52.3	**2**
Erosion	2.5	8.2	49.3	**4**	2.3	5.7	45.4	**4**
Ground Movement	2.2	7.1	43.9	**6**	2.3	5.3	45.4	**5**
Fallen Objects	2.4	5.3	47.8	**5**	2.0	8.4	41.0	**7**

The construction of bridges and culverts equally returned very low general responses except for the level of noise pollution (RII = 60.0). Apart from that, all the forms of pollution and hazards associated with the construction of bridges were relatively low. There were however high responses for quarrying activities. There results summarized in Table 8 show that dusts, noise, solid and liquid waste and fallen objects were the high forms of pollution for quarrying.

Table 8: Bridges and Culverts and Quarrying

	Bridges and Culverts				Quarrying			
Factor	Mean	SD	RII	Rank	Mean	SD	RII	Rank
Dust	2.1	7.2	42.4	**6**	4.0	7.1	80.0	**1**
Harmful Gases	2.0	7.2	39.5	**7**	3.4	6.3	67.3	**5**
Noise	3.0	5.7	60.0	**1**	4.0	9.1	79.0	**2**
Solid and Liquid Waste	2.5	7.4	50.2	**5**	3.9	7.0	78.5	**3**
Erosion	2.7	6.2	53.2	**4**	3.0	2.2	60.0	**7**
Ground Movement	2.9	6.1	57.6	**2**	3.3	5.0	66.8	**6**
Fallen Objects	2.7	4.2	53.7	**3**	3.7	5.0	73.7	**4**

In terms of the pollution and its related hazards, the chart in Fig 1 and Table 9 shows the average and percentage of responses respectively given irrespective of the construction activities considered. Noise pollution which was highly present in almost all the activities was averagely the highest followed by ground movement and finally dust.

