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The Impact of Unique Physical Features of Mass Housing Projects on Construction Site Safety

by

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DECLARATION

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

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ABSTRACT

Poor construction safety practices have been a major challenge to the construction industry. In order to effectively establish appropriate measures to curb the problem, there is the need for a thorough understanding of certain factors influencing accidents on sites. Mass Housing Projects differ significantly from the traditional "one-off" projects as such would require different unique management skills and approaches to its delivery. No specific focus has been accorded to examining the impact of unique physical attributes of MHPs on Construction Site Safety performance even though there have been studies on managing Site Safety in construction projects and on the impact of Construction project features on Health and Safety. The study sought to evaluate the influence of unique physical features of Mass Housing Projects (MHPs) on Construction Site Safety performance. Contextual definitions of MHPs and Safety on site were explored thoroughly and comprehensively through review of literature. Deductive research approach and Quantitative research methods became most suitable in addressing the research questions. The method of data collection was the use of questionnaires. Purposive Sampling became the most appropriate choice of sampling technique. Mean score ranking, Relative Occurrence Index and Structural Equation Modelling were the analytical tools used for the study. Out of 255 questionnaires administered, 202 were received from the various Health and Safety officers and Construction Site Engineers from 35 MHP delivery firms registered with Ghana Real Estate Developers Association. Data on the Site Safety performance indicators showed that *falling of material from heights to injure workers, contact with underground power cables, collapse of excavations or trenches, slips due to oily/dusty floors, falling of persons from scaffolds, repetitive bending at the waist causing injury, lung problems from dust, back injury resulting from the repetitive nature of a work item* occurs most in MHPs. In line with deductive research, the findings from the Structural Equation Model underpinned the development of a model of the causal influence of unique physical features of MHPs on Construction Site Safety. With respect to Multiple Construction Site physical features, *Quality Management Style* and *Construction Technology and Method* affect safety most. Safety Events occurring most due to the unique Multiple Construction Sites are; *Exposure, Contact With, Fall Same Level and Repetitive Stress Injury.* Cultural influence also showed high impact on safety due to Multiple Geographical Location. Safety Events that were identified to be mostly caused by Multiple Geographical Locations are; *Repetitive Stress Injury, Struck By, Fall to Below, Overexertion* and *Caught In accidents*. A framework was developed through the findings from the Structural Equation Modelling to establish the relationship between the major concepts and the substantial findings identified. The study adds significant contribution to the already existing body of knowledge in the field of safety performance in the construction industry in the area of MHPs. The developed framework should be the basis for developing a training program for the workforce and also the type of accident records kept on site.

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LIST OF ACRONYMS

BLS - Bureau of Labour Statistics
CFI - Comparative Fit Index
CPWR - Centre for Construction Research and Training
CSE - Construction Site Engineers
EQS - Structural Equation Modelling Software
GDP - Gross Domestic Product
GLD - Ghanaian Labour Department
GREDA - Ghana Real Estate Developers Association
GSS - Ghana Statistical Service
H&S - Health and Safety
HIPC - Highly Indebted Poor Country
HS - Housing Sector
HSC - Health and Safety Statistics
HSE - Health and Safety Executive

ILO	- International Labour Organisation
MHP	- Mass Housing Project
MPE	- Multiple Project Environment
NEBOSH	- National Examination Board in Occupational Safety and Health
PPE	- Personal Protective Equipment
R^2	- Coefficient of Determination
RMSEA	- Residual Mean-Square Error of Approximation
ROI	- Relative Occurrence Index
SEI	- Safety Event Indicators
SEM	- Structural Equation Modelling
SOCSO	- Social Security Organisation
SPSS	- Statistical Package for Social Science
VR	- Variable Ratio
WHO	- World Health Organisation

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DEDICATION

I dedicate my dissertation to my family and loved ones. A special feeling of gratitude goes to my loving parents, Dennis and Grace Abankwa whose words of encouragement and push for tenacity ring in my ears.

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CHAPTER ONE INTRODUCTION 1.1 BACKGROUND OF THE STUDY

Safety at the workplace is a core issue observed by various organisations responsible for protecting the well-being of their human resources. It is not an easy task to ensure site safety especially in construction due to temporary worksites and the various/different types of trades involved in the industry. The construction industry is among industries that records high rates of accidents (Fang *et al.,* 1999; Ahmed and Hassan, 2003). Accidents resulting from construction activities often happen due to certain failures and defects (Yates and Lockley, 2002; Fredericks *et al.,* 2002). The unpredictable nature of the environment also affects construction activities whether manual or mechanical. Most building contractors do not observe some principles of Safety such as the use of PPE's, protection against falls from heights and site H&S meetings (Musonda and Smallwood, 2008). Serious accidents continue to occur on various construction sites despite the awareness and importance of construction safety. The construction industry especially is being challenged with huge costs of projects arising from the fatalities and injuries associated with construction accidents.

Office of Government Commerce (2004) in the United Kingdom adds that, Health and Safety on construction projects has become a significant objective and this has created the need for the implementation of measures to reduce the rate of construction accidents. Determination of the effective and appropriate measures to control Health and Safety problems in construction is based on deep knowledge of the sites. Construction of the site is mostly dangerous for construction workers due to exposure to a number of hazards such as noise and dust, material handling and transportation, overhead work, chemicals and explosives, and adverse climatic conditions. Despite active promotion of programmes of occupational health and safety on construction sites, the safety record remains poor (Uher and Ritchie, 1998).

The construction industry has been dealing with a bad reputation of H&S over the last 20 years. In the 1990s, the number of fatalities in the construction industry showed an appreciable decline (HSE, 2000). It should not encourage complacency. Managing construction activities have a solid and everlasting challenge and it is to ensure safe working conditions (Griffith and Howarth, 2000). In order to realise the potential benefits of Safety compliance, McKay *et al.* (2005) stated that the construction industry could equally adopt a proactive H&S mind-set similar to the already existing ones in the manufacturing industry.

As seen in Behm (2005), Gambatese *et al.* (2008), Maitra (1999), and Szymberski (1997), Construction supervisors, Project Managers, Design Engineers and Architects have an efficacy to reduce or minimise occupational injuries on construction sites. The basic or primary causes of accidents on sites are linked to materials, workplace and work team, and equipment. These are brought into existence in shaping factors, such as designs, attitudes/motivations, and specifications.

In order to find the factors necessary for eliminating the root causes of accidents on construction sites, Toole (2002) undertook a study into some traditional design-bidbuild projects. The outcome of his study was that there are five typical abilities needed of a construction party to develop which were: 'task expertise', 'worker interaction and control' 'safety expertise', 'evaluate site conditions' and 'control site'.

Given the changing nature of construction projects, it is necessary to move from 'allfit-all' approach to specific projects (Sauser *et al.*, 2009). Safety studies in the construction sector have tended to focus on building 'one-off' projects (see Manu *et al.*, 2014; Musonda and Smallwood, 2008; Rowlinson and Farrell, 2008; Chileshe and Dzisi, 2012). The nature and unique attributes of construction projects is one of the reasons attributed to the causes of Safety issues on Construction sites. The inadequacy in these studies is the limitations in its generalisation and application to all project typologies.

Manu *et al.* (2010) mentioned that, construction projects have unique and certain distinguishing physical, organisational and operational attributes. The various unique attributes of construction projects significantly impact communication, health and safety, effectiveness of management and performance of projects (Adinyira *et al.*, 2013). Traditional building projects are often encounted in the construction industry but are significantly different from Mass Housing Projects (MHPs) and hence require distinctive managerial skills and approach to its delivery (Kwofie *et al.*, 2014; Adinyira *et al.*, 2012; Ahadzie *et al.*, 2007).

The natural choices for large scale housing in many developing countries are MHPs hence any attempt at improving its management will warrant the successful delivery of construction projects. The nature of MHPs makes Construction Health and Safety more significant as compared to other building projects due to its development on multiple sites in different geographical areas or on a large construction site. Some researchers have showed H&S on construction project features while others have developed unique features pertaining to MHPs but the contribution of the unique features of MHPs to Construction H&S performance remains to be interrogated empirically.

1.2 STATEMENT OF PROBLEM

Poor construction safety practices are a major challenge to the construction industry. In order to effectively establish appropriate measures to curb the problem of construction site safety, there is the need to have a thorough understanding of certain factors that influences accidents on sites. Attention must be given to the underlying causal factors in order to have sustained improvement in health and safety despite the persistent reporting of the accident causal influence of construction project features such as the method of construction, nature of project, subcontracting, design complexity, site restriction and procurement system (Haslem *et al.*, 2005; Brace *et al.*, 2009).

According to Ahadzie *et al.* (2007), Kwofie *et al.* (2014) and Adinyira *et al.* (2012), Mass Housing Projects differ significantly from the traditional "one-off" projects. Given the position that MHPs differs from 'one-off' projects, both types of projects would require different unique management skills and approaches in their delivery. There has been enough past and present literature on managing Construction health and safety whiles other studies have looked at the impact of Construction project features on Health and Safety (see Behm and Schueller, 2012; Manu *et al.*, 2014). Little or no specific focus has been accorded to examining the impact of unique physical attributes of MHPs on Construction Site Safety. In recent times, the need to improve construction site safety under physical, organisational and operational features of MHPs is become an utmost necessity. A clear understanding of unique features of MHPs and their impact on Construction Site Safety will be critical towards improving the delivery of Mass Housing Projects.

1.3 AIM AND RESEARCH OBJECTIVES

The aim of this study is to evaluate the influence of unique physical features of Mass Housing Projects (MHPs) on Construction Site Safety Performance.

The following objectives are established to endeavour to accomplish the broad aim stated above;

1. To identify the main challenges with Construction Site Safety performance on Mass Housing Projects.
2. To evaluate the impact of the Physical Features of Mass Housing Projects (MHPs) on Construction Site Safety performance.

3. To propose a framework for the management of Construction Site Safety performance on MHPs.

1.4 RESEARCH QUESTIONS

The following questions serve as guide to finding answers to the aim and objectives of the study;

1. What are the main challenges in relation to construction site safety performance on MHPs?
2. How do the physical features of Mass Housing Projects impact Construction Site Safety performance?
3. How can construction site safety performance on mass housing projects be better managed?

1.5 BRIEF RESEARCH METHODOLOGY

One way to systematically solve a problem of research is through the methodology of that research study. The research methodology also takes into consideration steps employed by a researcher in studying the research problem along with the logic behind them. Settling on the most appropriate methodology for a particular study is the most critical step after identifying the specific objectives for the study. The aim of a research methodology is to provide the work plan of the researcher. The study delves into the extent to which unique physical features of mass housing projects have an impact on Construction Site Safety. Contextual definition of MHPs and Safety was explored. The deductive research approach was adopted for this study. The research method employed was purely the quantitative research. For the purposes of this study both primary and secondary data were used. Primary data comprised of first-hand information participants gave during the survey by use of structured questionnaires. Secondary sources of data were obtained from the conclusions set out in published documents and literature (journals, books, articles, research papers and some thesis) which relate to the research problem.

The extant literature review helped discover the academic paradigms supporting the subject area. Related literature on construction safety, and mass housing projects were thoroughly and comprehensively reviewed in the early stages of the study through peer-reviewed conference papers, published journals, books and other publications to identify the challenges of Safety performance in MHPs. The Safety Performance Indicators were analysed using Relative Occurrence Index and Mean Score Rankings. In addition to this, it becomes appropriate to use Structural Equation Modelling (SEM) as an analytical tool to assist in the identification of the relationship existing between the variables from the collected data. The raw data collected was alo processed using Statistical Packages for Social Sciences (SPSS) and Microsoft Excel. The results were later transferred to the Structural Equation Modelling (EQS) Software (Version 6) for analysis.

1.6 SIGNIFICANCE OF STUDY

This study is of value to Mass Housing Project developers and the construction industry as a whole. The study not only enabled these developers know the Safety issues regarding the development of Mass Housing Projects but also provided these developers with a guide to direct them on how to manage Safety performance on construction sites. This guide was generated in relation to the unique key physical features of mass housing projects. The study would assist Mass Housing Project developers confidently undertake projects with little or no fear of Safety risks which brings about a sound and cordial working environment; effective communication at the construction work site; reduction in the occurrences of injuries; decrease in sick pay and lost time; reduction in material damage; decrease in insurance premiums; reduction in litigation costs; increase in the rate of production and productivity.

1.7 SCOPE OF THE STUDY

There have been several studies on health and safety practices in the construction industry. These studies generally considered the traditional "one-off" building projects. This study focused on Mass Housing Projects since mass housing projects are known to have different attributes and characteristics from the traditional "oneoff" projects (Ahadzie *et al.*, 2007). The study further focused on Unique Physical Features of Mass Housing Projects and their impact on Construction Site Safety performance. Construction Site Safety considered physical injury or accidents on Mass Housing Project sites. Health on construction sites and the environmental protection aspect of MHPs are not considered under this study. The study is limited to construction sites of firms managing mass housing projects. These firms belong to the Ghana Real Estate Developers Association (GREDA) of Ghana. The study focused on mainly one major region in Ghana that is the Greater Accra region. The Greater Accra region houses the capital of Ghana (Accra) and is one of the largest regions in Ghana as such sees a lot of construction projects. A study undertaken by Ahadzie in 2007 indicated that over 60% of construction companies registered tend to officially operate in the region Greater Accra given that the growth of the economy is largely skewed towards the capital. Ahadzie *et al.* (2014) also reported that about 95% of these Mass Housing construction sites have their head office based in the Greater Accra region with the remaining 5% based in the other 9 regions of Ghana The study was also limited to the Greater Accra due to the active contribution of the GREDA members in the region.

1.8 STRUCTURE AND ORGANISATION OF THE THESIS

This research dissertation shall be divided into six (6) chapters. These chapters related but were independent of each other. The structure is as follows;

Chapter one: **Introduction** – The introduction briefly described what the whole content of the study was about. The background discussed in the Introduction was on the health and safety issues relating to building projects. Chapter one spelt out the statement of problem warranting the research effort. Chapter one also introduced the research aim and objectives, scope of study and research questions.

Chapter two: **Mass Housing Projects** – This chapter focused on the review of literature on Mass Housing Projects; an aspect of project typologies and its economic significance. The various unique features of Mass Housing Projects that is operational, physical and organisational features is considered under this chapter. The contextual definition of MHPs and its current state is also presented in this chapter.

Chapter three: **Safety Performance** – Chapter three presented Safety performance in the construction industry. It looked at the definition of certain terms, benefit of Safety performance, promoting Safety in the industry, improving employee safety and the major causes of accidents in the Construction Industry. The first

part of the research objective which is to identify the main challenges with construction site safety performance on mass housing projects is addressed.

Chapter four: **Research Methodology** – This chapter described the structured process of conducting the research. Detailed discussions have been provided on the analytical tools that have been employed for the data collected. The Chapter highlighted the process of the research, research design, research style, and research approach. The sample population, sample size, the sampling technique and the questionnaire design were described in Chapter three. The methods used to analyse the data have been explained.

Chapter five: **Data Analysis and Discussion** – The appropriate formulas for all relevant statistics used in analysing and interpreting the collected data were discussed in this chapter.

Chapter six: **Conclusion and Recommendations** – Chapter Six gave the final summary of the research work done by reviewing the main contributions of the research to knowledge. The conclusion chapter stated the limitations to the research work and gave recommendations based on the findings of the data analysis. Other areas for future research were indicated and suggested in Chapter Six.

The organisation and structure of the thesis is summarised in **Figure 1.1**

Three

Chapter One

Chapter Four

Chapter Two

Chapter Five

Chapter

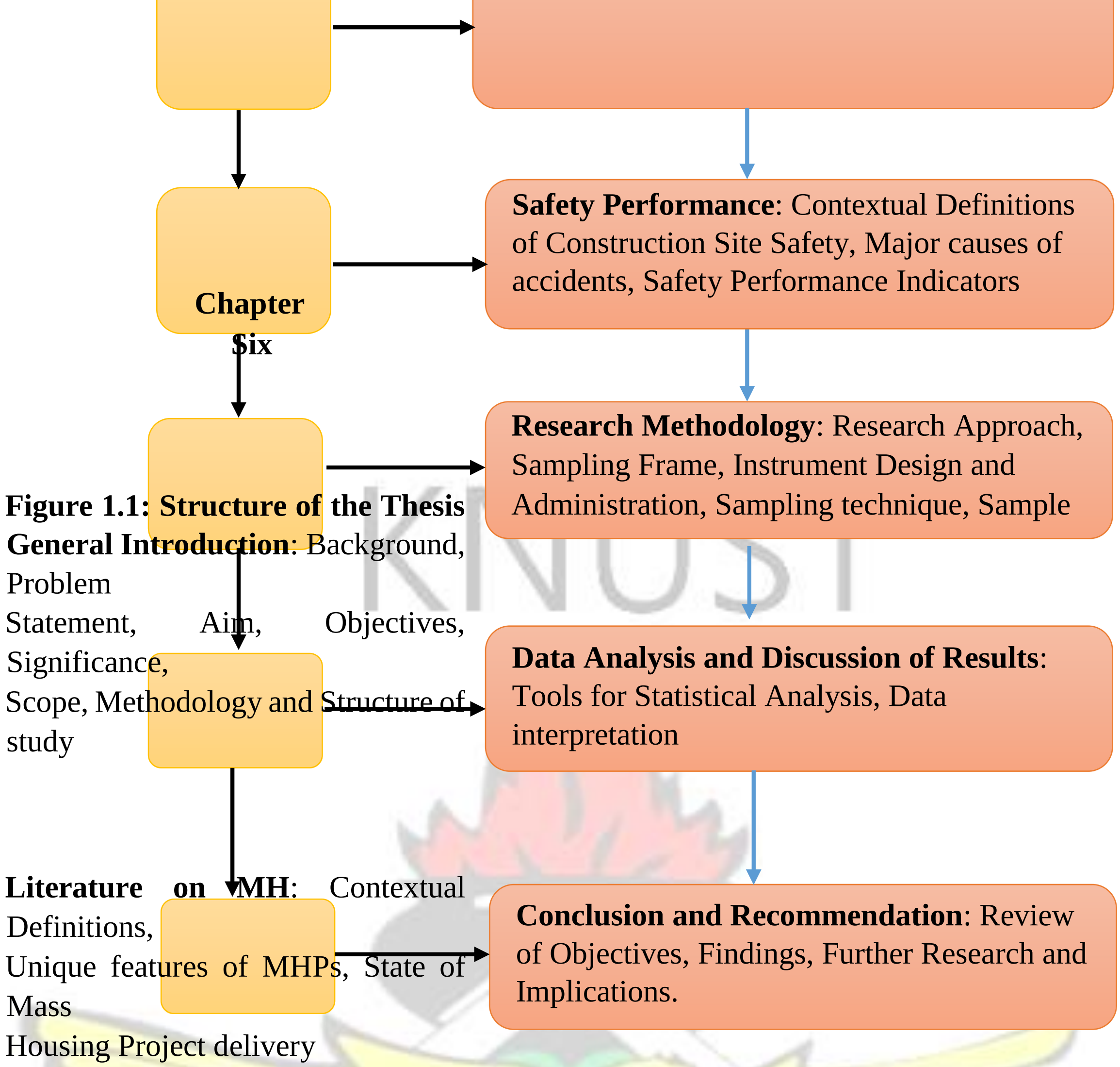

Figure 1.1: Structure of the Thesis

1.9 SUMMARY OF CHAPTER

The study sought to evaluate the influence of unique physical features of mass housing projects on construction site safety in the Ghanaian construction industry. The research approach employed for the study was the deductive research approach and the research method was quantitative research. The study was limited to construction sites of firms managing mass housing projects and registered with the Ghana Real Estate Developers Association. Six related but independent chapters constituted this research study.

CHAPTER TWO MASS HOUSING PROJECTS 2.1 INTRODUCTION

In many developing and some developed countries, adequate housing remains a great challenge or problem. According to Ajanlekoko (2001), it is seen that cities in Africa are growing at a fast rate and as a result Governments in African countries are under the pressure to make available infrastructure and house its populace which they are unable to match the demand. Ndubueze in 2007 claimed that, the factors responsible were interrelated, complex, interconnected, inadequate financial resources and low capacity in the public sector to implement many housing projects. For a number of reasons, Governments continue to fall short of the expectations of them providing housing for their populace and even fail to effectively manage various agencies acting on their behalf. Governmental institutions in many developing countries continue to hand over their prerogative of providing housing facilities to the private sector even when the project scheme on hand is completely feasible and on top of it affordable.

Mass Housing provides the enabling environment for the public and the private sector to take part more actively. The development of Mass Housing Projects aims at bridging the wide gap existing between demand and supply of housing units in many countries hence making the management of MHPs require certain distinct and special approaches.

This chapter focused on the review of literature on Mass Housing Projects; an aspect of project typologies and its economic significance. The various unique features of Mass Housing Projects (operational, physical and organisational) are considered under this chapter. The contextual definition of MHPs and its current state is also presented in this chapter.

2.2 THE CONCEPT OF MASS HOUSING

Housing has never been a major part of the national economic planning of many developing countries. In Ghana for instance, housing is usually being considered as part of the welfare sector. Housing and Housing groups entails a basic and vital life space in a residential environment to meet and fulfil the needs of the residence and to preserve the complete health and safety of people and the community. Several needs that arises due to problems or challenges showing up from housing is located in a psychological, physical and socio-cultural environment. This composed with their environs affect resident attitude and satisfaction hence guiding the total individual and public health, welfare and happiness.

The World Bank recognised the significance of housing in national economic progress in 1976 because residential construction projects contributed 20 – 30% of Gross Fixed Capital (GFC) formation in industrial economies in Western Africa. The most paramount economy in which the performance of the housing market has unalterably been considered an important indicator of economic health is that of the United States (Lee and Ngai-Ming, 2006). Hasty urbanisation has enticed cheap labour from country hinterlands in East Asia which at the same time yielded great claim for land use and housing since the 1970's. Lee and Ngai-Ming (2006) also indicated that demographic changes, increase in income, aspirations of housing together with matching changes in policy are essential for the increase of prices of houses both in the private and public sectors. Decent housing is considered to be the foundation or basis of a countries economic productivity. Housing is known to preside over the development of entrepreneurship and education and also of better neighbourhoods.

Yoney and Salman (2010) have shown that the purpose for the delivery of housing projects has gone through a lot of revolution since the early 1990's. Mass Housing approach of project delivery took over the market which was being dominated by "build and sell" or "build and rent". Mass Housing involves the construction of building projects in large quantities of housing units in many countries around the globe (Pulat and Ozsoy, 2008). Mass Housing therefore is an idea of housing development that is overtly financed and administered for low-income families.

Kolawole (2012) and Turk and Guven (2008) outlined in their study that, meeting the rising housing demands in several nations in the sure genuine paradigm globally is the development of Mass Housing Projects. There has been a lot of witnessing in the interventions aimed at swelling the rate of housing development by developed and developing countries.

In reducing housing deficits in many developed and developing countries, mass housing development has become the sure production paradigm. In modern times, the fast extension of cities such as freshly developed mass or reasonable housing estates are being situated away from the congested urban centres. In the developed countries, it is rather within the city urban textures that public housing projects have been incorporated in order to create a strong foundation for the development of fresh townships along with cheaper land. Mass production methods of housing development projects can be described as the absorption of mass housing into the construction industry from the industrialised segment as indicated by Kwofie *et al.* (2014). Various definitions of mass housing have therefore taken into consideration the physical features of MHPs. This is to say that, most definitions by researchers if not all on mass housing looks at the size, extent of resources involved and nature of designs (Ahadzie *et al.*, 2008). To the Indians, mass housing projects refer to a multistoried apartment-type house constituting a floor area of 70–120 square meters costing about $27,000 – $77,000 (THDC, 2014). The underlining theme here is “large unit production” which is a physical attribute of MHPs. Other themes that have been considered under the definition of mass housing are “multiple site locations” and “repeated schemes”. Kwofie (2014), however, realised that, the various definitions of mass housing failed to take into consideration the managerial contractual aspects of the project that makes MHP distinct or different of traditional one – off projects. Due to numerous and different interpretation of construction practitioners, it is difficult to define the number of units that represents a mass housing project. The delivery of mass housing projects practically dominates by way of schemes. Under contractors or subcontractors in itemised procurement characteristics, these schemes are embarked on by manifold contract packaging of housing units.

A yearly production rate of 10 house-units per 1000 populations for emerging nations is very suitable to meet their current and imminent housing necessities as recommended by Edmonds and Miles in Kwofie (2014). Unique managerial challenges, coordination and programming site projects and repetitive nature of mass housing projects are furthermore given.

In Ghana, the development of the housing industry began after the attainment of independence from colonial rule. The following section critically examines the differences between Mass Housing Projects and traditional "One – Off" projects to identify literature gaps that need occupying and go on to make certain cases for bridging those gaps.

2.2.1 Mass Housing and "One-Off" Traditional Projects

Adinyira *et al.* (2013) defines Mass Housing as the development of standardised, several, repetitive domestic type house units which is either in same or different geographical locations but constructed under one project scheme with one management body for either speculative or user defined delivery. Kwofie *et al.* (2014) added to this explanation by stating that Mass Housing Projects is the ***design*** and ***development*** of standardised several domestic house-units mostly in one or different geographical locations, undertaken within the same scheme of project by one management body and contract. This definition considers the three key aspects of mass housing projects which are the physical, organisational/managerial and operational. Knowing the nature or attributes of various project typologies is key to the management of its delivery. Identifying the features of construction projects enables practitioners make right choices in terms of the style or approach towards the management of projects. It is therefore unmistakeable or unquestionable that a clear understanding of the nature and features of projects is required towards an effective management style to ensure successful delivery of projects (Kipp, 2008). Mass housing projects (MHPs) share attributes that are significantly different from “oneoff” construction building projects (see Adinyira *et al.*, 2012; Ahadzie, 2007).

One of the key attributes of mass housing projects is that, it is developed on multiple construction sites. This makes it have the multiple site nature of projects which is totally different from one-off projects where it is developed solely on single sites. Unlike in traditional one-off projects where the construction of the building project emanates from one particular building design on a single construction site, Mass Housing Projects constitutes repetitive design units. Studies of some research have pointed to the impact of repetitive nature of mass housing projects and delivery strategy on the organisation and scheduling complexities (Mahdi, 2004; Hwang *et al.*, 2013). McKay (2002) indicated in his study that, one-off projects have easily defined source of environmental impact. The multiple site location nature of MHPs has led to the multiple sources of environmental impact from various schemes (Kipp, 2008). MHPs demonstrate multiple sites location that outlines the immediate cognition and method of management making MHPs unique to ‘one-off’ traditional construction building projects regularly chanced upon in the construction industry (Ahadzie *et al.*, 2014). Ahadzie *et al.* (2014) again indicated that mass housing projects often occupy large geographical areas which transcend to more than one geographical and administrative land boundaries of administrative regions, suburbs, cities, communities and towns. Concerning the procurement of goods and services under the various project typologies, traditional “one-off” projects have a relatively simple procurement system unlike mass housing projects that are characterised by complex network of procurement systems peculiar to its development (Ogunsanmi, 2012). This makes traditional procurement arrangement and task management approaches highly unsuitable under MHP due to its multiple design typologies in its contract packaging.

MHPs are characterised by exclusive repetitive simultaneous engineering elements often displayed in its design and contract packaging that meaningfully affects construction health and safety across the project life-cycle. One-off traditional projects are characterised by single geographical locations and as such requires single duration for project unlike MHP where multiple duration for several standardised design-units under schemes are required.

Favie and Maas (2008) indicated that mass production often show multiple duration for finishing tasks and construction units when centred on by housing developments outside the broad attributes of most construction projects. Traditional “one-off” projects processes relatively easier subcontracting processes or procedures than MHP which constitute multiple interdependent subcontracting procedures under various schemes (Manu *et al.*, 2010).

Oladapo (2002), McKay *et al.* (2002) and Enshassi (1997) have identified the unique features of mass housing projects as: project duration of repetitive units, wide extensive geographical locations, procurement system, management concepts, contract packaging, subcontracting and concurrent engineering elements.

Kumaraswamy *et al.* (2005) added that MHP displays several scheduling and planning attributes inherent from multiple interrelated tasks, elements and packaging making them highly susceptible to risk induced failures than traditional projects. Health and safety, communication, managerial effectiveness and project performance are greatly influenced by the exceptional groups of features of projects (Adinyira *et al.*, 2013).

2.3 MASS HOUSING IN GHANA

In Ghana, providing housing has frustrated successive governments since independence. The problem lies with money. Factors like corruption, mismanagement and fraud have combined to sabotage many efforts made to house Ghanaians of which some of these are genuine. Series of 'affordable' houses that were built for ordinary Ghanaians were not affordable. The houses built by the Government went to the wrong people. As a result, the perennial problem of acute housing deficit in the country still persists. Most housing units in Ghana are produced by individuals and the owner's savings as the source of funds. In Ghana, those who vigorously carry out mass housing projects are three core bodies. They are the Government, NonGovernment Organisation (NGOs) and Ghana Real Estate Developers Association (GREDA).

The participation of Government in active mass housing distribution from the turn of the 1980s, nonetheless, has been non-existent (Konadu-Agyemang, 2000). Since the turn of the 1980s, all initiated mass housing project schemes in Ghana stayed uncompleted and neglected. Konadu-Agyemang (2000) attributes this to the fact that Government of Ghana has been incapable of making any single contribution to housing supply. Proper and useful records do not exist on organisations carrying out or delivering mass housing projects (MHPs) and unfortunately, delivery from NGOs has also been very inconsistent and almost unattainable. This makes recognising and contacting these NGOs very hard. In mass housing delivery the determination of Quasi-

Government institutions such as the Social Security and National Insurance Trust (SSNIT) is also accredited. Mass Housing projects is speculative or owner defined and its development has been defined by the Ghana Real Estate Developers Association (GREDA). Through mass housing delivery, the government of Ghana has also recognised Ghana Real Estate Developers Association as the major contributor to the national housing stock and gone ahead to frame policies to back and strengthen GREDA to escalate their out-put (BOG, 2007).

2.3.1 The Economic significance of Mass Housing Sector in Ghana

According to Giang and Pheng (2011), the construction industry of every country be it developed or developing plays a major role in its economic development. The contribution of the construction industry of many countries is manifested in the Gross Domestic Product (GDP) of the country. The total contribution of GDP by the industry is about 5% in most African countries as compared to 7% in the developed countries. Wells (2007) indicated that, out of these GDP contributions, the Housing Sector (HS) accounts for about 60%. It is stated by Kolawole (2012) that, the delivery of mass housing has gained global acceptance as a way a country meets the growing demands in housing. This opens many countries up to foreign investments or investors.

2.3.2 The State of Mass Housing Sector in Ghana

The housing shortage in Ghana is between 1,500,000 to 2,000,000 units as projected currently. To keep this situation from deteriorating is to be able to produce 150,000 housing units annually but the country can produce only 45,000 housing units yearly. In the near future given the existing situation on the ground the situation cannot be expected to be better. In Ghana’s development framework, Housing development has never been considered a serious area.

With the interest rate approaching 60% and inflation over 50%, the cost of funding houses became so expensive. That even made it difficult for real estate developers to finance new projects. New pronouncements were made on housing when there was a change of Government in 2001. They looked globally for housing funds, like all others before them, but none materialised at that time (GREDA, 2014). The Highly Indebted Poor Country (HIPC) debt relief program of the World Bank with Ghana's involvement permitted for some funds to be made obtainable for housing. Government of Ghana has received 10 million Euros in support from a Belgium bank since that time, for the development of infrastructure for fresh affordable housing projects (GREDA, 2015). Available statistics indicate that current housing deficit exceeds 1.7 million units and is expected to increase at a rate of 70,000 housing units annually (Issuers Department of the Securities and Exchange Commission, 2014). Although the Real Estate Industry is growing at an annual average rate of about 10%, not many Ghanaians benefit properly from that growth. Majority of construction going on the country are done by foreign businesses, the materials and expertise used are imported and the cost of the completed buildings is far beyond the reach of the average Ghanaian. That leaves many underprivileged indigenes in the position of mere spectators in an industry that is fast becoming the cash-cow of the economy (GREDA, 2014). Lack of records on the various agencies registered under GREDA made obtaining the output of mass housing sector and its actual size difficult. Due to population increase and relocation to the urban areas, simple infrastructure lags ominously behind demand. A tale of futile economic policies, the history of housing in Ghana is de-facto.

A number of developers in Real Estate projects carry out their activities under the auspices of the Ghana Real Estate Developers Association (GREDA). Even though investments such as Treasury Bills and Bonds are safe and profitable, it prevents

Commercial Banks from getting involved in financing Real Estate projects. The housing conditions in Ghana were worse than in most nations in Sub-Saharan Africa, according to a report evaluation of World Bank staff on April 17, 1990. The key features were as follows: -

- Yearly income was 12 times lesser than the price of houses. This was 4 times lesser than that of Western Europe and the United States.
- The total lack of long-term mortgage financing.
- About 26% - 30% interest rates recorded as high.
- Unproductive housing and land markets.
- Restrictions on rent, which contributes to fewer incentives for the construction of private rental housing.
- 50% foreign exchange content in housing delivery.
- Conservative estimate of yearly housing delivery deficit was 27,000 units Fuelled by a speedily growing middle-class, as well as fast and uncontrollable urbanisation high property charges predominantly in the urban centres such as Accra, Tema, Kumasi and Tarkoradi have turned the housing industry into one of the serious developmental matters facing policy makers in Ghana. Compared with number of households as at 2000, total number of houses indicated severe overcrowding in most houses. There are about 8.7 persons living in each house in Ghana on the average. The average household size is 5.1 persons in Ghana with about 1.7 people in a house and a total of 2,181,975 national units as indicated by the census (GREDA, 2015). The population vis-à-vis this number of households' is obviously insufficient. A total of 3,708,250 housing units will be needed in Ghana in a situation where every household of 5.1 persons for instance were to have individual units of housing then ceteris paribus.

Since the formation of the association in 1988 private real estate developers have erected over 10,954 new homes under the umbrella of the Ghana Real Estate Developers Association. Value of land for instance, at a prime locality such as East Legon ranges between $40,000 and $60,000 per residential plot. In Tema (a suburb of Accra), serviced plots range between $15,000 and $18,000. Lands close to main road networks attract huge prices for instance in Kumasi, the second largest city the prices of un-serviced urban lands range from $20,000 to $40,000 (Mahama, 2004) cited in BOG (2007).

According to the latest Living Standards Survey of Ghana, urban areas compared badly for standards of Habitat for Humanity of three rooms per family. 62.9% of households have only a single sleeping room. Twenty-five (25) years after the establishment of GREDA, there has been some militating factors such as:

- Challenges in land acquisition and management;
- Unavailability of long term capital;
- High cost of capital;
- Low disposal income of the working class (both formal and informal);
- Lack of engagement and high cost of Professional/Technical services fees;
- Low absorption capacity for external funds by the Ghanaian financial institution;
- Non-adherence to strict development regulations and management
- Nonexistence of any collaborative engagements between construction product manufacturers and estate developers
- Nonexistence of any collaborative engagement between statutory agencies and the estate developers
- High taxes on construction input resources (i.e. materials and plants) (GREDA, 2015)

Often, Ghanaians hide behind the huge housing deficit and throw up her hands in despair. Unfortunately, Ghana cannot afford to despair because with the population growth rate of over 2.5% per annum, the housing deficit, which currently stands at 1.7 million, will get even worse. That is because, by 2030, Ghana will have a population in excess of 30 million and a major housing crisis would just be on our hands. In Kalmoni's (2014) opinion, cited in GREDA (2015) he proposed to define a house having the following features; One hall (or more), One bedroom (or more), One washroom (or more), Secured and enclosed with independent electricity and water meter/connection, Minimum net area of $45m^2$, Kitchen may be part of hall or partitioned. He went ahead to propose to define the cost of affordable as follows

- Cost of house and land: not more than $65,000
- Cost of legal/survey fees: not more than $1000
- Cost of electricity and water meters: extra (Kalmoni, 2014) cited in GREDA (2015).

2.4 UNIQUE FEATURES OF MASS HOUSING PROJECTS

The unique characteristics of Mass housing Projects were identified and distinguished from the characteristics of traditional "one-off" projects in Kwofie (2014). In addition to the above, Kwofie *et al.* (2014) classified the unique features of mass housing projects under operational, organisational and physical features. This unique nature of MHPs contributes to the managerial challenges that result in development failures when management do not adapt approaches to the project characteristics. Having knowledge and understanding these unique features are critical towards enhancing the planning, organisation and delivery success of mass housing projects. Kipp (2008) has also shown that building projects that are referred to as mega are huge in terms of size, have complex procurement systems, consist of different delivery durations and exhibit great challenge with reference to management. The several unique characteristics of mass housing projects classified under the physical, organisational and operational features of MHPs is represented in **Table 2.1** below. These various classifications were adopted for the research. The complex network of team relationship, multiple inter-reliant subcontracting and complex network of procurement systems are portrayed as the organisational features of MHPs (Ogunsami, 2012; Adinyira et al., 2013). The physical features of MHPs are shown by multiple sites for the numerous units, multiple geographical locations and multiple standardise design-units as indicated in a study by Ahadzie *et al.* (2014). The operational functions that surround MHPs define its unique operational features. According to Hwang *et al.* (2013), the operational features of Mass Housing Projects are found in their planning and scheduling of the housing units, the organisation of the project preliminary activities and also the various packages for subcontracting and labour contracting.