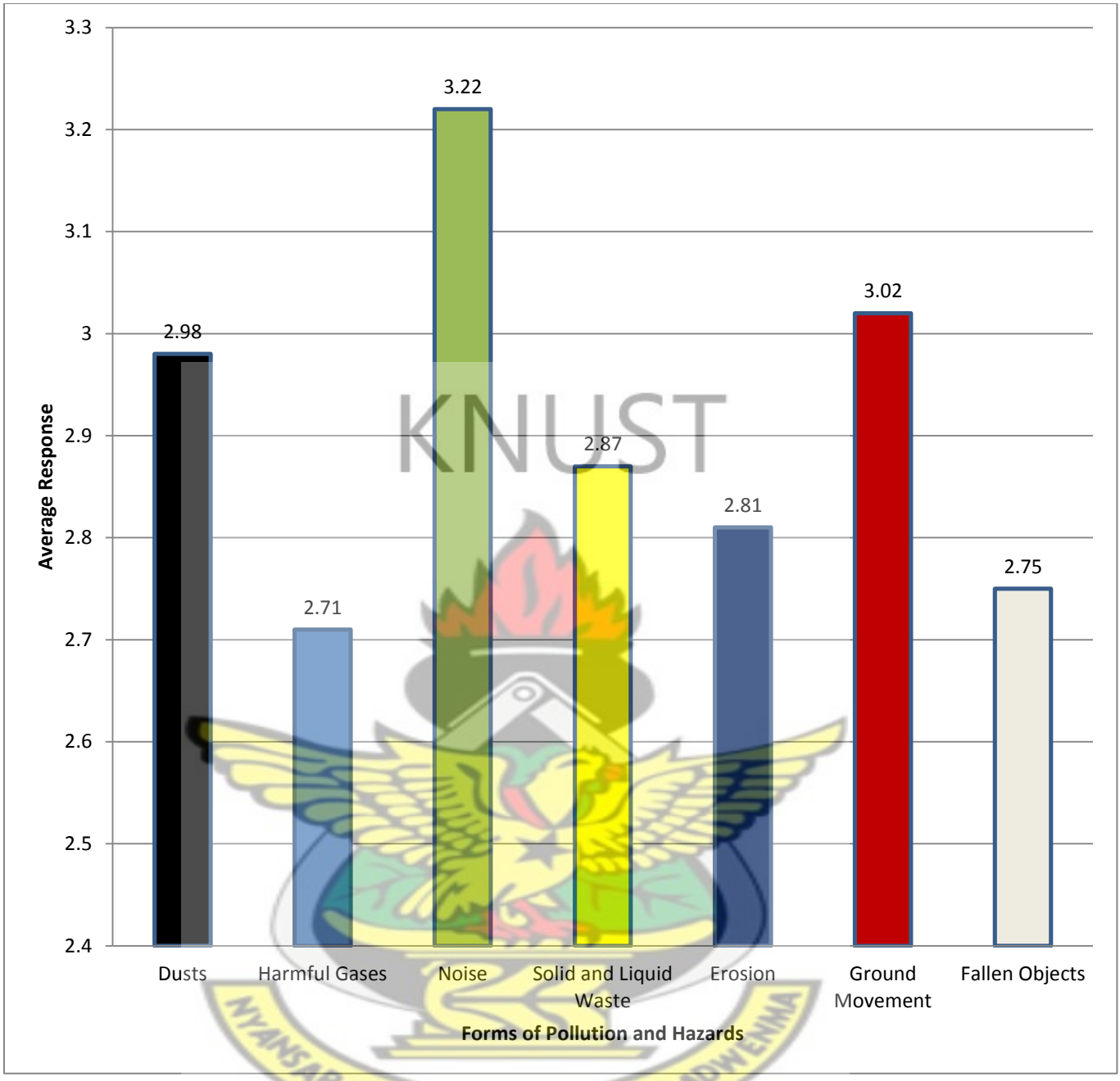

Figure 1: Average Responses for Forms of Pollution and Hazards

Table 9: Percentage of Responses for Forms of Pollution and Hazards

Factors of pollution	Responses	Percentage (%)
1.Dust	29.8	14.6
2. Harmful Gases	27.1	13.3
3. Noise	32.2	15.8
4. Solid and liquid waste	28.7	14.1
5. Erosion	28.1	13.8
6. Ground movement	30.1	14.8
7.Fallen objects	27.5	13.5
Total	203.6	100

4.3.2 BEST MANAGEMENT PRACTICES MOSTLY USED

The research also investigated best management practices mostly used in the effective management of pollution and hazards which respondents were asked to rank using the likert scale as follows: 1 – poor, 2 – average, 3 – credit, 4 – very good and 5 – excellent for controlling pollution and hazards during road construction.

The specific management practices that were examined and ranked included management of erosion, dust, harmful gases, noise, ground movement (vibration) and solid liquid waste and fallen objects.

The minimization of vegetation clearing was notably ranked as very good observed management practice for controlling erosion during road construction.

Watering road area with water was also ranked as the mostly used best management practice for controlling dust generation on road construction site. However, the water used in watering the road area was averagely mixed with additives. Other practices like deep ripping smooth surfaces

and avoidance of leaving disturbed land in an unstabilised condition were averagely practiced. This information is summarized in Table 10.

Table 10: Management of Erosion and Dust

	Factor	Score	Average	SD	RII	Rank
1	***Erosion*** Minimize clearing of vegetation	149	3.63	7.56	72.68	2
2	***Dust*** Water road area with water	174	4.24	10.01	84.88	1
3	Watering road area with mixture of water and additives	119	2.90	4.32	58.05	3
4	Deep ripping smooth surfaces and left rough and cloudy	99	2.41	9.07	48.29	5
5	Avoid leaving disturbed land in an unstabilised condition	115	2.80	7.01	56.10	4

Table 11 shows the summary of respondents' opinions on the management of harmful gases during road construction. It shows that generally appropriate emission controls are fitted and machines used on site are also mostly serviced. However, there is often a non-avoidance of prolonged visibility of smoke from equipment.

Table 11: Management of Harmful Gases

	Factor	Score	Average	SD	RII	Rank
1	Fitting appropriate emission control	158	3.85	7.40	77.07	1
2	Frequent maintenance of equipment	141	3.44	6.30	68.78	3
3	Serviced Machine to manufacturers specification	153	3.73	12.34	74.63	2
4	Avoid prolong visibility of smoke from equipment	110	2.68	7.36	53.66	4

Noise pollution which was observed as the highest form of pollution according to this research is however poorly managed compared to other forms of pollution. The average responses and relative importance indices are revealing of this fact as shown in Table 12.