Table 2.1: Classification of unique features of MHPs

S/No	*Variables*	*Physical*	*Organisational*	*Operational*	*Remarks*
PF1	*Multiple sites for various units*	***33***	*3*	*0*	***Physical***
PF2	*Multiple standardised designunits in scheme*	***32***	*2*	*2*	***Physical***
PF3	*Multiple geographical location for schemes*	***31***	*5*	*0*	***Physical***
PF4	*Virtual team participation*	*3*	***31***	*2*	***Organisational***
PF5	*Complex network of team relationship*	*1*	***30***	*5*	***Organisational***
PF6	*Multiple interdependent subcontracting under scheme*	*0*	***30***	*6*	***Organisational***
PF7	*Complex network of procurement systems*	*0*	***29***	*7*	***Organisational***
PF8	*Multiple duration for units under scheme*	*2*	*10*	***24***	***Operational***
PF9	*Multi-collinear repeated preliminary activities on units*	*3*	*5*	***28***	***Operational***

PF10	*Repetitive tasks on standardised units*	*0*	*7*	***29***	***Operational***

Source: Kwofie *et al.* 2014

2.4.1 The Unique Operational Features of Mass Housing Projects

The operational features of Mass Housing Projects are well-defined by time schedules and planning on housing units, organisation of preliminary activities and contract packaging, and management concept for labour contracting and subcontracting (Hwang *et al.*, 2013).

2.4.1.1 Multiple duration for units under schemes

Manu *et al.* (2010) indicated that, it is mostly found on construction projects that the specified time for a construction project estimated may have changes or variations which may be as a result of either time over-runs or early completion. Brace (2009) also added his voice by stating that in a situation where there is an unrealistic duration set to an activity or the entire project, there is time pressures which would influence the safety management and performance significantly. The duration of a construction project is considered as one of the most essential success elements for a building project along with cost and quality.

2.4.1.2 Multi-collinear repeated preliminary activities on units

Traditional "one-off" projects involve one-time preliminary activities which is not the case under mass housing projects. The Chartered Institute of Building published a Code of estimating Practice which described preliminaries as "the cost of governing a project and providing general plant, site staff, amenities, and site based services and other items not encompassed in the rates".

2.4.1.3 Repetitive tasks on standardised units

Construction projects that are repetitive requires schedules that ensure continuity of work for the resource crews as they move from one unit to another performing a particular task. Traditional "one-off" construction projects consist of "one-off" interrelated skill tasks on a project. Repetitive construction projects are characterised by repetitive activities. Typical examples of such projects are; mass housing projects, multi-storeyed buildings, multi span bridges, pipelines and highways. A great portion of the construction industry is being represented by repetitive projects. There is the movement of gangs or crews from one unit to the other in repetitive tasks on standardised units hence the provision of uninterrupted work-flow of human resource from one unit to the other. It is against this background that Nassar *et al.*, (2003) indicated that, planners need to select a construction schedule that strikes on optimal balance between minimising the project duration and maximising the gang work continuity.

2.4.2 The Unique Organisational Features of Mass Housing projects

According to Ahadzie *et al.* (2004), mass housing project attributes pose some implications on project team in its management. Organisational features of MHPs are described by its intricate network of team relationship, complex network of procurement systems and multiple interdependent sub-contracting under schemes.

2.4.2.1 Virtual team participation

Katzenbach & Smith (1998) defines team as an insignificant number of people with balancing skills who are dedicated to a common goal, objective and approach for which they hold themselves responsible. Unlike teams working in the same location, when teams begin to operate in many geographical locations at a time, there are many challenges present that can have an effect on the efficiency of the teams. Not only will the teams be geographically dispersed but would operate in a completely virtual environment which is what Mass Housing Projects presents. Virtual teams are groups of persons who interconnect through interdependent responsibilities, having a common goal, and work across space, time and organisational boundaries with links reinforced by webs of communication technologies (Lipnack & Stamps, 1997). Geographical dispersion, responsibilities are often highly complex and strategically vital, works are normally undertaken apart more than in the same location are characteristics of mass housing projects visible in virtual teams. The different cultural backgrounds of the team members like the possession of different technical expertise, diverse styles of work, how to work within varied languages, and cultural diversity are one great challenge with virtual team participation are. Communication can be harder among team members since non-verbal cues moreover, such as facial expressions, are missing.

It was stated that one major reason for improving communication within virtual teams and between project manager and contractors would reduce most construction failures that might arise from the construction designs, in Zakaria *et al.* (2004). These design failures might pose certain safety problems to construction workers.

2.4.2.2 Multiple interdependent subcontracting under scheme

Subcontractors provide a solution to the ever booming construction industry that is causing shortages of skills and holding projects up. It is very challenging to manage multiple subcontractors in multiple geographical locations or in multiple construction sites. Many large construction companies sub-contract much of their work, but subcontractor management can be a head ache when you have multiple subcontractors at once. A major problem to face is the keeping of timelines. The delay or lateness of one subcontractor can have a knock-on effect for others. Even in one-off traditional projects, if the plumber or the tiler is delayed, there could be a substantial over-run of the job. Also, the increasing technologies and specialisation with mass housing projects has created a huge reliance on subcontracting in the industry which has consequences for health and Safety in terms of clarity of duties and working relationships and consistency of Health and Safety practices among the workforce (Mayhew and Quinlan, 1997).

2.4.2.3 Complex network of procurement systems

In the successful delivery of the project, Gray and Hughes (2012) stated that procurement systems used in construction projects are considered very essential. Responsibilities within single or multiple project team members that may improve or hinder communication and contractual arrangements would stipulate due to the procurement mode and style adopted on construction projects (Hoezen *et al.*, 2010).

Mass housing projects implement different approaches to procurement in the choice of consulting teams, contractors and procurement of materials unlike one-off projects where there are single procurement approaches. The nature and scope of the work proposed, the allocating of risks, the positioning of responsibility concerning designs, the coordination of work activities, and the price on which the contract is to be awarded is possible to prove the most suitable procurement method to employ on a project in a given situation. The nature of mass housing Projects poses complex networks of procurement systems. This is to embrace situations where design units are constructed to client's branded taste and preference. MHP development has shifted focus from speculative approach in Ghana and many developing countries. These developments tend to spread the contractual and communication network on the project. Contractual agreements on mass housing projects define the contract packaging styles, layout and management of subcontracting works adopted (Ogunsanmi, 2012).

2.4.3 The Unique Physical Features of Mass Housing Projects

Cho *et al.* (2009) indicated that, the physical attributes of a project defines the technical inclination of the work. Unique situations are often encounted with managing projects that involves repetition of work activities or projects in different geographical locations. Construction projects pose critical physical features that define the management style adopted on site (Favie and Mass, 2008).

2.4.3.1 Multiple sites for various units

Managing multiple construction projects is demanding and intensive. This involves the management of multiple vendors, navigating city officials and meeting delivery objectives. This is completely different from the management of one-off projects which deals with one unit on a single construction site. The construction of mass houses on multiple sites would require independent plan, schedule, and control for the multiple projects. Limited resources available would also have to be managed simultaneously across multiple projects. Syed *et al.* (2010) indicated in his study that the uniqueness of multiple sites for various units of MHPs embodies the approach to site management, methods of construction and adopted technologies, management concept of health and safety and the location of site for the housing units.

The most interesting area in handling MHP by far, as indicated by Hashim and Chileshe (2012) is the multiple project environments (MPE) which falls under the physical features of MHPs. Managing Multiple Project Environments (MPEs) poses a lot of challenges to the delivery of MHPs. To offer greater insight into the problems multiple project environments generate, Payne (1995) itemised five categories. First is the inability of the organisation to provide resources. The second category deals with people issues, systems issues and organisational issues. The peoples issue considers the work environment, system issues looks at the work scheduling process and organisational issues turns to consider the approach of matrix organisation.

A single project is an autonomous entity, Olford (2002) explained in his study. With the obligation and duty to get the project done within the specified duration, such projects have devoted project teams which is led or headed by a project manager. Handling multiple projects on multiple sites, in contrast, is allied by logic, the use of common assets or both. Project management on multiple construction sites is therefore, confronted with many more challenges to be likened with managing a single project for a project manager.

2.4.3.2 Multiple standardised design-units in scheme

The close relationship that exists between construction and design is very essential to building projects and should be recognised in the planning of activities. Both processes of construction and design can be viewed as an integrated system. Designs are normally generated from the descriptions of new building projects which are best represented by detailed plans and specifications. Construction is the execution of a design envisioned by architects and engineers hence, in the built environment. Every project is custom designed and constructed. The design of a facility must placate the conditions peculiar to a site and also most projects are site specific and as such its implementation is influenced by natural, social and other conditions such as weather, local building codes etc.

These factors and more poses great challenge to the management of mass housing projects when one particular building design is used on several or multiple construction sites. Having a standard design for the several building units opens the designs to the impact of building codes. In building codes, lack of uniformity has great influence on the design and construction as well as the regulation process for structures. Ahadzie *et* *al.* (2014) revealed that wide geographical area within mass housing construction sites offers design and documentation complexities that affect information flow and site communication.

2.4.3.3 Multiple Geographical Location for schemes

The most shared project types are "One-off" traditional projects. Frequently in closely related departments, a single project is presented in a particular location with a team equally similar, at least to the point where the members of the project team are all associated with the same organisation. In MHPs, units are located on multiple geographical locations. But with totally separate construction works ensuing with separate contractors and designers, it may alternatively be geographically the same site. A situation like this can create administrative difficulties for safety management such as:

- Interface complications between varied contractors, for example deliveries or moving plant and equipment at the same time
- Safety challenges with personnel where the safety procedures differ between different groups of employees on the same site who are working in close proximity to each other
- Administrative difficulties with different parties responsible for housekeeping, security and exclusion zones
- Impacts to public safety from the several construction projects.

The crucial importance in the management of all projects is the planning, because of location away from one project to another. In order to realise true global optimisation, there is a potential requirement for sharing resources. Gholipour (2006) and Blismas *et al.* (2004) indicated that there have been few studies on examining MHPs with little analytical devotion to the management of several projects environment within the construction industry. A situation where a single site for MHPs spreads into different local government administration refers to a feature of mass housing projects. A unique situation when programmes are instituted to advance construction projects by a geographically distributed network organisations face is again noted by Blismas (2001). In the context of Ghana, it could be said that schemes spreading across different geographical locations experience different cultural, political, and socioeconomic practices unique to the different geographical locations.

2.5 SUMMARY

A review on Mass Housing Projects was presented in Chapter Two. This chapter also looked at the state of the housing industry in Ghana and adopted the various classifications of mass housing projects from literature. Mass Housing Projects are different from traditional one-off projects sharing exceptional operational, physical and organisational features as revealed from literature. The next chapter highlights the performance of safety in the construction industry taking into account some performance indicators of construction site safety.

CHAPTER THREE SAFETY PERFORMANCE IN THE CONSTRUCTION INDUSTRY 3.1 INTRODUCTION

Evidence has been documented universally that among other industries the Construction industry records the maximum rate of accidents comprising deaths and immobilising damages (see Ahmed *et al.*, 2001; Fang *et al.*, 2004; Koehn *et al.*, 1995). Safety on Construction Sites is one of the central affairs in many construction firms particular about their human resources. It can be said that wounds, illnesses, or even mortalities are caused by accidents and frequently ensue due to construction failures. Numerous construction or building firms have enjoyed several advantages by enhancing construction safety performance (Jaselskis *et al.*, 1996). Naturally or unnaturally, construction activities are affected by errors and mistake, and the unpredictable nature of the environment. This is due to its mechanical, operational and manual nature. There are several studies on Safety performance in the Construction Industry that sought investigate the root causes of accident occurrences (see Suraji *et al.*, 2001; Abdelhamid and Everett, 2000). Toole in 2002 studied the connection between 'ability to prevent construction accidents' and 'responsibility for site safety'. Objects with limited capabilities should have limited obligation, he proposed. The provision of a safe environment and monitoring of safety performance and those who work closely with operatives should be accountable for site safety as shown in his pragmatic study.

Chapter three presents Health and Safety performance in the construction industry. It looks at the definition of certain terms, benefit of H&S, promoting H&S in the industry, improving employee safety and the key roots of accidents in the Construction Industry. Ascertaining the ineptitude of construction site safety performance on mass housing projects is addressed in the first part of the research objective.

3.2 DEFINING SAFETY, HEALTH AND ACCIDENT

The following Sections considered the definition of safety, health and accident as it applies to the construction industry.

3.2.1 Safety

In order to reach a satisfactory level of danger, safety must be considered as the regulator of hazards. In the construction industry, no work or activity is so important that, it does not require the consideration for safety. To achieve proper or effective safety performance, one key factor is to assign responsibility. In industrial safety, one of the worst records produced emanates from the construction industry. Annually, statistics are being produced by the Health and Safety Executive. These statistics show that fatalities and major injuries in the construction industry are high (HSC, 1990).

Table 3.1: Fatalities and Major Injuries

S/No	*1981*	*1982*	*1983*	*1984*	*1985*	*1986/7*	*1987/88*	*1988/9*	*1989/90*
Fatal injury									
Construction	*9.7*	*9.7*	*11.6*	*9.8*	*10.5*	*10.2*	*10.3*	*9.9*	*9.2*
Manufacturing	*2.0*	*2.4*	*2.2*	*2.7*	*2.4*	*2.1*	*1.9*	*1.8*	*2.0*
Major injury									
Construction					*225.8*	*282.7*	*276.5*	*285.9*	*306.9*
Manufacturing					*92.3*	*145.0*	*142.0*	*143.7*	*141.1*

Source: HSC, 1993

Mortality rate in the construction industry of Malaysia, according to the organisation of Social Security (SOCSO) was more than three time of any accidents in the workplace.

Ailments accounted for nearly RM650 million including reimbursement costs paid out by SOCSO for industrial mishaps.

Abdul Rahim *et al.* (2008) undertook a study on hazards at construction sites. The locations varied from infrastructure works, high rise buildings, housing development (mass housing projects), industry structure and institutional buildings. With regard to housing development, there were twelve (12) main groups of dangers in Abdul Rahim's study. These hazards were power access tools, ladder, roof work, manual handling, plant and machinery, excavation, fire and emergency, dangerous elements, noise, protective clothing and safety to public. The two major hazards at the construction site involved in housing development were manual handling and working at height. A hazard control hierarchy was developed by Professional Safety in 2003 to show the most effective way to control hazards on site to the least effective. **Figure 3.1** shows the hierarchy of controlling hazards.

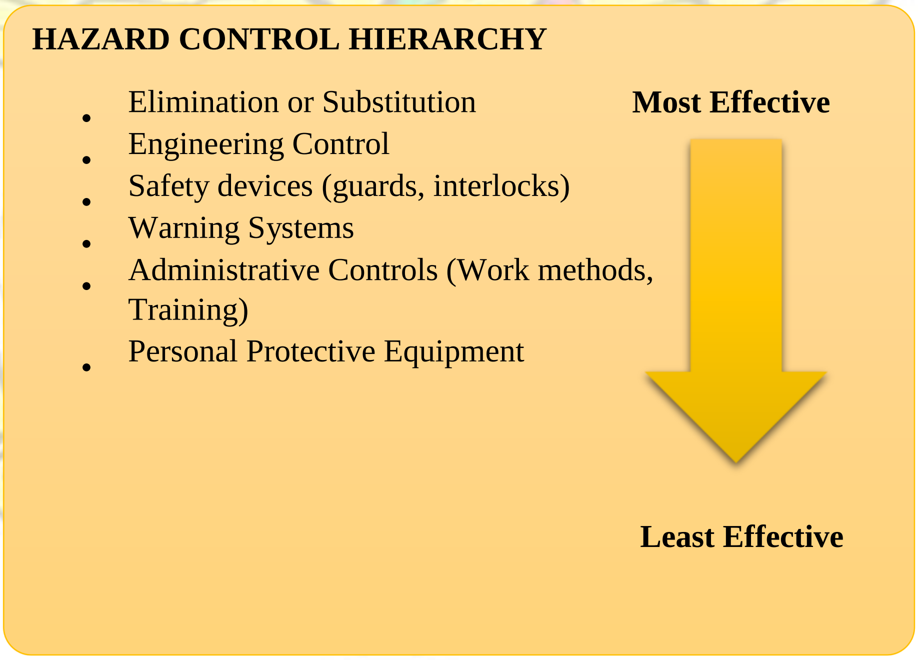

Figure 3.1: Hazard Control Hierarchy

Source: *Professional Safety, February 2003*

Poor safety culture is a decisive factor in the poor security of the construction industry and that unsafe behaviour is a feature of this culture or attitude (Dester and Blockley, 1995).

3.2.2 Health

Defining Health depends on developing enlightenment about a wide variety of perceptions, experiences and subjectivities that are, sequentially, historically, culturally and socially located. Earle (2001a) mentioned that people can find it hard to explicate Health because it has been called ‘an abstract concept’. Not merely the absence of disease or infirmity, Health is a state or place of complete physical, mental and social well-being (WHO, 1948 cited in WHO, 2006). On many occasions, Lucas & Lloyd (2005) and Ewles & Simnett (2003) have criticised the definition by WHO as being unachievable and idealistic and have added that, there are other magnitudes of health that are not considered in the definition like emotional, sexual and spiritual health. In a positive and a negative way, Health can be seen. This definition is likely to consider health as the inexistence of disease if considered in a negative way but in more positive way considers the broader perspective of health taking into account concepts such as ‘well-being’.

Health is something that can be bought (Aggleton, 1990). Through investing in private health care, vended through healthy food stands, given by way of medical mediation or lost through ailment or injury, Aggleton goes on to argue that, health can be purchased. Health can also be interpreted as the foundation for achievement as described by Seedhouse in 2001. Health is a multifaceted and challenged concept and is seen as the means by which we attain our potential, both as persons and as groups. The optimal state of health is equivalent to the set of conditions that allow a person to work to fulfil his or her chosen realistic and biological potentials (Seedhouse, 1986).

Blaxter (1990: 35) also claims that, 'health is not, in the minds of most people, a unitary concept and it is pretty probable to have "good" health in one respect, but "bad" in another, it is multi-dimensional. Colin Johnson (2007) offers a useful framework to the definitions of health. Into four major types he classifies definitions – dictionary definitions, assumptive definitions, determinist definitions and spiritual definitions. These are further explained and sub-grouped in the table below.

Table 3.2: Classification and Sub-Classifications of 'health'

CLASSIFICATION AND SUB-CLASSIFICATION	
Dictionary Definitions	These explain shared everyday ways in which health is defined but, Johnson (2007) argues, are unhelpful.
Assumptive Definitions (including)	Health is presumed to exist if certain conditions can be obtained
- The conceptually relative - The Aspirational (or idealistic) - The descriptive (or stipulated)	Health is explained by reference to other ideas (such as disease). See WHO definition for a classic example of an aspirational description of health Definition expending terms as good or bad to describe quality of health
Determinist definitions (including)	Based on a variety of factors that can be measured and documented
- The Statistical - The Functional	Measuring diverse phenomena as 'health' (for example, fatality rates, healthy life years. Health as the capacity to function (produce, act etc.).
Spiritual definitions	Grounded on a level of faith, a level of affinity in 'other' existence or any other mantra. These are essential to holistic concepts about health.
- Religious - Alternative - Humanist	Health related with the 'moral' and with faith constituents. Definitions based on 'holistic' ideas about health or 'wholeness'. Can be highly private and very personal. A precise approach to human life concerned with development – health is a means to an end.

Source: Johnson (2007)

3.2.3 Accidents

An accident is involuntary and uncontrolled event which has resulted or may result in serious injury, property damage or other loss (Stranks, 1994). Ridley and Channing (2003) also explicate accident as "an unexpected, unplanned event in the sequence of events that occurs due to a combination of reasons, which leads to physical damage (injury or illness) on a natural person, property damage, near-miss, a loss or any combination of these effects". Duff *et al.* (1994) and Lingard & Rowlinson (1994) perceives accidents to be instigated by environmental causes, latent threats in the nature of construction work and psychological features owned by the individual workers. Site conditions (e.g. access to work, etc.), site cleanliness, accessibility of technical resources, inter- and intragroup co-operation, control and supervision of work, effectiveness of long-term organisation, role and place of the safety officer and safety representatives, and pay structure were viewed as the environmental factors. The psychological causes comprised: maintenance and attention by the individual; ability and experience brought to the job; safety training; origins of safety models, accuracy of subjective risk evaluations, perceived tasks, and feeling of capable autonomy or fatalism. The environmental causes have been, in the main, of these two subjects, enacted for and are in the jurisdiction of mechanistic guidelines about guards, safety risks, personal protective clothing, safety at depths and altitudes, collecting statistics, etc. It was until recent that the psychological issues became an addition to the safety research agenda.

3.3 WHY SAFETY

There are several studies on Safety performance in the Construction Industry investigating into the root causes of accident occurrences (Suraji *et al.*, 2001;

Abdelhamid and Everett, 2000). Injury occurrences are of a major concern since the incidence of that lost is a negative parameter (Hinze and John, 2003).

Helander (1991) also added to this by indicating that, the cost in relation to or as a result of construction worksite accidents comprises over 6% of all construction costs.

The effective management of Construction safety will ensure the mitigation of cost incurred as a result of construction accidents (Cascio, 2001). However, statistics from the National Labour Department in Ghana indicate that, the rates of accidents have been increasing steadily every year. The number of fatal construction accidents that occurred between year 2004 and 2009 were significant. In 2004, the number of accidents was 8 but in 2009 rose to 28 (250%). When safety is however addressed, so is health, because a safe workplace is also a healthy workplace. The temporary nature of construction projects poses a major challenge to the various interventions aided for the promotion of safety at the construction work site. Also the workers are often employed to undertake jobs for only a short period and hence do not stay at one job for a long time but transition from one job to another making safety a key issue as compared to health issues that develops over a period of time (Sorensen *et al.*, 2008). It was also confirmed in the study of O'Connor *et al.* (2005) that construction workers are likely to receive inadequate safety training because of the temporary nature of the construction work. Migrant construction workers have known to affect the performance of safety in the construction industry negatively. He added that the change of jobs, over a comparatively diminutive time period, put excessive burden on the administrators of site safety. This is evident where performance is thwarted especially at a period when the construction industry is progressing successfully in addressing issues relating to safety of construction employees. Lin and Mills (2001) also added that the size of a construction industry is a major determinant of the safety performance and the extent to which health and safety practices can be implemented in the organisation.

3.4 BENEFITS OF CONSTRUCTION HEALTH AND SAFETY COMPLIANCE

Safety and health on site is a cross-discipline. That is, they are both concerned with guarding the safety, welfare and health of people involved in work or employment (Lingard and Rowlinson, 2005). Aiming to improve its safety performance so that accidents are eliminated making work form part of a satisfying life to the benefit of both the individual and the organisation is the ultimate goal in any construction firm or organisation. Injury occurrences are of a major concern since the incidence of that lost is a negative parameter (Hinze and John, 2003). Helander (1991) also added to this by indicating that, the cost in relation to or as a result of construction worksite accidents comprises over 6% of all construction costs. Some major costs incurred from the lack of construction health and safety compliance includes; cost of repairing or replacing damaged equipment, cost of time lost in dealing with matters of accidents, the cost involved in the compensation of injured workers, the cost of recruiting or hiring new workers to replace and fill the positions of injured workers and the cost of medical care or mediation incurred by a company which are unexpected and unbudgeted for.

The effective performance of Construction health and safety will ensure the mitigation of cost incurred as a result of construction accidents (Cascio, 2001). Benefits of H&S Compliance lead to the avoidance of loss which is also known as the total loss approach. Accidental damage to product, property and the environment imposes cost on construction firms as well as injuries and ill health. Other benefits derived from the incorporation of safety measures into construction activities were identified by Rudin in 2005 and it is as follows:

- Promote sound and cordial working environment

- Enhance effective communication at the construction work site
- Increase the morale and work quality of employees and
- The likely reduction in the occurrences of injuries, illness or death on the construction site.

HSE (2006) indicated cost savings as the direct benefits of health and safety compliance. The saving of time, expenses on medical care and the possible decrease in the costs of mishaps as a result of improvement are inclusive of extra savings outside the costs of accident. Plummeting sick costs, lowering accident rates, reducing material damage, decreasing insurance premiums, reducing litigation costs and ameliorating the rate of production and productivity are the direct advantages (HSE, 2006). The indirect benefits of health and safety compliance include decreasing nonattendance; enhancing corporate images, enhanced job fulfilment, decreasing sick pay, lost time and overtime working.

3.5 SAFETY PERFORMANCE IN THE GHANAIAN CONSTRUCTION INDUSTRY

The Ghanaian construction industry is an industry among other industrial sectors accounting for the highest level of work-related deaths, the Ghanaian Labour Department (2000) indicated in the year 2000. According to the Labour Department (2000) report, 902 occupational injuries happened in the construction industry out of which 56 were fatal. Ghana has a deprived safety record likened to other countries and this may be attributed to the little practice of technology, labour intensive methods and the low involvement of the workforce in health and safety issues. There is a low infrastructural development level and an equally uneven political climate in Ghana. Joined with an inactive inspectorate division, these factors have steered to poor construction site safety in Ghana and this has been aggravated by shortage of financial and administrative funds to effectively fight construction site injuries and ill health (Nongiba, 2008). To put in place laws governing employment, Cotton, Sohail and Scott (2005) also affirms this by indicating that, less-income countries are controlled by inadequate of effective mechanisms. Many construction operatives in Ghana are hired on temporary and casual basis hence do not have proper definitions of employment conditions therefore giving little protection on employers' safety (Mitullah and Wachira, 2002). Legislation including ILO conventions on health and safety are accepted by parliament nevertheless, their implementation by the significant government bodies is poor. Noticeable by poor performance like many other developing countries is Ghana's construction industry (Anvuur and Kumaraswamy, 2006; Eyiah and Cook, 2003).

3.5.1 Safety practices in the Ghanaian Construction Industry

As an essential part of national improvement many countries and industries rarely recognise health and safety norms. As a result of this, Barling *et al.* (2002) indicated that, health and safety has continued to persist outside mainstream organisational and management researches. Ghana's safety practices may be inseparable from that of other nations in Africa; Ghana is one of the self-governing countries in West-Africa.

Critical areas in construction that must be given attention in terms of effective safety performance are; working at heights, demolition works, excavation works and shoring (Fenson, 2007). Dien (2000) indicated accidents which are normally associated with excavations include the collapse of excavation walls on workers and the bodily contact of workers with underground service lines. Some precautions are taken when working in excavations as stated by the General Provisions regulation (1961). Every worker is to employ proper excavation methods

- Workers with the necessary skills are required to work in excavations

- Provision of safe exits at the work place in the event of any disaster
- Near-by structures need to be inspected regularly to prevent the collapse
- Provide fencing where work is exposed to the public or suited near roadway
- Fix a good quality of timber or other equally good material to excavation sides

Demolition works on the construction site introduces a lot health and safety issues. Some practices were theorised by Sayed (2008) to be incorporated before the undertaking of any demolition work. The following are observed when undertaking a demolition exercise;

- Review the work;
- Stabilise the adjacent buildings;
- Disconnect or Modify Services;
- Secure site to avoid unapproved access;
- Consult Specialists at an earlier stage;
- Re-coup important materials;
- Maintain few operatives on site always;
- Supervision should be done constantly;
- Adopt practical and safe methods that prevent collapse of structures SAFETY should be the main focus at all times.

The erection of scaffolds should be done carefully through the assistance of expects. Every construction firm should consider the loads to be carried on scaffolds before its design and construction. Scaffolds are temporary structures with platforms provided for construction works at heights above 2 meters from the ground level (Abdelhamid and John, 2000). Construction firms must employ safety officers full-time, make available to all worker’s health and safety policies, worker training on health and safety, no alcohol or drug use on site, and make provisions for fire protective equipment (Deany and Yorke, 2005).

3.5.2 State of Safety in the Ghanaian Construction Industry

In 2011, construction events grew by 8.5% in 2010, 8.9%, in 2012 it grew by 10.55% and in 2013 it grew 12.6% (GDP, Ghana Statistical Service, 2013). After the mining sector (International Labour Organisation, 2005), one of the most risky industries is the construction industry. High Health and Safety risks are related with construction jobs such as working at an altitude, underground, in spaces that are restricted and in vicinity close to falling items or materials (Akintoye and Macleod, 1997). Materials, plant and heavy duty equipment used, condition of the physical environment, method employed in executing the works, unsafe exposure to dust, fire, live cables, noise, hazardous substances and the properties of the project itself (Langford *et al.*, 2000) makes the industry risky. In the Construction Industry, accidents are growing at a disturbing rate in Ghana. Almost 90% of the construction locations visited as revealed did not put in place the policies of Occupational Health throughout the implementation of their works, a study conducted by Laryea (2010). Major accidents in the Ghanaian Construction Industry are: Falling of persons from heights; Falling of materials; Collapse of structures on workers; Manual/mechanical handling; Fire/Electric; Struck-by; and Collapse of excavations.

Myers (2007) stated further that about 2% of accidents that occur cannot be prevented due to the unpredictable nature of such occurrence. The following can be associated with the causes of accidents in the Ghanaian Construction Industry: Failure to wear PPE, Disregarding equipment or tool defects, Improper working position, Wrong use of equipment, Failure to secure equipment, Use of Alcohol, Horseplay, Inappropriate lifting, Desecration of Safety and Health guidelines, Operating equipment without authority, Congested work areas, Defective tools, Poor illumination, Poor ventilation, No firefighting equipment, Unstable work areas/platforms and Weak support for excavations. Accidents associated with excavation works include bodily contact with underground services and collapse of wall on people (Dien, 2000). Lin and Mills (2001) under listed the size of the company, commitment of management and workers to health and safety norms as major factors that influence H&S performance in construction companies. The root causes of accidents that Abdelhamid and John (2000) observed are: even after a defective condition has been acknowledged workers proceed with a specific work activity; failure to recognise insecure working conditions before an activity commences; and performing harmfully regardless of the poor working circumstances. Challenges related with H&S management that Tam *et al.* (2004) uncovered comprise; site safety meetings not held regularly, lack or inappropriate Health and Safety training, management having poor levels of awareness on H&S, insufficient provision of protective equipment, reluctance of stakeholders to capitalise in safety assets and thoughtless construction actions.

Accurate statistics of accidents and mortalities in the construction industry in several emerging countries are difficult to come by because a lot of these accidents go unreported (Boakye et *al.*, 2010). In Ghana, nonetheless, the National Labour Department produces certain statistics that show that, accidental rates have been rising steadily every year. Displayed in Table 3.3 below is the number of mortal construction accidents that ensued from 2004 to 2009. The number of accidents was eight (8) in 2004, and in 2009 this rose to twenty-eight (28) (250%).

Table 3.3: Record of Accidents per year

YEAR	**Number of accidents per year**	***Index***
2004	8	*100*

2005	21	*262.5*
2006	29	*362.5*
2007	20	*250*
2008	30	*375*
2009	**28**	*350*

Source: National Labour Department cited in Donkoh, 2015

Safety matters at work according to the ILO (2014), are frequently given less consideration than health issues because the earlier are generally harder to confront. Accident statistics informed to the Labour Department, display that, construction accounted for 1,108 out of a total of 6,064. In the nation's working setting and over 1,500 accidents per 100,000 employees this translates into 18% of accidents. Yet again, only 10% were settled, amounting to 150,000 US Dollars out of the claims recounted (Kheni *et al*., 2010).

Past and present governments of Ghana have not revealed any political will, commitment and provision of policies on occupational health and safety. This was exposed by a study undertaken by Amponsah-Tawiah and Dartey-Baah (2012). The ILO have made and provided over 70 recommendations and conventions that are OHS related, yet only ten have been approved by the government of Ghana.

3.5.3 Challenges to the performance of Site Safety in the Construction Industry

Identification, elimination and management of health and safety risks are key component of effective performance of Health and Safety. Identified risks should be reduced through design or planning and remaining risks should also be managed. The administration of Health and Safety risks requires the coordination and cooperation between all stakeholders or parties of a project who could affect or be affected by risks on a construction project. Most issues of Construction Health and Safety in Africa is the inadequate attention given to Health and Safety by government and the construction industry. In Africa, one of the major perspectives to this concern is that, many countries have meagre health and safety culture (Regional Committee for Africa Report, 2004). Another being that, concerns have greatly been given to increasing profitability and productivity whiles health and safety standards, policies and procedures have been compromised. A neglected view, several African nations have frail administrative justice systems to handle construction health and safety matters. In most African states, there is the rapid spread of several hazards, accidents and health and safety risks. Amweelo (2000) undertook a study on health and safety issues in the construction industry of Namibia and identified careless attitudes towards work as the major factor leading risks and hazards. It is reported in a country like South Africa that, more than 300,000 incidents of health and safety risks takes place every year (Bell, 2007). In most evolving countries for example, like India, Kartam *et al.* (1998) discovered that, there are no training programs for staff and employees; therefore, no orientation for new staff or personnel is organised; risks are not pointed out; and no safety seminars are held. From their own faults and experience, employees are expected to learn. Benin in 2005 held a global meeting to discuss health and safety practices in Africa. It was reported after the meeting, that, most countries in Africa have poor H&S review mechanisms, and others have insufficient H&S policy particularly Ghana.

The absence of a complete national Occupational Health and Safety policy is the major challenge of Health and Safety in Ghana. In the Ghanaian Construction Industry among the main drawbacks to an effective health and safety practice is the poor H&S infrastructure and funding, lack and insufficient number of H&S practitioners in the industry and lack of information (Muchiri, 2003). Challenges also identified by Kheni's study in 2008 were lack of qualified personnel, insufficient state support for regulatory bodies and incompetent institutional structures responsible for health and safety standards. Additionally, one of the challenges to occupational health and safety practices has been insufficient H&S edification (Ministry of Health Report, 2002).

Within emerging countries, International Labour Organisation (ILO, 1996) characterises the poor records on safety and health in construction projects to:

- The high percentage of small firms and the high number of self-employed employers;
- The diversity and comparatively short life of construction sites;
- The high turnover of employers;
- The huge ratio of seasonal and migrant workers;

In executing rules effectively, Regulatory authorities are frequently very weak and work risks are either not observed at all, or perceived to be less hazardous than they actually are (Larcher and Sohail, 1999; Hinze *et al.*, 1998). The following section identifies the cost of Ill-health and Injuries.

3.5.4 The Cost of Ill - health and Injuries

Construction firms and the various stakeholders in a contract have in the past ten years focused on identifying ways of reducing injuries and mortalities that are construction related (Joyce, 2001). The interests of these parties are grounded in the fast moving pace of the cost of injury which is often attributed to the costs of medical treatments. Knowledge on the various costs incurred as a result of bad or poor safety management would enable management perceives the monetary benefits of a competent health and safety management system. A more apparent understanding of the cost benefit can afford an incentive to ameliorate construction safety management, Ikpe *et al.* (2006) indicated. The reduction in the cost of ill-health and injuries leads to the expected benefits of improved health and safety performance. Injuries in the construction industry denote a substantial constant cost to the employers, employees and society (Haslam *et al.* 2005).

Hughes and Ferrett (2008) added that, the cost of ill-health and injuries can be considered in terms of direct costs and indirect charges. Those actual costs that can be directly attributable to injuries and fatalities is defined as Direct cost (Tang *et al.*, 2004). Ferret and Hughes (2007) stated that, resulting from an accident; some costs are less tangible and may not be catered for by insurance. These are indirect costs and are incurred by the changing of time to deal with the outcome of an accident as categorised by HSE. The various direct and indirect costs emanating from ill-health and injuries are shown in **Table 3.4**.

Table 3.4: Direct and Indirect Costs from Ill-health and Injuries

DIRECT COST	INDIRECT COST
Public liability insurance and employers claims	Lowering of employee confidence possibly leading to reduced productivity
Loss through Production and/or general business	First aid provision and training
Fines resulting from prosecution by the enforcement authority	Cumulative business loss
Pay resulting from sickness	Determent of workers from entering the industry
Increases in insurance premiums	The recruitment and training of replacement staff
Any compensation not covered by the insurance policy	Loss of goodwill and a meagre corporate image
Legal representation relating to prosecution	Accident investigation time and any consequent remedial action required
Compensation claim	Production suspensions
Pain, suffering and psychological impact caused to victims, their families and friends	Additional overtime payments
Loss of enjoyment of life	Lost time for other workers
Medical cost	The economic impact on victim's family e.g. decrease in family income

Source: Ipke *et al.*, (2007) and Hughes and Ferrett (2008)

In the construction industry, the consequences of injuries not only affect the owners but also workers, co-workers and the society. Lee and Halpin (2003) indicated that construction work is extremely hazardous but key factors that play a key role in the poor level of safety performance are; poor safety training, inadequate task planning, poor safety management and inadequate incident or accident investigation. Figure 3.2 shows the various parties affected by the cost of accidents in the construction industry.

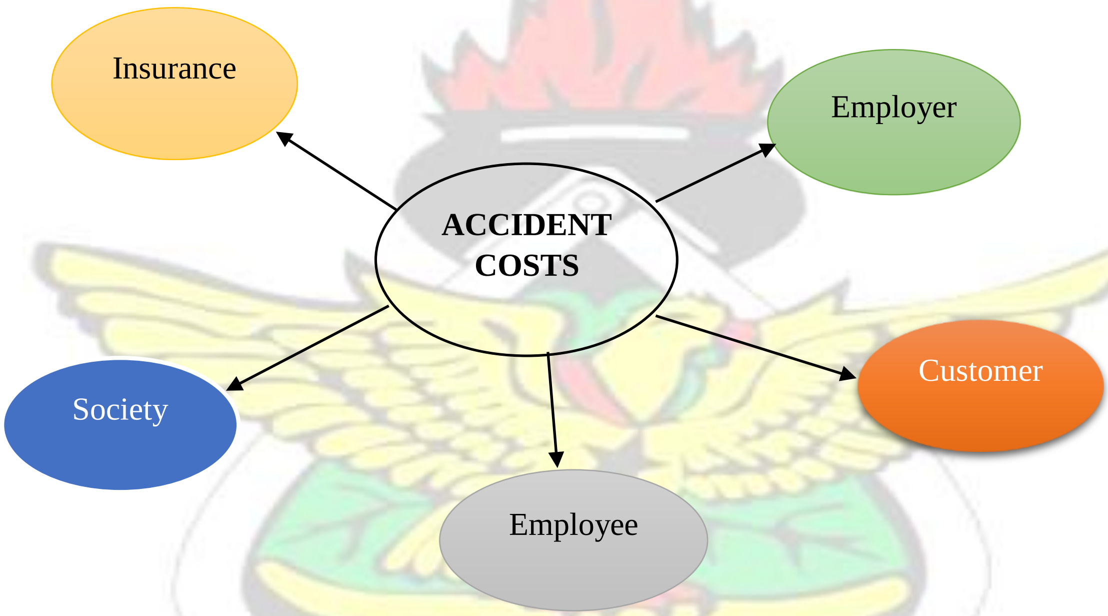

Figure 3.2: Effects of Accident Costs (HSE, 2005)

3.6 PROMOTING CONSTRUCTION SITE SAFETY

In relation to employing, accident reporting and subcontracting of works, there are health and safety problems that can be mentioned on almost all construction sites. Measures should be put in place in all aspects of a construction activity to promote site health and safety. Hinze *et al.*, (2005) said safety performance measure implemented is only significant when that measure is able to prevent injuries from happening on the construction site. Researchers have promoted a lot of behaviour based methodology to health and safety which management of construction firms can employ to promote H & S on site (see Lingard and Rowlinson, 1998).