Table 12: Management of Noise

	Factor	Score	Average	SD	RII	Rank
1	Limit times of operation of machines	132	3.22	6.80	64.39	3
2	Installation of silencers on machines	140	3.41	7.98	68.29	1
3	Servicing equipment frequently	133	3.24	7.85	64.88	2
4	Avoid out of hours deliveries	115	2.80	6.42	56.10	4

Table 13 shows the results for management of ground movement (vibration).

Apart from the installation of appropriate mufflers on earth moving equipment, all other factors are not being practiced standardly.

Table 13: Management of Ground Movement (Vibration)

	Factor	Score	Average	SD	RII	Rank
1	Limit times of operation of machines	121	2.95	5.02	59.02	5
2	Installation of appropriate mufflers on earth moving equipment	155	3.78	6.57	75.61	1
3	Servicing equipment frequently	132	3.22	5.89	64.39	3
4	Avoid out of hours deliveries	129	3.15	5.54	62.93	4
5	Application of New technologies	141	3.44	7.26	68.78	2

The management of liquid and solid waste was significantly in force given that waste generated on site is disposed of in a responsible environmental manner, there was recycling of water for

usage, improved technology were used and there was reuse of water on site. See Table 14 for the summary of responses on management of solid and liquid waste during road construction projects.

Table 14: Management of Solid and Liquid Waste

	Factor	Score	Average	SD	RII	Rank
1	Using improved technologies	153	3.73	7.60	74.63	3
2	Reuse of waste on site	151	3.68	6.10	73.66	4
3	Recycling of waste for usage	158	3.85	8.17	77.07	2
4	Disposing off waste in responsible environmental manner	166	4.05	7.29	80.98	1

Table 15: Management of fallen objects

	Factor	Score	Average	SD	RII	Rank
1	Recycling of waste	56	1.37	0.61	56	3
2	Improving technology on site	134	3.27	0.43	82	2
3	Applying good safety control	154	3.76	0.45	94	1
4	Applying good recovery measures	79	1.93	0.70	48	4

The management of fallen objects was responded to be significantly in force as good safety control measures were applied in combination with improving the technology on site to curb the hazard of fallen objects on road construction site. Recycling of waste and application of good recovery measures were hardly practiced. See Table 15 for the summary of responses on management of fallen object during road construction projects.

4.3.3 CHALLENGES OF THE ENVIRONMENTAL PROTECTION AGENCY

From the interview made with the EPA on the challenges it faces in the enforcement of the mitigation measures stated in the Environmental Impact Statement or the Preliminary Environmental Report on urban road construction projects the following findings were identified,

Firstly, there is a resource limitation for monitoring of road construction project operations.

The EPA does not have adequate number of qualified personnel, funds and equipment to monitor road construction project activities. It was identified that most of the essential equipment to assist the personnel in checking the levels of pollution on road construction sites are few and only the Headquarters of the EPA has them.

Moreover, the frequency of visitation to road construction sites by the EPA personnel is minimal as they lack the funds and personnel to be frequently visiting the many road construction sites to enforce the mitigation measures stated in their environmental impact statement.

Furthermore, there is the problem of institutional gab between road construction stake holders in charge of protecting the environment from the adverse effect of the road construction operations. This is because EPA deals directly with the client of undertakings and not the contractors. That is to say that the EPA deals directly with the Department of Urban Roads and not the urban road contractors who will be undertaking the activities which have adverse effects on the environment. This could lead to the Department Urban Roads submitting an Environmental Impact statement which the urban road contractor might have less input in it and hence the permit could be granted for the commencement of the road construction project without the urban road contractor having an environmental management plan for mitigation of adverse effects associated with the road construction.

Adding to these, breaks in road construction projects due to financial constraints from the Government makes it difficult to enforce mitigation measures. This is because the contractor wouldn't be on the site to be charged with the duty of mitigating the pollution associated with the cleared road area surface which is left untarred due to the financial constraints on the side of the client.