In ensuring health and safety on the construction site, there should be proper coordination in the roles of contractors, subcontractors, designers and engineers on the construction site (Toole, 2002).

3.6.1 Measures of Improving Employee worksite safety

Management should ensure during the employing of workers, that all personnel who are employed are competent, experienced, and apt to undertake the work safely without placing their own or the health and safety of other workers in danger. Given clear orders workers must also be accurately overseen and again, workers must have the exact protective clothing, tools, plant and equipment. Another key measure to promoting safety is training of workers by educating them on health and safety issues. Within a rational or stipulated timeframe all accidents should be stated to the right authorities. The major or main contractor on a construction project should ensure that every sub-contractor they intend to use on site has been checked of their safety performance procedures. This is very useful in Mass Housing Projects. One key Organisational feature of MHPs is *multiple interdependent subcontracting under the scheme.* Mass Housing Developers employ the services of multiple subcontractors hence must discuss about the work with them before they commence; offer subcontractors the necessary information they need on health and safety before the job commences; and make sure that subcontractors have been provided with everything decided (e.g. safe scaffolds, access to welfare, the right plant, etc.). Mass Housing Developers must check the performance and of their subcontractors and remedy shortcomings.

3.6.2 Measures to Enhance Employee Health and Wellbeing

‘Well-being’ is another concept all together comparing it to health and is hard to define (Chronin de Chavez *et al.*, 2005). The three key facets of theoretical understandings of well-being, centres on the physical, social and psychological wellbeing. Laverack (2004) makes known a suitable way of thinking further about the notion of well-being and categorises it into three different types – physical, social and mental. Physical well-being of a person is concerned with healthy functioning, performance capacity and fitness. Issues such as involvement in social and interpersonal relationships, as well as employment opportunities are a social and mental welfare – which includes a range of factors comprising self- esteem and the capability to cope and adjust. Access to washing and toilet facilities should be available and maintained by contractors throughout the duration of the project. These amenities can and should be provided a vital location reachable within a rational distance or time in Mass Housing Projects where mobile teams work at a number of multiple sites. Clients must guarantee this happens, contractors offer welfare facilities. Within a reasonable or stipulated timeframe all job-related sickness should be reported to the right authorities. Management of MHPs should consider providing living accommodation for employees coming from far to the construction site which can reduce the level of fatigue and stress on workers. Workers must have portable drinking water to prevent dehydration. Where employees have to put on special attires for the purposes of their work, changing rooms and lockers are essential. The rooms must be available with seating, means of drying and keeping clothing and private materials safe. Rest and Canteen amenities are also required on site. These facilities should be adequate for the number of personnel likely to utilise them at any one time. The above are some of the measures to put in place to ensure employee well-being.

The various safety performance indicators are discussed in the next section.

3.7 SAFETY PERFORMANCE INDICATORS

There are numerous safety requirements but the main ones in construction relate to clean sites (proper housekeeping) and decent welfare, transport or vehicular movement on site, manual handling and falls from height. Construction site operators must strategize or arrange activities of workers and certify that they have acquired the necessary training hence competent and aware of all necessary risks of their trade. Difficulties on a construction site must be raised with site supervisors or safety officer operators (HSE, 2009). Personal Protective Equipment (PPE) are essential aspects of managing health and safety but must be regarded as the final resort when considering controlling measures to risk. Mass Housing developers must ensure that all workers or operatives on multiple construction sites have access to PPEs. The following are some health and safety performance indicators identified by researchers;

- Safe access on multiple construction site
- Availability of welfare facilities
- Working at altitude safety precautions
- Harmless scaffolds and ladders
- Roof work safety precautions
- Safe excavations
- Physical handling
- Safe traffic, vehicles and plant
- Harmless emergency procedures
- Fire protection
- Safe storage, control and disposal of dangerous substances
- Handling of noise levels on sites in multiple geographic locations
- Safety in the usage of electricity and other services
- Public protection (Lingard and Rowlinson, 2005; HSE, 2009; Ringen *et al.*,

1995)

Subcontractors must be provided with PPEs to some extent free of charge. Mass Housing Project developers must make sure that all their multiple interdependent subcontractors are in compliance to Health and Safety regulations on site (Laryea, 2010). Laryea (2010) also identified certain key safety performance indicators and these are as follows;

- Execution of works by experienced trained personnel
- Personal Protective Equipment (PPE) – Helmet, safety boots, protective clothing, gloves, eye protection, high visibility vest
- First aid available to all workers employed under the scheme
- Safety officer on all construction sites
- H & S induction on site dangers and site rules
- Display of typical site rules
- Danger signs
- Protection of holes
- Health and Safety fire equipment
- Environmental and waste discarding
- Simple hygiene on site
- Site neatness
- Drug and alcohol check
- Site risk assessment
- Working at height precautions
- Manual handling

Drawing from basics or essential point of this study, the various health and safety performance indicators identified by Layrea (2010), HSE (2009), Lingard and

Rowlinson (2005), and Ringen *et al.*, (1995) were adopted and conceptualised into a framework in Figure 3.3 below. The various safety issues on mass housing project sites derived from the absence of the above indicators can be classified under these various events which cause injury to construction workers. Fall, overexertion or energetic movement, injuries caused by manual handling, struck by falling/flying objects, contact with moving objects or immobile objects, contact with chemicals and exposure to electricity are the main events which cause injury on construction sites (Helander, 1991). The hierarchy of central events for a long time in the construction industry (Falling from heights, contact with falling items, contact with electricity, contact with moving machinery fragments, falling from a moving platform, hit by an automobile, pressed between or against something) continued unchanged (Baradan & Usmen, 2006; Horwitz & McCall, 2004; López *et al.*, 2008; CPWR, 2007). In the safety area this reveals a key weakness.

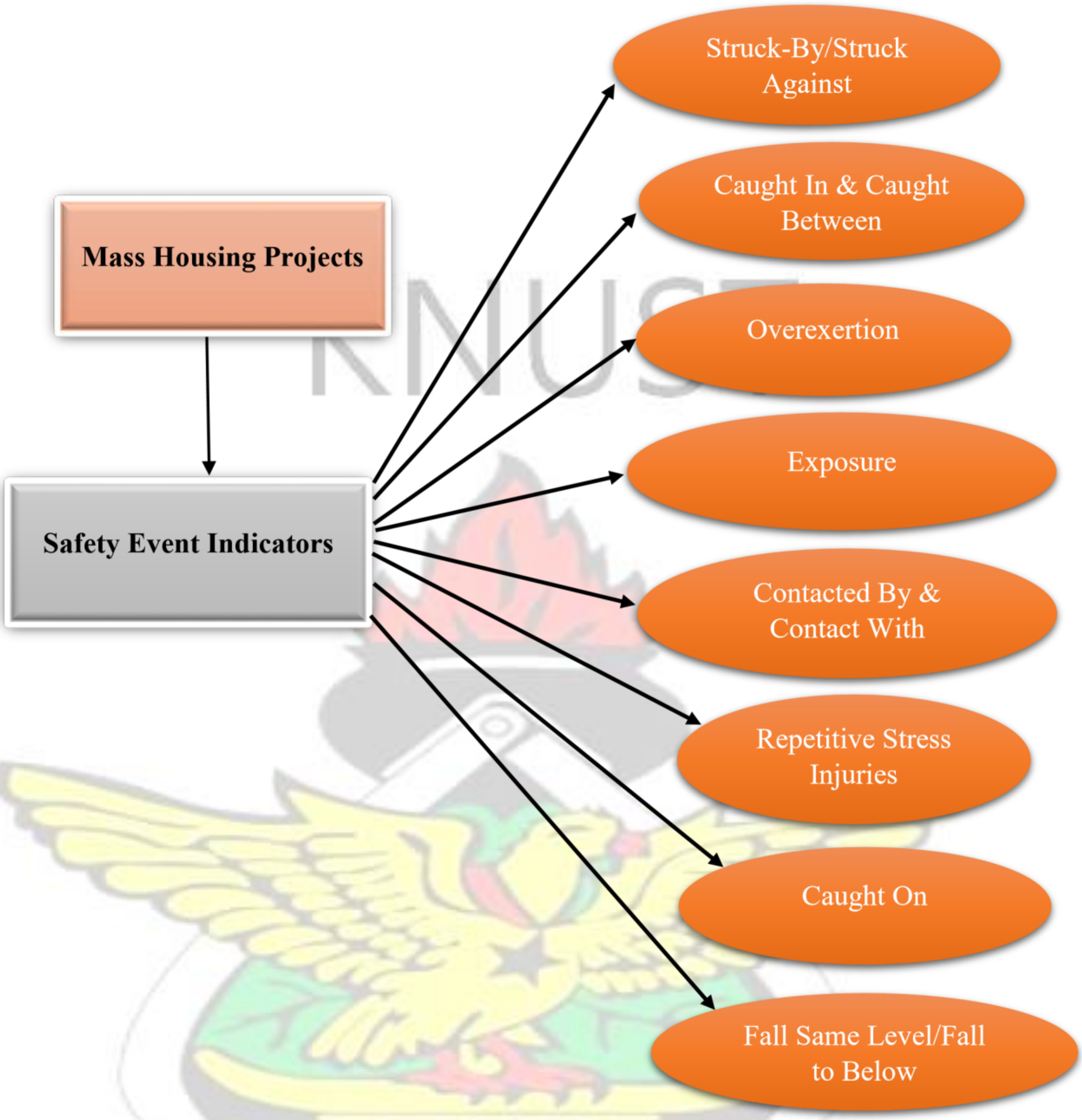

Figure 3.3: Safety Performance Indicators (Source: Author's Construct) These events have been identified from literature and as such it is very essential to present precise meanings of these variables.

3.7.1 Struck-By (SB)

Struck by events on the construction site happens when an individual or a worker is forcefully struck by an item. With such types of events, the force of contact is normally generated by the item. Struck by are caused by or occurs as a result of workers being hit by moving vehicles or heavy equipment, flying or falling items and built masonry or concrete walls. These accidents cause severe physical trauma that frequently leads to death.

When the effect alone creates the injury, that event is known as Struck. Struck-by falling object, Struck-by flying item, Struck-by swinging object and Struck-by rolling objects are some categories of Struck-by hazards.

Due to work-related mortalities, struck-by hazards have created severe concerns in the construction industry. The Bureau of Labour Statistics (BLS) published in a preliminary data report titled “Manner in which fatal work injuries occurred, 2009” that, the total fatal work injuries that occurred was 4,340. Out of the 4,340, “Contact with” objects and equipment was 17%. “Struck-by object” was 10% of the 17% which was more than half.

3.7.2 Struck Against (SA)

Unlike Struck By accidents where the item comes into contact with the person, here the individual forcefully strikes the object; the person affords the force. With 111 deaths, providing a mortality rate of 0.3 per 100,000 populations, in NSW, struck against occurrences were the tenth leading source of death in NSW during 1998-2002 (Schmertmann *et al.*, 2004). Struck against injuries are the most under rated work place and off the job injury category. Struck against are normally caused by distraction, inattention to job surroundings, poor housekeeping on site, and horse play on the construction site.

3.7.3 Caught In (CI)

Caught In accidents involves a person or a part of that person being confined, stuck or better still caught in an opening or enclosure. Whether the effect of the object alone caused the wound is the main factor in making determination between a Caught event and a Struck experience. When the effect alone creates the wound, that event should be documented as struck. The event should be noted as Caught when the injury is created more as a result of crushing injuries between items. Events that are normally categorised as caught in are in relation to excavation cave-ins or trenching. Workers can be caught in three types of openings: trenches, basements and wide excavations (pits, pile and pad foundations) (Davies and Tomasin, 1999). In various areas of work in the construction industry, working in excavations in the construction industry has traditionally had a higher accident and injury rates than other employees (Arboleda and Abraham, 2004). It is recoded that the death rate for earth works is 112% higher than the rate of general construction according to OSHA (2007). Accidents relating to caught-in events occur by breakdown of sides/cave-in (HSE, 2005). In excavation works, Cave-in is possibly the most feared and chief root of accidents. Caught In accidents cause crushing damages to survivors and in some instances burry employees (HSE, 2005).

For excavation jobs in the construction industry, Hinze *et al.* (2005) identified five threat rating variables, and Lee and Halpin (2003) analysed excavation-related accidents via: configuration of excavation (width, depth and length); Geological state (soil type and water table); Vehicular traffic nearby (vibration and surcharge load); Presence of underground utilities (electrical, water and sewer lines); and Nearby structures.

3.7.4 Caught Between (CBT)

An accident is classified as Caught In when an employee comes between a moving object, a still object or between two moving objects. Caught-between threats according to OSHA, are defined as injuries resulting from a person being pressed, crushed, pinched, caught, or compressed between two or more objects, or between fragments of an object.

3.7.5 Contacted By (CB)

A Contacted By accident are in its very nature injurious and causes damage. A worker on a construction site can be contacted by a matter or material. One of the several hazards under the categories of Contacted By that construction workers could experience on site is Fire. Fire threats need to be considered at all phases of the building procedure, although the treat of fire is not realised as such as high risk compared with a fall from a height and slip, tripping and falling (HSE, 2000). Employees are killed or incapacitated as a result of fire annually on many construction sites. The Construction industry in United Kingdom (UK), experiences about 400 construction fires every year and about 100 of them cause over £50,000 worth of destruction and can result in the unfinished dislocation (34) of the project plan **(**Hughes and Ferret, 2011). On the construction site, fires are provoked by gas lines and other tools, very good braising work carried out by plumbers, petrol and diesel demanding machines, and chemicals that can be harmful.

3.7.6 Contact With (CW)

Workers on a construction site can come into contact with dangerous materials. When a person gets into contact with a material, it is said that the person initiates the contact. The major injury in relation to contact with is Electricity on the construction site. With possible deadly results, construction sites make major use of electricity which has the potential to be very harmful. Shocks are events that lead to damages or even death. It happens when someone gets into contact with a live electrical conductor. 2% of all mortalities at work are initiated by electric shocks in the UK (Huges and Ferrett, 2011). Most grievances and deaths on construction sites that are caused by electricity normally happen due to workers using poorly stored electrical equipment, working near domestic electricity deliveries or overhead high tension lines, workers coming into contact with underground power cables during excavation work and using improper safety gears during work.

3.7.7 Caught On (CO)

Accidents on a construction site are determined as caught on when a person or a part of his clothing is caught on either a moving or immobile item. An individual can also be dragged into a machine, or suffer some other damage when caught on a moving item. Aside this, the individual can be caused to miss his or her balance and fall.

3.7.8 Fall-Same Level (FS)

As the name instigates, a fall same level accident happens when an individual slips or trips and falls on the surface he or she is walking or standing on. Hughes and Ferret (2011) added that Fall Same Level contributes to over a third of all main injuries. Slips and trips are perceived as the most common workplace exposures. HSE (2003) indicated that 95% of main slips result in broken bones. Slips and Trips are inevitable on all construction sites as mentioned by HSE, (2003). Slips and trips is the most common cause of injuries at the construction site, and these cost employers more than 512 pounds a year in lost production and other costs which makes up more than half of all reported injuries to members of the public (HSE, 1998).

Lipscamb *et al.* (2008) undertook a study in the United States in which it was indicated that slips accounted for 18% of all accidents and 25% of employees' compensation payments. Musculoskeletal injuries can also be related to slipping. Out of the injuries caused by 'fall on the same level', slips alone contributed to 85% whereas falls from heights accounted for over 30% (IBID). Falls from heights can also be the preliminary cause of a variety of other kinds of accidents. Major causes of falling on same level can result from the following site conditions; the haphazard dispersal of materials, wet or greasy floors, wearing of inappropriate footwear (mostly by casual employees and visitors), carrying of a large or heavy material, and when the lighting systems on site are poor.

3.7.9 Fall To Below (FB)

'Fall to below' accidents occur when a worker on site slips or trips and falls to a level beneath the one on which he or she was walking or standing. Fall to below event takes place when the injury involved has to do with heights. Workers either fall from scaffolds, ladders or roofs. The most general way of providing platforms to works at heights, is Scaffolding. Associated with scaffold use are the subsequent perils (Davies and Tomasin, 1999);

- Falling of workers from a working platform,
- Workers below the working platform being struck by things falling from it and
- With the collapsed structure and crushing workers underneath it or nearby, the scaffold or part of it disintegrating and throwing workers off.

Many serious accidents result from the misuse of ladders which is sometimes used in accessing scaffolds because:

- Ladders slip when users are climbing or working from them;
- Users slip or miss their footing while climbing;
- Users overbalance when carrying materials or tools; and
- When defective ladders are used, they fracture under the weight of the user.

The scaffolding and ladder-related mishaps, Bentley (2006) investigated and reported two main risk factors:

- Design factors - relevance of the type for the duty and height; height of the scaffold/ladder; and adequacy of design (member size, bracing, guardrails, platform size, and toe board).
- Work environment and conditions –slippery condition on the platform; defects in the members of the scaffold/ladder; loading of materials and employees on the platform; and the nature of the platform the scaffold/ladder is relaxed on.

With working at height, the main dangers related are individuals and objects falling onto people below. One of the most common killers of workers on construction sites were seen as fall to below. Nearly 1,000 construction employees are killed each year at their work places, statistics show that. One third or over 300 demises of these are a result of construction site falls (ILO, 2005). The main cause of occupational injuries at construction sites in New Zealand are fall from heights (Bentley *et al.*, 2006). Yung (2009) indicated that, in the construction industry in China, "falls" represents about 51% of all injuries. In Hong Kong, the work associated with falls from height showed more than 47% of all fatal accidents (Chan *et al.*, 2008). Also in Taiwan, more than 30% of the deaths can be attributed to falls (Chi and Wu, 1997). In various nations, the utmost costly occupational hazards are falls. Roof related falls, crane falls, scaffolding falls, elevator shaft falls, falls resulting from holes in flooring, and falling objects comprised common construction site falls. Falls may happen as a result of edge insufficiently protected, or improper protection of items in storage. Masons, painters, decorators, window cleaners and those who undertake one-off jobs without any proper training, planning or equipment consisted of employees at risk of falling from a height (Murie, 2007).

King and Hudson (1985) observed a higher proportion of roofing accidents during maintenance period/activities as well. These include falls through delicate roofing materials, roof edge falls and falls from the inner structure of roofs. Extremely usually severe, requiring long periods of treatment and recovery and resulting in significant medical expenses are the damages caused by falls from roofs (Parsons and Pizatella, 1985; Gillen *et al.*, 1997).

3.7.10 Overexertion (OE)

While doing a job, a person overextends or stresses him or herself. In the United States, overexertion wounds resulting from work activities (e.g. low back pain, cervicobrachial disorders, and upper extremity cumulative trauma injuries) are the single largest classification of injury in construction accounting for about 24% of all injuries (Construction Accidents, 1992).

Overexertion injuries are classified as "nonimpact cases in which the injury resulted from excessive physical effort, as in lifting, pulling, pushing wielding, or throwing the source of injury (The Bureau of Labour Statistics and OSHA). In construction, the statistics on the magnitude of the problem is difficult to achieve due to cumulative trauma disorders and other overexertion injuries which tend to be "undeclared or misdiagnosed. Nonetheless, 'All the crafts have it,' claims Jim E. Lapping, director of the AFL-CIO Building and Construction Trades Dept." *(Repeat* 1989). The underlying causes of the injuries are made into the approved tools and work methods while overexertion damages are not deliberate. It should be possible to engineer them out of the work, if the causes can be recognised. This is in contrast to other types of injuries (e.g. struck by, struck against, fall same level, fall from elevation, etc.) which occur due to a mistake or unintended event. Into a task, these so-called traumatic accidents are not purposely built.

3.7.11 Exposure (E)

Exposure opens a person up over a time period to dangerous substances or conditions. Examples of these dangerous conditions or substances are; chemicals that are harmful, noise and dust. Noise is an inevitable condition in the Construction Industry as such workers turn to suffer from industrial deafness. This condition on the other hand is known as noise-induced hearing loss. National Code of Practice (2004) explains this as hearing impairment which arises from being exposed to extreme noise at work. Among building employees or workers on site, occupational deafness is very common. The destruction of rocks during demolition exercises or the usage of jack hammers exposes employees to dangerous noise levels. Activities of this nature on a construction site are disreputably noisy. The use of explosive powered nail guns, vibrators, vibrating wacker plates and during the course of pouring concrete all creates noise problems for workers in the vicinity and operators involved in such work activities with respect to keeping their hearing ability. HSE (1998) also indicated that noise emanates from the operation of power equipment, plant and machinery and also from vehicles delivering materials on site.

The use of chemicals on site also poses some health and safety risks to employees. These harmful chemicals can be found in paints, pesticides used to treat timber, agents used for bonding, adhesives and lacquers (HSE, 1998). Murie (2007) made mention that, by breathing them in, ingestion and absorption, through the eyes or skin opens site workers up to harmful chemicals. Excessive exposure to the harmful substances on site can cause irritation of the eye, sleepiness, headaches, dizziness and also affect human coordination and judgement. The human central nervous system suffers the most from such hazards. These harmful substances can damage the liver, kidneys, cardiovascular system and skin (Huges and Ferrett, 2011).

Also, solvents can cause reproductive challenges. Cause birth weaknesses and miscarriages, and they can lessen fertility (Murie, 2007). Exposure to some agents of bonding and resins, varnishes and paints causes health defects like asthma and dermatitis. Welders can also suffer in the long term, great health problems. This can result from workers inhaling a cocktail of metal fumes. The brain and internal organs can be affected when the respiratory system compromised through the absorption of chemicals (Huges and Ferrett, 2011).

Dust can be classified as physical, chemical and mineralogical. The health threats related with a dusty jobs depend, which will determine its toxicological features, and hence the ensuing health effect; and the exposure, which defines the dose. When there is dust in the air on site the probability that a worker will inhale it is high. There is a possibility that someone suffers a negative effect on health, if the dust is harmful, which can vary by some slight damage to the permanent and even dangerous disease conditions for life (Huges and Ferrett, 2011). Respiratory disease has caused higher death rates resulting from lung and stomach cancers. Dust from wood, cement, silica and dust from medium-density fibre board poses specific threats at construction sites

3.7.12 Repetitive Stress Injuries (RSI)

Repetitive stress injuries (RSIs) are described as wear and tear on joints and surrounding tissue because of overuse. RSI is also known as Cumulative Trauma Disorder. Although every joint in the body has the potential for being affected, the lower back and upper limbs (arms, shoulders) are the areas that receive the most injuries. RSIs are chronic conditions that worsen over time if the wear and tear continues.

Affecting young people who are considered to be in good bodily health, RSI is not a disorder that is age specific. RSI is much easier to avert than to cure once it has developed which is good news. Activities leading to RSIs are;

- Awkward and fixed postures - i.e., standing, sitting, and reaching for long periods.
- Recurrence of movements/vibration - i.e., performing a single duty constantly, work, working with a chainsaw or jackhammer.
- Forceful exertion - i.e., heavy lifting.

3.8 HEALTH AND SAFETY MANAGEMENT

Effort must be dedicated to the planning and management of health and safety but should be in accordance to the risks related to the project. Construction firms must always consider actions necessary to reduce and manage risks when deciding what to do to comply with safety management regulations.

3.8.1 Health and Safety Management Systems

A process an employer of an organisation puts in place to reduce or minimise the risk of injury and illness constitutes the system of health and safety management. In all workplace operations, a health and safety management system can only be accomplished through the identification, assessing and controlling of threats to employees. It has been established in the previous chapter that Mass Housing Projects differs from One-Off traditional projects hence requires different health and safety management systems. According to the type of workplace and the nature of operations carried out, the scope and complexity of the system will change. Mass housing projects has features such as multiple construction sites, multiple geographical location and repetitive nature of housing units which would demand a complex H&S management system. The following eight components should be in pace for an effective Health and Safety management system.

Identify and analyse health and safety hazards: To recognise all potential causes of harm to workers, all equipment on the site should be evaluated as well as machinery, work areas and processes.

Control measures to eliminate or reduce the risks: Controlling measures to eliminate these risks can be than through the provision of Personal Protective Equipment. Since this is very crucial for the health and safety management system to be effective, senior management must also commit themselves in putting all measures in place.

Training and Competency: Without threat to their health, every worker needs to have an in-depth knowledge on how to do their work securely. Inspecting job undertaking by workers is a way to check and identify any more hazards that have not been ode notified before.

To avert the repetition of related incidents, a health and safety system enables employers investigate any accidents which occurs so that appropriate measures can be put in place. Appropriately looked after and communicated to employees, Program administration is put in place to guarantee all parts of the health and management system. In the absence of an H&S system, the rate at which employees are subject to risk especially in Mass Housing Projects are high.

3.8.2 Risk Control Systems

To competently cope with them, Brustbauer (2014) stated that threat management may aid managers to detect important risks that could jeopardise the success or existence of the company in time. And probably, even bankruptcy, misjudging or failing to identify risks can – in the worst case – have tragic consequences, ranging from customer loss to destructive liability, environmental damage (Hollman and Mohammad-Zadeh, 1984). A construction firm's budget for risk management normally increases with size of the project and sometimes the decision-makers in smaller companies have a lower risk tolerance.

Risk control systems are employed to identify, analyse and implement control strategies. Risk identification in construction project works may be hindered by the employees due to their limited risk management knowledge (Gao *et al.*, 2013). The identification of risk must be carried out continuously and systematically. There are several tools and methods for handling risks and they are; selection of supplier, overcapacity in production, emergency plan, asset securitisation and networking or cooperative relations. Risk control systems enables mass housing developers avoid unnecessary avoidable financial risks. With risks systems put in place, mass housing developers are able to detect fraud and safeguard assets. The principles employed through risk assessment in controlling safety are the same as those for health. Unlike injuries resulting from accidents, the nature of health risks can make the connection between employee ill-health and work activities less apparent. Safety risks lead or can lead to immediate injuries but this cannot be said of health risks. Even in certain cases decades, health risks might result in illness which may not become obvious for days, months, years and. Before the risk is apparent, health may be irrevocably damaged. This is the reason why management of Mass Houses must develop strategies to construction risks before it harms any worker. Failure to do this may lead not only to worker disability and loss of livelihood but to financial losses for the organisation through sickness absence, lost production, recruitment and training costs, compensation and increased insurance premiums.

3.8.3 Positive Health and Safety Culture

The emphasis of H&S awareness endeavours as Krause (1993) mentioned in his study should be determining the H&S culture in the construction industry. In high risk industries such as construction, safety is an investment that gives real profit. Unlike one-off projects, mass housing projects are developed on multiple geographical areas. A safe work in these multiple geographical areas would help to keep trained employees on the project and the project itself on track by reducing accidents which results in schedule delays and injuries. From the project managers, foremen and the individual employees on the various work sites, fostering a successful safety culture in Mass Housing Projects would require commitment. Because of the dangers of domestic work, which often involves working with large machines and power tools, often many floors above ground, builders are more open to an accident at work. The following health and safety cultural practices are required on Mass Housing Projects.

Start at the top: Safety has to become a central value of the construction firm to have an actual influence on the employees. Project managers and site foremen are required to take the necessary training on health and safety. For them to get a much better knowledge of how safety measures are being implemented, all safety managers of the construction firm should be a part of the job.

Recognise success but hold everyone accountable: A core section of the safety culture must be accountability. Everyone should be responsible for the security of the individual employees to team leaders, project managers and executives. In an effort to save time and money, workers may be tempted to cut corners without accountability.

Plan safety into the project: Safety begins with pre-planning because every project is built on paper first. By lessening the potential for mishaps that can impede productivity and cause schedule delays, successful executed pre-planning permits the project to run un-impeded.

Prequalify subcontractors for safety: With safety history and performance, the prequalification of subcontractors should not halt. And how the firm integrates safety into its daily operation, it should contain a review of the subcontractor's own safety culture.

Focus on fall management: A leading source of injuries and demises remain or is falls. In 2011, about 35 percent of the 721 fatal construction industry mishaps were owed to slips and falls. Where the possible of falls from elevations will be faced, a comprehensive fall management plan should be established for each operation.

Combat substance abuse: Construction had the second highest rate of illegal drug use at 13.7 percent, among 19 main industries, behind accommodations and food service at 16.9 percent. Firms, in light of this fact, should centre on avoiding impaired personnel from working on a site.

Evaluate each project phase for safety: A constant process, is scheduling for safety. A job safety task scrutiny, as a project advances, must be done to ensure that work equipment is suitable and safe at the fingertips of workers so employees do not try to do with the fact that equipment are not enough or take risks that endanger their safety.

Review accidents and near misses: The facts and situations in the occurrence that there is an accident should be reviewed to detect root causes so that corrective action can be taken and future happenings can be averted. To near misses that had the potential to become severe accidents, the same attention should be given.

Toward zero injuries: To capable clients and insurers, a safer firm suffers fewer losses, relishes lower costs, becomes a more competitive bidder and makes it more attractive.

3.9 MASS HOUSING AND CONSTRUCTION SITE SAFETY

Construction site safety when used in Mass Housing Projects involves the planning or scheduling of work activities and its effect on site safety. A construction site might have many subcontractors working on it. Safety challenges could arise on such sites due to the competing interests of these subcontractors. These problems are easily seen when each subcontractor or contractor wants to finish his or her work in a particular time. In occupying the same space at the same time by these contractors or when a contractor had to undertake his work activities overhead another, problems can happen. One of the most common problems that occurs naturally in Construction than in fixed industry is when competing interests of subcontractors has to do with operations and maintenance.

Unlike traditional one-off projects, it is much more difficult to introduce and run regulatory efforts concerning health and safety on a multi-employer workplace. In construction, it is important to identify which employers are responsible for what dangers and solutions. Defining risk responsibilities to employers on a Mass Housing Project delivery becomes difficult. As such, any controls of administration which seem to be eminently workable in a traditional "one-off" project may need important modification to be workable on Mass Housing Projects. Any information concerning dangerous materials used on a construction project must be communicated to workers working near that dangerous material or better still these workers must have amply training. In traditional one-off projects, information on harmful materials by a subcontractor is easily acquired and controlled but with respect to MHPs on multiple construction sites, it becomes difficult for the main contractor to ascertain all information on harmful materials being brought on site by the various subcontractors. In addition, workers employed by one subcontractor using a specific material may have been trained, but the team working for another subcontractor in the same area but doing something completely different might not have knowledge of the material and may still be subject to the risk as much as those who use the material directly.

3.10 MAJOR CAUSES OF ACCIDENTS IN MASS HOUSING PROJECTS

Lingard and Rowlinson (2005) explained in their textbook on occupational health and safety in construction project management that the Construction industry is broadly viewed as an accident prone industry. Majority of accidents happening on construction sites are as a result of unsafe conditions and certain unsafe act. Accident investigation programmes are very necessary in acquiring data since not all hazards are possible to be identified and eliminated. The construction industry accounts for the highest degree of work-related injuries and demises compared to other industries in Ghana (Labour Department, 2000). In Ghana, in the year 2000, according to the Labour Department, 56 out of a total of 902 accidents on construction sites were fatal. In project completion, construction activities lead to delay, proliferate the expenses made and destroy the reputation and reliabilities of constructors (Wang *et al.*, 2004).

Heinrich explains accident prevention as an integrated program, a series of coordinated actions directed to the control of unsafe personal performance and unsafe mechanical circumstances and established on certain knowledge, attitudes, and skills. Certain synonyms for accident avoidance identified by Abdelhamid and Everett (2000) were; loss control, loss prevention, total loss control, incident loss control and safety management. To ascertain the sources of construction accidents regarding construction health and safety practices, a research study was commissioned in the UK by their Department for Work and Pensions. The causes of accidents identified were placed under the following three main categories;

- Macro – Societal and industry wide influences
- Mezzo – Project and process factors

- Micro – Worker/supervisor/workplace causes

At the Macro level, industrial and societal influences are considered. These influences involve lack of leadership from government as the important client, immature corporate systems, inappropriate enforcement of health and safety policies, absence of proper accident data and lack of impact of trade unions. Mezzo factors comprised of the project and process factors. These factors included immature project systems and processes, unsuitable supply chain and procurement arrangements, lack of understanding and engagement by some of the design community, a lack of organisational education and consequently, lack of appropriate accident data or investigation. The ineptitude of training or certification of competence, lack of ownership, participation and empowerment, accountability and communication with workers and supervisors, shortage of qualified managers, lack of individual abilities and understanding of workers and managers consists of the micro reasons.

3.11 WHY PHYSICAL FEATURES OF MHPs

Naturally or unnaturally, construction activities are affected by errors and mistakes, and the unpredictable nature of the environment. Syed *et al.* (2010) indicated in his study that the uniqueness of multiple sites for various units of MHPs embodies the approach to site management, methods of construction and adopted technologies, management concept of health and safety and the location of site for the housing units. The most interesting area in handling MHP by far, as indicated by Hashim and Chileshe (2012) is the multiple project environment (MPE) which falls under the physical features of MHPs. Managing Multiple Project Environments (MPEs) poses a lot of challenges to the delivery of MHPs. To offer greater insight into the problems multiple project environments generate, Payne (1995) itemised five categories. First is the inability of the organisation to provide resources. The second category deals with people issues, systems issues and organisational issues. The peoples issue considers the work environment, system issues looks at the work scheduling process and organisational issues turns to consider the approach of matrix organisation. Project management on multiple construction sites is therefore, confronted with many more challenges to be likened with managing a single project for a project manager. In the context of Ghana, it could be said that schemes spreading across different geographical locations experience different cultural, political, and socioeconomic practices unique to the different geographical locations.

3.12 SUMMARY

This chapter examined safety performance in the construction industry and has presented the need to focus on Safety problems in the Mass Housing Industry which has created a gap in existing literature. Existing literature has focused on health and safety implication on "one-off" traditional projects. Agreeing to the usefulness of these studies, this study gave attention to a project typology with unique features which is mass housing projects.

CHAPTER FOUR STUDY DESIGN AND METHODOLOGY 4.1 INTRODUCTION

Research constitutes literature, sociology, history, science and technology. Research is vigorous, assiduous and involves a systematic process of inquiry. This inquiry is done to ascertain, interpret or revise facts, behaviours, events and theories no matter the subject. Planned processes and schemes followed to undertake a research is known as the research methods whiles the research methodology involves the orderly way of resolving problems. Basically, research methodology is the procedure researchers follow to go about their study of describing, clarifying and conjecturing phenomena. Chapter four described the general research paradigm (philosophy), research approach, research methods, the study population, research instrument, technique for sampling, administration of the research instrument and the statistical tools for the data analysis.

4.2 PHILOSOPHICAL COHERENCE OF THE RESEARCH

The philosophical considerations of a research study are very vital for both the shaping of the design of the research and for clarifying the various research approaches taken. This is done so that the result of the research can be dependable. Kincheloe and Berry (2004) indicated that, researchers are in better positions to provide an acceptable explanation to the process of research and defend the results. Researchers do this by making use of the several tools of philosophy through process clarification and provision of an acute observation into the expectations on which it conceptually rests which strengthens the rationale for the research methodology. Sikes (2004) adds that, research credibility can be reinforced when the research methodology selected which corresponds to the questions set for the research can be justified. The philosophical considerations underpin a research study and its attention can get possession of the research value generated (Snape and Spencer, 2003). Wilson and Stutchbury (2009) indicated that, the philosophy underpinning the justification of a research methodology should be made visible as this can strengthen the thoroughness of research. It is against this background that the Epistemological, Ontological and Axiological philosophical considerations were examined.

4.2.1 Epistemological Considerations

According to Oliver (2010), epistemology concerns the basis for which something is believed to be right resulting from the philosophical study of knowledge. Sharp (2009) puts this in other words by indicating that, epistemology is about what counts as educational knowledge and how it is acquired. The choice of a research study taking into consideration the purpose and goals is dependent on the epistemological stance of the researcher (Snape and Spencer, 2003). Reality is objective which most research works undertaken in organisational science have based their assumptions on that it is "out there" somewhere awaiting discovery and that it is possible to identify knowledge and transfer to others. Epistemological philosophical considerations can be grouped or classified under positivist or interpretivist. The 'positivist position' emphasises on objectivity, measurement and repeatability hence the researcher takes an objective stance, detaching himself of the research situation. As a response to positivism, interpretivist was established as such it is sometimes referred to as an 'anti-positivist' paradigm. Interpretivist requires an individual to construct meaning and as such it is also sometimes referred to as constructivism. Interpretivist is different from positivism in the sense that, a researcher taking an interpretivist position is part of the research situation and the impelling cause of the explanation of outcomes is based on the values and beliefs of the researcher. This makes the interpretivist subjective.