Again, it becomes difficult to enforce mitigation measures stated in environmental impact statement when road construction projects are funded by international bodies with a time frame on the spending of funds. This released fund goes back to the international body to another country if funds are not used within the scheduled time. This makes it difficult to enforce mitigation measures as it could delay the project finish time and hence sometimes these types of road projects could start before permit is even granted.

CHAPTER FIVE

SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUTION

5.1 INTRODUCTION

This chapter presents a summary of the findings, the recommendations made to address the findings and finally the conclusions drawn from the analysis of this research.

5.2 SUMMARY OF MAJOR FINDINGS

The aim of this work is to identify the severity of pollution and or hazards on urban communities during urban road construction projects and recommend measures to manage the pollution and hazards which affect the health and well being of people in the urban communities in Ghana even with the implementation of Environmental Assessment Regualtion,1999(LI 1652).

The study revealed that though all the seven factors of pollution contribute to pollution during road construction but the most prominent sources of pollution were *noise pollution* recording 15.8% followed by *ground movement* with 14.8% and then pollution from *dust generation* with 14.6%. That is to say that the severity of noise pollution was identified to be highest in almost all the activities followed by ground movement and then dust pollution.

Moreover in the usage of best management practices in controlling pollution and hazard the following were identified; firstly, watering of road area with water was ranked as the best management practice mostly used for controlling pollution from dust. Other practices like deep ripping smooth surfaces and avoidance of leaving disturbed land in an unstabilised condition were averagely used dust controlling measures on road construction sites.

Moreover, the findings of the data analyzed showed that the mostly used way of managing water erosion was to minimize the clearing of vegetation as much as possible during road construction. Again, it showed that mostly appropriate emission controls are fitted following the servicing the machines used on site. However, there is often a non-avoidance of prolonged visibility of smoke from equipment used on site.

Moreover, Noise pollution which was observed as the highest form of pollution according to this research, was poorly managed compared to other forms of pollution in our urban environment.

According to the analysis, it was identified that apart from the installation of appropriate mufflers on earth moving equipment, all other factors are not being practiced standardly to manage ground movement.

However, the management of liquid and solid waste was significantly in force as waste generated on site were mostly disposed of in a responsible environmental manner, there was, however, recycling of water for usage, improved technology were used and finally reuse of water on site.

Moreover, it was gathered from the interview with the Environmental Protection Agency that its major challenge to the effectively enforcement of the pollution and hazard mitigation measures stated in the Environmental Impact Statement of projects is the lack of adequate resources. This cuts across with the lack of adequate scientific equipment, vehicle, personnel and like of others which will help the Agency in intensifying its environmental monitoring duties holding road construction project managers and developers to task of safeguarding the environment.

5.3 RECOMMENDATION

Based on the analysis of this research, it was identified that the three most critical sources of pollution are *noises*, *ground movement* (*vibration*) and *dust generation*.

The researcher thereby recommends that road construction project managers increase the frequency of employing best management practices to control pollution and hazard with special attention to the three critical sources of pollution during urban road construction operations. This is believed to go a long way of help safeguard the environment in the urban communities.

The Environmental Assessment Regulations, LI 1652, was promulgated in 1999 to give complete legal status to the Ghana Environmental Impact Assessment procedures to control pollution in the environment. However, enforcing the mitigation measures stated in environmental impact assessment of road construction companies has not been effective due to lack of adequate resources on the part of the Environmental Protection Agency and hence the researcher recommends that adequate resources should be allocated to the Environmental Protection Agency in other to help intensify the monitoring system of the EPA to help safeguard the sustainability of the urban environment.

Furthermore, the researcher recommends that the urban road contractors should be educated on adoption of international standards of environmental management systems like Leadership in Energy and Environmental Design (LEED), (ISO 14000) into their construction management practice through organization of seminars and workshops by the Environmental Protection Agency. This will enlighten urban road contractors on the need for adoption of international management systems in Ghana.

By so doing the urban road construction companies can integrate the concept of environmental management practice.