From this background, it is clear that the study epistemologically lies within the positivist domain because it tends to investigate the causal relationship between variables (safety performance indicators and the unique physical features). This research is also not based on the researcher's ideas or opinion or perception but by gathering actual facts on the ground using research instruments. It is also possible for the study to be replicated with relative ease if necessary. This research was also explored through a systematic but simplified approach.

4.2.2 Ontological Considerations

The term ontology is a study in philosophy concerning the nature of reality. Grix (2004) defines ontology as the study of requirements and assumptions that are made about the nature of social reality, claim concerning the existence of something, its resemblance, what units make it up and the interaction between those units. Greener (2011) mentioned that, there are two things that come to mind when a researcher undertakes an ontological study; whether the world exists unconventionally or how the researcher perceives of it. Sikes (2004) added that, researchers can only observe knowledge, measure and quantify it if their assumption is that knowledge is real, impartial and exists in the world to be gathered. The thought of how a researcher perceives something to be true and issues on the decision of data collection are embedded in a researcher's ontological perspective (Oliver, 2010). The research phenomenon is mostly viewed from the 'realist' or 'idealist' perspective when considering Ontology (Creswell, 2009). Bryman (2009) indicated that, a realist vision leans toward the positivist philosophy whiles the idealist falls in the domain of interpretivist. A person of an idealist nature appreciates things in a very expectant manner, using his own ideas to shape situations. A realist person would access a situation as it is, devoid of unconcealed involvement of emotions. In simple terms, ontology is observing knowledge as reality that is out there, separate from a researcher's explanation meaning epistemologically, one can obtain knowledge from objective observation, whereas in situations where ontology views knowledge as subjective to explanation means epistemologically, that knowledge is attained through meaning and sense-making.

It is against this background that this research falls under the realist point of view. The reason being that, the variables that explain the safety performance indicators and the features of MHPs exist in literature. The aim of the study (evaluating the influence of unique physical features of MHPs on Construction Site Safety) is viewed as more practical than it being abstract. Also, the impact of the physical features on Safety in the Ghanaian Mass Housing Sector exists as external hard facts that are beyond the influence of the researcher.

4.2.3 Axiological Considerations

The Axiological considerations of a study are concerned with values. Creswell (2009) established two values concerned with the axiological considerations namely ‘valuefreedom’ and ‘value-laden’. Creswell (2009) again pointed out that, value-freedom is the position in the paradigm of positivism while the value-laden focused on the paradigm interpretivist. Objectivity drives value-freedom under the axiological considerations in the sense that, what to study and the means of studying it is not determined by human interests and beliefs. Under value-laden, researchers are motivated by their own skills, interests, values and beliefs resulting in the innate biasness of what to study and how to study it. Pathirage *et al.* (2005) affirms this by mentioning that, the position of value-freedom is always in congruence with the positivist epistemological and realist ontological positions. A study evaluating the causal relationship between pre-determined structures in variables often adopts objective criteria in its approach (Pathirage *et al.*, 2005) which is found under the value-freedom axiological perspective.

It is again against this that this research work is positioned in the value-freedom axiological perspective.

4.3 RESEARCH APPROACH

The research approach denotes the means of undertaking research, which a substantial number of people in a research society may or may not admit. The philosophical considerations of a research corroborate the study hence must be first item to resolve (the paradigm embodies the general approach to solving the questions of the research and answering the research problem). The choice of an appropriate research approach depends on the research paradigm chosen (Saunder *et al.*, 2009; Bryman, 2009). A complete way to view the approaches is the basic assumptions of philosophy brought to a study by researchers, the employed research strategies and the type of method engaged in undertaking these strategies. A research approach is classified in terms of whether it is inductive or deductive.

4.3.1 Inductive and Deductive Research Approach

Saunders *et al.* (2003) describes the **'Inductive Research Approach'** as an approach requiring a researcher to collect information in an effort to develop a theory. As a result of this **'Inductive Approach'** is referred to as building a theory. Hussey *et al.* (1997) added that, inductive approach to research involves the development of theory by observing reality empirically; thus deducing general interpretations from particular occurrences. The deductive approach to research considers the opposite looking at separable observation to statements of general laws or patterns". Creswell (2009) indicated that, the inductive research approach in its nature is subjective, exploratory and requires full contribution of the researcher. The **'deductive approach'** involves developing a theory or hypotheses and testing that articulated theory by designing a research strategy. Baxter and Jack (2008) indicated that, the deductive approach is sometimes referred to as quantitative method or design. The deductive method involves moving from the general to the specific and it often requires considerable data (Hussey *et al.*, 1997). Oppenheim (2003) mentioned that, with the deductive approach, survey instruments such as questionnaires and statistical tests are the most appropriate and major instrument used involving sampling in its data collection to generalise or draw inferences.

4.3.2 Research Approach chosen

Based on the positivist epistemological position and realist ontological positions of the study, deductive research approach was appropriate as it tends to use considerable data which would in turn favour the use of quantitative methods to analyse (see Travers, 2001). The study also draws on deductive reasoning by operating from a general to specific perspectives making conclusions based on facts (see Burney, 2008). The deductive approach was adopted also because certain observed variables were identified from literature to measure safety performance through quantitative empirical testing.

4.4 RESEARCH DESIGN

According to Creswell (2009), research design refers to a reasonable level of information necessary to provide the mounting answers to the research questions in each study, as well as indicate the collection and analysis of data. Burns and Grove (2003) also define research design as the outline for conducting a research study.

Researchers may encounter factors interfering with the validity of their study but by the design of their research gain maximum control over them. It was further acknowledged by Yin (2009) that, the design of the research is a central structure that controls and drives the most appropriate and the right tool for data collection and analysis in addressing the research questions. Three types of research designs are advanced: Descriptive Research Design, Exploratory Research Design and Explanatory Research Design.

4.4.1 Descriptive Research Design

Situations are normally described using Descriptive Research Design. Generally, description of things is made by offering measures to an activity or event. Descriptive research designs are usually well-thought-out and explicitly designed to measure the features described in a research question. Profile of persons, events or situations are the fundamental object of measurement in descriptive research. Saunders, Lewis & Thronhill (2003) indicated that, prior to the gathering of facts, it is important that a researcher has a clear picture of the phenomena on which data is being collected. According to Aggarwal (2008), descriptive research design is keen on the collecting of data about predominant situations or conditions for the purpose of interpretation and description. Descriptive research design is not simply amassing and tabulating facts but comprises of proper analysis, identifying trends and relationships comparisons and interpretation.

4.4.2 Exploratory Research Design

Insights and understanding of an issue or situation is possible with exploratory research. Exploratory Research Design merely proposes to explore the questions of the research and does not anticipate offering concluding and decisive clarifications to problems that exist. Saunders *et al.* (2007) warns that when undertaking exploratory research, the direction of a researcher can change due to certain new insights or data as such researchers ought to be willing to change when direction or focus changes. Brown (2006) also added that, exploratory research tends to address new issues on which there has been little or no previous research. Nargundkar (2003) showed that, exploratory research can be used to influence decisions on how to conduct subsequent studies hence it is necessary to undertake an exploratory study as precisely as possible.

4.4.3 Explanatory Research Design

Explanatory Research Design deals with the clarification of the existence of a relationship that exist between two or more aspects of a phenomenon or situation. The development of research designs by researchers is overpoweringly affected by whether the research question is explanatory or descriptive and this affects what information to collect. Not only does explanatory research expound why a phenomenon ensues but also forecast future happenings. Explanatory research is mostly considered by research questions or hypothesis. The hypothesis or questions of the research specifies the nature and direction of the relationships among or between variables being studied. In an explanatory research, a probability sampling technique becomes a necessity because the principal aim of such research study is mostly to take a broad view of the results to the population from which the sample is chosen.

4.4.4 Research Design Adopted for this study

The research design chosen for the purposes of the study is the Explanatory research design (casual study). Explanatory Research Design deals with the clarification of the existence of a relationship that exists between two or more aspects of a phenomenon or situation. Explanatory research was used to obtain a picture of the influence of unique physical features of mass housing projects on construction site safety with the view of improving the standard of safety performance in the housing sector.

4.5 RESEARCH STRATEGY

Researchers have specific plans of how to provide solutions to the research questions set for a study. These plans as indicated by Saunders *et al.* (2009) can be defined as the Research Strategy. Bryman (2008) on a similar note added that, the research strategy is a general orientation to the conduct of research. According to Remenyi *et al.* (2003), research strategy provides the general direction of research along with the process by which research is conducted. Yin (2003b) recommended that, to select a particular research strategy, one must base the selection on three (3) conditions; the research questions set for the study, the degree of focus on contemporary or historical events and the amount of control a researcher has over real behavioural events. Yin (2003b) and Saunders *et al.* (2009) both recognised that there are big overlaps between the research strategies, although there are several strategies to research. The essential contemplation would be to choose the most advantageous strategy for a particular research study. By adopting positivism as the paradigm underpinning this study, the epistemology, ontological and axiological assumptions dictated that either; experiments, surveys or case studies would be most ideal as the research strategy. Based on this, these three strategies were elaborated on and the most appropriate to answer the research questions selected for this study.

The philosophical considerations employed by the study influenced the research strategy adopted which is presented in **Figure 4.1** below.

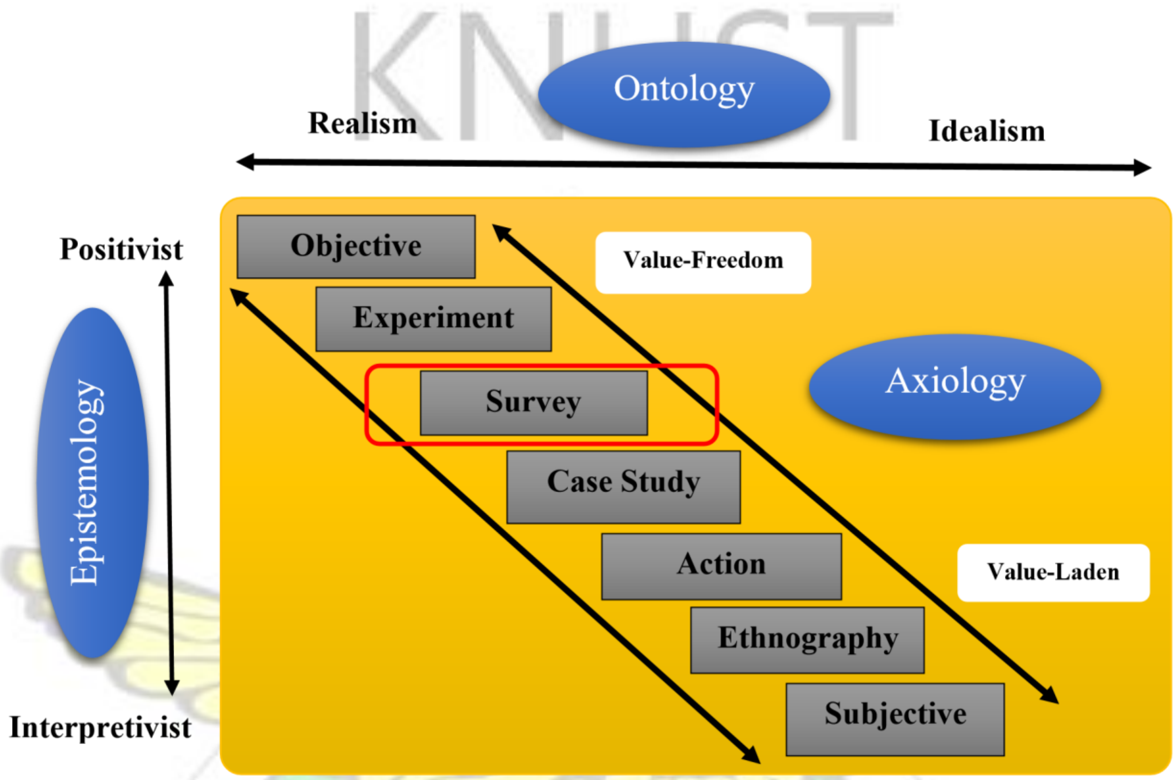

Figure 4.1: Research Philosophical Considerations (Adopted from Pathirage *et al.*, 2005)

4.5.1 Experiment Research Strategy

Experiment research pursues to determine if a specific treatment influences an outcome. This influence of experiment research is assessed by providing an exact treatment to one group and withholding it from another and then defining how the two groups scored on an outcome. Keppel (1991) stated that experiments include true explorations, with the random assignment of subjects to treatment conditions, and quasi-experiments that use nonrandomised designs. Single-subject designs often include quasi-experiments.

4.5.2 Survey Research Strategy

In a survey research, data is collected in a systematic way. It is essential for a researcher to document societal conditions that already exists, opinion of a community and characteristics of a population. Survey research offers a numeric or quantitative description of attitudes, leanings or opinions of a population by studying a sample of that population. According to Zikmund and Babin (2010), a survey involves the use of a structured research instrument in collecting responses from a sample in some form or respondents behaviour as observed and defined in some way. Saunders, Lewis & Thornhill (2007) affirms this by indicating that, research surveys are associated with deductive logic and are a consistent method of gathering information in research management by employing a questionnaire that gathers data from a sample then analyses the data statistically. Zikmund (2003) also indicated that some aspects of a survey research might be qualitative. The qualitative method usually makes use minor samples which mean the outcomes cannot be generalised to the population (McDaniel & Gates, 2006).

4.5.3 Case Study

Yin (2003b:13) defines case study as an "empirical inquiry that examines an up-todate phenomenon within its real-life context, particularly when the boundaries between phenomenon and context are not plainly evident". Collis and Hussey (2009) also identified case study as "a research style used in exploring a single phenomenon in a natural setting using diverse methods to acquire in-depth knowledge". Yin (2003b) identified some of the common reproaches of case study research as; taking too long to produce cumbersome documents, difficulty to generalise, lack of consistency and being bias. Following the four tests common to empirical research, the quality of a case study can be enhanced. Fellows and Liu (2008) identified these four tests as construct validity, internal validity, reliability and external validity

4.5.4 Research Strategy Adopted for the study

The research strategy adopted was the survey because according to Saunders, Lewis & Thornhill (2007), surveys are linked to deductive logic. The study intends to take in account participant's perception concerning beliefs or attitudes in order for a researcher to comprehend the preferences of respondents. The use of likert scales which are popular methods of gathering information for surveys was employed. Likert scales consist of a number of statements and demands that respondents choose a statement that ranges from 'strongly agree' to 'strongly disagree' to measure attitudes required (Saunders, Lewis & Thornhill, 2007). The researcher also collected information from respondents by means of telephone, posting some of the questionnaires and a face to face method of data collection which is the case of a survey research strategy.

4.6 RESEARCH METHODS

Three methods to research are advance in this chapter: qualitative, quantitative and triangulation/mixed methods. Newman & Benz (1998) indicated that, researchers should not see Qualitative and Quantitative research methods as polar opposites or contradictions; but rather see it as methods representing different ends on a continuum. Historical evolution to research methods shows that quantitative research methods has superseded the various research forms in the social sciences. This began with the end of the 19th century to the mid-20th century, but in the second half of the 20th century, interest was obtained by conducting qualitative research, and along with it, the development of mixed-methods study (Creswell, 2009). It is against this background that it proves helpful to view definitions of these key terms (quantitative, qualitative and triangulation) as used in this study.

4.6.1 Quantitative Research Method

Quantitative research methods are written off as methods involving the gathering of information which can be numerically examined, the findings of which are typically presented using descriptive statistics, graphs and tables. A quantitative research method takes into consideration words of the past, actions and records to their mathematical significance and measures the outcome of these observations (Creswell, 1994). Sarantakos in 2005 indicated that, the objective of quantitative research is to advance and engage certain mathematical models, theories and hypotheses concerning the natural phenomena. According to Hittleman and Simon (1997), quantitative research makes use of questionnaires, surveys and experiments to gather data that is revised and tabulated in numbers, which permits the data to be characterised by the use of statistical analysis. Quantitative research method is used mostly in testing theories of research objective by scrutinising existing relationship among variables. Creswell (2009) commented that, the complete written report on a quantitative research has a structure which consists of an introduction, literature and theory, methods, results and discussions. Most quantitative research methods are also deductive, which involves the testing of an already established hypothesis before the collection of numbers. It is essential to comprehend two terms when doing quantitative research. The first is **reliability** which means a test or measure that would consistently reveal the same results. The second is **validity** also meaning that the test or measure actually shows what it is intended to show.

4.6.2 Qualitative Research Method

A qualitative research is by definition exploratory. It is grounded in practical investigation and evidence. Qualitative Research Methods explore data from the viewpoint of both individuals and groups. They also engenders case studies and summaries rather than to indicate a group of numeric data. Denzin & Lincoln (2000) indicated that, qualitative research involves an interpretive, naturalistic approach to its subject matter; efforts are put in sense making or to interpret phenomena in terms of the meaning brought by people. With qualitative research, the researcher converses with, and acquires knowledge concerning the phenomenon being studied because it is a form of social interaction (Jean, 1992). Here, information is retrieved directly from observing human behaviours, written opinions, public documents and interviews (Sprinthall et al., 1991). Data acquired under this method of research is in writing in the form of actions or practices, descriptions of behaviours and texts. Actions of the subjects and their verbal statements are what is being analysed for meaningful interpretation.

Table 4.1: The major differences between qualitative and quantitative research approach

	Qualitative research	Quantitative research
Orientation to the role of theory to research	Inductive and geared towards the generation of theory from specific instances	Deductive and associated with verification of theory and hypothesis testing.
Objective	Study issues in depth and detail and pursues to gain insight and comprehend people's perceptions	Gather factual data and study relationships between facts and relationships in accordance with theory
Common data collection techniques	Interviews, observations and documents	Questionnaires, tests and existing databases
Data characteristics	Soft data, less structured analysed, using nonstatistical methods	Hard data, structured, large sample size, analysed using statistical methods
Outcome	Exploratory and/or investigate and findings are contextual	Conclusive findings used to recommend a final course of action

Sources: Fellow and Liu (2008), Bryman (2004)

4.6.3 Triangulated/Mixed Methods

Triangulation/Mixed research methods reside in the middle of Quantitative and Qualitative research methods. Tashakkori & Teddlie (2003) stated that, it was during the 1980's that the third methodological undertaking in the social and behavioural sciences called mixed methods began. The triangulation or mixed methods are used when all information required cannot be provided by one form of methodology. Tashakkori and Creswell (2007) indicated that, mixed method involves incorporating quantitative and qualitative methods to generating new knowledge which can include either sequential or concurrent use of these two methodological classes to monitor a line of inquiry. Similarly, Creswell (2003) also indicated that, mixed or triangulation method is the incorporation of qualitative and quantitative information gathered and analysed in a single study or a program of enquiry. Combining both quantitative and qualitative research methods makes available a better understanding of a research issue or problem than either research method alone. This is the main purpose of the mixed method of research.

4.6.4 Research method employed for this study

Quantitative research becomes the most appropriate to address research the research questions and thus adopted. The aim of the study is to evaluate the influence of unique physical features of Mass Housing Projects (MHPs) on Construction Site Safety in the Ghanaian Construction Industry. The research is also mainly quantitative because the study engages statistical and mathematical techniques to gather data, analyse and detect causal relationships among determined variables.