5.4 CONCLUSION

In order to minimize pollution and hazards generated by urban road construction projects in Ghana, the researcher first presented a quantitative system to identify the severity of the road construction operations in the urban environment.

The challenges of enforcing pollution mitigation measures with the introduction of the environmental assessment regulation were also identified.

In conclusion, there is more to be done in pollution management even with the implementation of the Environmental Assessment Regulation, (1999).

The severity of pollution associated with urban road construction projects identified in this research can assist road construction project managers and contractors to identify the most critical sources of pollution during road construction operations.

This will go a long way to assist road construction project managers and the Environmental protection Agency to identify the critical source of pollution on various road construction operations in other to take necessary preventive measures to reduce the amount of pollution and hazards.

It will be beneficial if this research is taken up in the near future and scientific devices are employed in the measurement of these sources of pollution from the various road construction activities on several urban road construction projects in the country.

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APPENDIX

QUESTIONAIRE TO ROAD CONSTRUCTION PROJECT MANAGERS

Introduction

This questionnaire is aimed at achieving adequate information to come out with a systematic approach to environmental management of pollution and hazards caused by urban road construction projects in Ghana. The information you provide will assist me in achieving the goals for this research and hence guarantee you that information you provide will be kept confidential.

Personal Data

Name: ----------

Name of company: ----------

Position: ----------

Qualification: ----------

Level of experience (years):----------

Section 1

1. With your experience kindly rank on a scale of 1-5(with **5** as the highest and **1** as the lowest) where, indicating severity the following sources of pollution and hazard are during the listed road construction activities.

Activity	(A) Dusts	(B) Harmful gases	(C) Noise	(D) Solid& liquid waste	(E) Erosion	(F) Ground movement	(G) Fallen objects
(a)Road Clearing							
(b)Excavation							
(c) Filling							
(d)Compaction							
(e)Waste disposal							
(f)Piles driving							
(g)Services							
(h) Grading							
(i) bridges and culverts							
(j)Quarrying							
Others(please specify)							
(k)							
(l)							
(m)							
(n)							
(o)							

Section 2

2. On a scale of 1 to 5 with (**5 as the highest and 1 as the lowest in usage**) kindly rank the best management practices mostly used for controlling the following pollution and hazards during road construction.

MANAGEMENT OF EROSION AND DUST					
Erosion	1	2	3	4	5
(a)minimize clearing of vegetation					
(b) others (pls specify)					
Dust					
(b) water road area with water					
(c)watering road with mixture of water and additives					
(d)deep ripping smooth surfaces and left rough and cloddy					
(e)avoid leaving disturbed land in an unstabilised condition					
(f)others(pls specify)					

MANAGEMENT OF HARMFUL GASES	RATINGS				
	1	2	3	4	5
(a)fitting appropriate emission control					
(b)frequent maintenance of equipment					
(c) serviced machines to manufactures specification					
(d)avoid prolong visibility of smoke from equipment					
(e)Others(pls specify)					

MANAGEMENT OF NOISE	RATINGS				
	1	2	3	4	5
(a)limit times of operation of machines					
(b)installation of silencers on machines					
(c) servicing equipment frequently					
(d)avoid out of hours deliveries					
(e)application of new technologies					
(f) others(pls specify)					

MANAGEMENT OF GROUND MOVEMENT	RATINGS				
	1	2	3	4	5
(a)limit times of operation of machines					
(b) Installation of appropriate mufflers on earth moving equipment.					
(c) servicing equipment frequently					
(d)avoid out of hours deliveries					
(e)application of new technologies					
(f) others (pls specify)					

MANAGEMENT OF SOLID AND LIQUID WASTE	RATINGS				
	1	2	3	4	5
(a)using improved technology					
(b) reuse of waste on site					
(c) recycling of waste for usage					
(d)disposing of waste in an environmental responsible manner					
(e)other measures(pls specify)					

MANAGEMENT OF FALLEN OBJECT	RATINGS				
	1	2	3	4	5
(a)recycling waste					
(b) improving technology on site					
(c)applying good safety control					
(d)applying good recovery measures					
(e) others(pls specify)