4.7 SOURCES OF DATA

The study depended on both primary and secondary sources of data. Primary data comprised of first-hand data or responses participants gave to the researcher during the survey by use of structured questionnaires. The secondary sources of data on the other hand were derived from findings stated in published documents and other forms of literature (journals, books, articles, research papers and some thesis) which related to the research problem.

4.8 ETHICAL CONSIDERATIONS

This study made use of human participants (respondents) to evaluate the influence of the unique physical features of Mass Housing Projects (MHPs) on Construction Site Safety and as such certain ethical issues were addressed. These included security and privacy of the respondents. The issues considered by the author in advance to prevent future problems included confidentiality, data protection and consent. The survey instrument was therefore drafted in a concise and clear manner to prevent conflicts among respondents. The Safety issues on one particular site of a respondent were not made known to another participant. As a result of this, the questions demanding for respondent's name and address were waived. Respondents were assured that the responses given would be treated with the strictest confidentiality. Participants were given ample time and space to provide answers to the questions on the form to avoid any inaccuracies and errors. All these were done with the hope of strengthening trust between the researcher and the respondents.

4.9 SURVEY QUESTIONNAIRE

Questionnaires are data collection tools that are developed to be "respondent friendly" to enhance the maximisation of response rate. In the construction industry, response to research on construction management is relatively low (Xiao, 2002). The content of a questionnaire is set of questions for gathering information from individuals. Questionnaires can be administered as hand-outs, by mail, telephone, using face-toface interviews or electronically. The questionnaire design must address the needs of the research which is a characteristic of a good research design.

4.9.1 Structure and Design of Questionnaire

No survey can achieve success without a well-designed questionnaire. Questionnaires are used to obtain data from participants to a study and contain formalised set of questions. According to Frazer and Lawley (2000), questionnaires include instruction for its completion, specific ways for response recording and alternative choices to responses where appropriate. The devising of a questionnaire forms a fundamental part of a research design stage (Oppenheim, 1992). Questions formed on a questionnaire could be open-ended or close-ended or a blend of the two centred on the projected outcome (Frazer and Lawley, 2000). The questionnaire was prepared in accordance with the objectives set for the study, on a comprehensive literature review conducted on the subject. The questionnaire was intended for professional health and safety officers and construction site managers. The questionnaire was made up of three (3) sections; refer to **APPENDIX 1**.

- Section A
- Section B and
- Section C

Section A which was the first part of the questionnaire was designed to request for respondent's demographics. The responses were used to test if any of the variables in Section A had an essential impact on the rating of the experience and expertise. It is indicated that, in construction, years of professional experience in construction, professional's role, level of education and professional affiliations are known to be very significant indications of experience and expertise in construction (Hallowell and Gambatese, 2009). Data was thus collected on these variables

Section B which represented the second part of the questionnaire demanded that respondent's rate certain provided Construction Site Safety Challenges on the rate at which those indicators occur in Mass Housing Projects undertaken by their firm. The indicators provided were the dependent variables in the study. The Safety performance indicators were identified from literature as relevant to the study. These are shown in the **Table 4.2**. The rate of occurrence was assessed using a likert scale of 1 – 5 where 1 = Never, 2 = Rarely, 3 = Occasionally, 4 = Frequently and 5 = Very Frequently. This is similar to that used by Kwofie (2014) in investigating the influence of project features on project team communication performance on Mass Housing Projects.

Most or several studies considered the traditional measures of safety performance such as accident statistics and injury rate in measuring the performance of firms in terms of site safety (see Kheni, 2008). These measures of performance are undertaken after incidents occur. The study identifies challenges with safety occurring on MH sites in order to aid management curb the issues before they really occur in order to increase safety performance in the various firms delivering mass housing projects. Near-miss and dangerous occurrences do not result in injury but must be measured because when allowed to occur can be fatal.

Table 4.2: List of Construction Safety Challenges

SB	**STRUCK BY (SB)/ STRUCK AGAINST (SA)**
SB1	Falling of material or debris from heights to injure workers
SB2	Struck-by a moving heavy equipment e.g. bulldozer
SB3	Materials drop from a crane onto an employee
SB4	Step on sharp objects such as nails
SB5	Workers striking foot against sandcrete blocks
CW	**CONTACT WITH (CW)**
CW1	Contact with underground power cables
CW2	Contact with overhead high tension lines
CW3	Workers coming into contact with hot surfaces
C	**CAUGHT IN / CAUGHT BETWEEN / CAUGHT ON**
C1	Collapse of excavations or trenches
C2	An operator is trapped in an equipment on site
C3	Collision of heavy equipment causing operator injury
C4	Overturning of equipment resulting to operator injury

C5	Strangulation of a worker caught on running machinery
FS	**FALL-SAME LEVEL (FS)**
FS1	Slips due to oily or dusty floors
FS2	Fall resulting from inappropriate footwear
FS3	Trips when something large or heavy is being carried
FS4	Poor lighting system causing workers to fall
FB	**FALL TO BELLOW (FB)**
FB1	Falling of persons from scaffolds
FB2	A worker falling from the roof
FB3	Slip of ladder causing worker to fall
FB4	Workers slip and fall whiles climbing
FB5	Persons overbalance when carrying materials or tools
OE	**OVEREXERTION (OE)**
OE1	Low back pain from pulling
OE2	Strain resulting from heavy lifting
OE3	Musculoskeletal disorders from excessive work activities
OE4	Repeated bending at the waist causing injury
OE5	Injury from a long term poor posture (either sitting or standing)
OE6	Long term truck driving causing injury from vibrations
E	**EXPOSURE (E)**
E1	Explosions as a result of inefficient electrical wiring
E2	Burns sustained from fire outbreaks
E3	Exposure to hazardous substances like asbestos which causes cancer
E4	Lung problems from dust, fumes, gas and vapours
E5	Noise Induced Hearing Loss (NIHL)
RSI	**REPETITIVE STRESS INJURIES (RSI)**
RSI1	Neck injury resulting from improper manual handling
RSI2	Back injury resulting from the repetitive nature of a work item
RSI3	Injury on the upper limb areas of site workers
RSI4	Shoulder injury due to long periods of reaching
RSI5	Knee injury from long periods of standing

Section C comprising of the third and final part of the questionnaire demanded respondents indicated how often each of the following Indicators of Safety performance occur due to the unique physical features of Mass housing Projects. The physical features were identified from literature as those unique to the construction or development of mass Housing Projects. The unique physical features were adopted from Adinyira et al. (2013) where the unique features of Mass Housing Projects (MHPs) were determined. These were also assessed on a 5 - point likert scale (1 = Never, 2 = Rarely, 3 = Occasionally, 4 = Frequently and 5 = Very Frequently).

Table 4.3: The unique physical features of Mass Housing Development

MCS	**Multiple Construction Sites**
MCS1	Contractor management style adopted on housing units
MCS2	Site management style adopted on the housing units
MCS3	Construction technology and method adopted for repetitive works in housing units
MCS4	Change orders (Variation orders) procedures adopted on repetitive housing units
MCS5	Health and safety management techniques adopted for repetitive task construction works on housing units
MCS6	Computer application software(s) adopted by project teams on housing units under scheme
MCS7	Quality Management style and approach adopted on housing units
MGL	**Multiple Geographical Location**
MGL1	Influence of Local Development Controls across different geographical locations on housing units
MGL2	Cultural influence within labour work force due to geographical locations
MGL3	Influence of customary laws and practices on the tennural lands under scheme in various geographical locations
MGL4	Geographical constraints and challenges due to location influence on repetitive works and housing delivery
HUD	**Housing Unit Design and Contract Package**
HUD1	Composition of housing design in each contract packages under housing scheme
HUD2	Construction elements and components adopted in design units in contract packages under scheme

All parts of the questionnaire put together constituted a 6-page survey instrument. The questionnaire also constituted of a cover page which had brief information on the research aim, the respondents, approximate time it takes to complete the questionnaire, the various sections and the contact information of the researcher (see Appendix 1). The approximate time to complete the questionnaire was obtained during the pilot survey which was 20 minutes.

4.9.2 Pilot Study

Munn and Drever (1990) indicated that, it is necessary to pilot or pre-test questionnaires because it helps demonstrate the methodological rigor of a survey. All trial runs done in preparation of the complete study or a mini-version of a full-scale study is known as the pilot study. Pilot study is also known as a 'feasible study'. Van Teijlingen & Hundley (2002) indicated that, a pilot study can be a precise pre-testing of research instruments, involving interview schedules or questionnaires. The pilot study normally follows the research style, research approach and research strategy. Blaxter *et al.* (1996) defined piloting as a 'reassessment without tears' trying out all research techniques and methods which the researchers have in mind to see how well they will work in the field. Piloting of questionnaires ensures the flow and along with modification text ensures that every question is answered in correct order. It also gives a fair idea of how long it takes to answer the questionnaire. Awkward or repetitious wordings are identified during the pre-testing stage (Welman and Kruger, 1999). Creswell (2009) and Oppenheim (2003) stated that a pilot study is anticipated to bring about feedbacks that are very critical in smoothening the questionnaire by reducing uncertainty in the questions.

In this study, the pilot questionnaires were administered to astute persons from GREDA, general construction industry and academia who have thorough knowledge in the subject area. They were to check for any ambiguity, clarity and the time it will take to complete the questionnaire. The feedback showed that responses to be taken from the questionnaire were going to be relevant but there were several issues identified. The issues included;

- To state "ineffectiveness of construction site safety" in objective one was prejudicial hence the word "challenges" was suggested and used.
- It was known from the pre-test that it would take on the average 20 minutes to answer the questionnaire.
- In respect to Section C of the survey instrument, the instructions and questions were not clear and understandable. A guide in the form of a sample table then suggested.

These feedbacks were used to modify the data collection instrument for the main survey.

4.10 THE STUDY POPULATION

The study population needs to be defined before commencing sampling procedure. Population can be said to be the amount of units (households, individuals, legal entities) which entails one or more similar feature among each other. The population of a study also refers to the whole group that the study focuses on. In defining a population, it should be done as precisely as possible. With regards to the physical features of mass housing projects, the construction sites of these members of GREDA formed the study units hence were the main focus. This makes the population for this study undefined because the total number of mass housing construction sites were unknown. The physical features of MHPs also indicate that many construction sites could exist in the same place or in multiple geographical areas.

4.11 THE ORDER IN DEFINING SAMPLE FOR RESEARCH

The sample method involves selecting a representative of the entire population and acquiring information from the research using the data collected. A sample is a sub group of a population. The sample must represent the value of each unit meaning the sample must embody the characteristics of a certain number of units in the population Sampling of a population is a method used by all disciplines in undertaking research, and across all disciplines, the definition is standard. The standard definitions always comprise of the ability of the research to choose a fraction of the population that is truly representative of the said population.

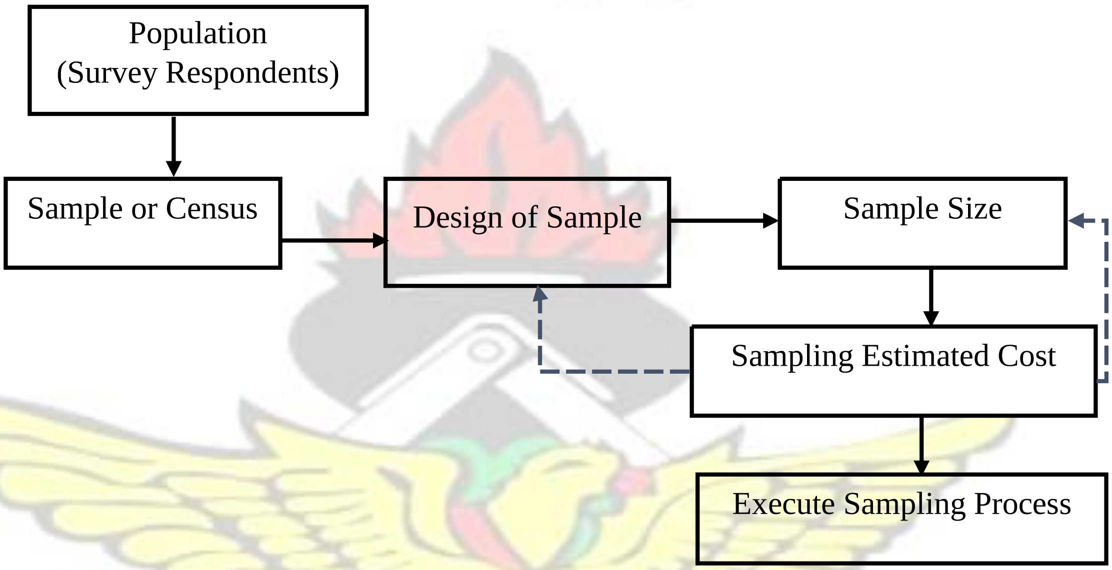

Figure 4.2: Defining Sample; Source: Authors own construct

In sampling, the processes involve two types of costs: fixed and variable. Costs that are constant and determined are fixed costs. The volume of study being conducted decides the variable costs to be incurred. The broken lines in Figure 4.2 indicate the interrelation between costs and sample design. The researcher must reconsider the design of the sample or sample size when costs are too high.

4.11.1 Sampling Technique

According to Hair et al. (2006), the primary idea of sampling is that a certain result is based on the notion that the sample (smaller portion) is representative of the larger population. It becomes very necessary that the researcher investigate the whole sample (census) or work with just a portion of it (sample) in the final moments of defining a population. The choice depends on the size of population. Census can be an ideal preference if the size of population is small otherwise a sample should be created. There are two categories of sampling techniques: probability and nonprobability sampling. The major difference between the two is that, the sample elements in non-probability sampling do not have a recognised, nonzero opportunity of being selected for the sample. Non-probability method is also a case where the researcher chooses elements or the components of a sample in terms of availability, convenience and the researchers own judgement (Smith and Albaum, 2005). Smith and Albaum (2005) also indicated that, in probability sampling each element has a known and equal probability of selection. Here, a non-probability sampling technique was employed due to the unknown nature of the population. The technique adopted under non-probability sampling was 'Purposive sampling'. With Purposive sampling, the researcher selects a sample that suits their needs. For the purpose of the study the following were the criteria for selecting sites.

1. Construction sites visited should belong to members of Ghana Real Estate Developers Association. In Ghana, the body responsible for the Mass Housing Sector is the Ghana Real Estate Developers Association (GREDA). This is so because unlike other countries where the Government is responsible for Housing Development, in Ghana, the Governments participation in vigorous delivery of mass housing projects has been non-existent (Konadu-Agyemang, 2001). KonaduAgyemang (2001) also indicated that, there has not been any single addition to housing supply by government since the turn of the 1980's and all commenced housing schemes either remains abandoned or unfinished. Active mass housing projects have been by GREDA. It is against this that the government of Ghana has

appointed GREDA to be the key contributor to the national housing stock through mass housing delivery. It is also to this knowledge that the study identifies GREDA members to be the most suitable participants for the study. GREDA is recognised as the main provider to mass housing in Ghana and also the umbrella bodt that controls and regulates the expansion of housing by private developers in Ghana.

2. Mass Housing Project sites selected must have professionals with knowledge on site safety issues. Taking into consideration the aim of the study which is to evaluate the influence of the unique physical features of Mass Housing Projects (MHPs) on Construction Site Safety in the Ghanaian Construction Industry, it was necessary to select sites with people with knowledge and understanding about the development of mass housing projects as well as managing safety on the site. From the sites of the firms registered as members of GREDA, the presence of a Health and Safety Officer or Construction Site Managers was required because it is these professionals that see to the performance of safety during housing deliveries. These professionals can as well give good and accurate responses to the challenges of safety performance in Mass housing delivery.

3. Findings from Kwofie (2015) indicated that, from the particulars on the knowhow of housing units managed per scheme, approximately 68% of the respondents were said to have managed over 50 housing units per scheme. It is against this that this research study states the minimum number of units for selected sites should be 50. Certain organisations have their principal activities enabled by geographically dispersed network of tasks. According to Blismas et al. (1999), such organisations would come across a unique situation when programmes are introduced to achieve any construction work across the network. Blismas (2001) further acknowledged that, the geographical incongruence, multiple repetitiveness

of tasks on such sites exacerbates the difficulty of such programmes. The familiarity in the housing units per scheme managed would indicate that the respondents are more likely to have reasonable experience in the safety challenges in managing the schemes. Hence, they are more likely to reveal the practical viewpoint of the mass housing project environment taking into consideration the physical features.

4. The developers owning the sites visited should have been in active construction works for the past 5 years to enable the reporting of current construction site safety issues.

4.11.2 Sample Size Determination

The determined sample size forms the basis of the actual sampling procedure. The sample size is the portion of the population which actually selected using the sampling technique. The sample size may contain one or more population elements. The units in a sample size may be single elements or aggregates of single elements (Smith and Albaum, 2005). The sample size indicated in this section was influenced by the analytical tool employed for the study. In Structural Equation Modelling (SEM) analysis and model testing, sample size significantly affects model fit (Tong, 2007). Bentler (2005), Kenny and McCoach (2003), Jackson (2003) and others have all made recommendations on appropriate constituents of a sample size that will yield effective results towards model fit. The smaller the sample size, the more bias and ineffective the model fit (Tong, 2007). A sample size of 100 was indicated as small for a study employing SEM as the analytical tool (Kline, 2010). Structural Equation Modelling has been debated to be a sample sensitive analytical approach and that the outcomes obtained are highly dependable when sample size are large and disseminated normally (Bollen *et al.,* 2007). Iacobucci (2010) added to this by indicating a sample size of 200 with certain number of variables suitable for a good fit model analysis. The use of variable ratios in determining an appropriate sample size has been confirmed by several studies (see Kwofie, 2014; Hair et al., 2013; Curran et al., 2004) as very convenient. The variable ratio should be at least 5:1 as indicated by Tong (2007). Taking into consideration the 51 observed variables with a 5:1 variable ratio for an ideal SEM model, a size of 255 samples was considered.

4.12 DATA COLLECTION

In all 255 questionnaires were administered. All 255 questionnaires were selfadministered. Some of the questionnaires were retrieved on the spot whiles the rest were retrieved some days after their administration. All questionnaires had cover letters introducing briefly the research and its purpose. Regular reminders in the form of telephone calls and emails interspersed the survey duration to ensure accurate response. These reminders in the form of emails were sent every 3 days to the participants. Some Real Estate developers were very helpful by granting access to all their construction sites. As many as 20 questionnaires were gotten from construction sites of individual firms due to the firm having more than one construction sites. As a means of explaining the purpose of the research to the participants, the researcher made use of telephones and emails. The services of nine (9) other field assistants who unconditionally sought for the data collection from active Mass Housing Construction sites were employed. These assistants were briefed on the purpose of the study and what the survey required of the respondents. 202 questionnaires were finally received from the various Health and Safety officers and Construction Site Engineers from the MHP delivery sites. This constituted the sub-sample. These 202 questionnaires were successfully retrieved from 35 active GREDA members.

4.13 DATA ANALYSIS AND STATISTICAL TOOLS

To ensure the consistency and completeness, the retrieved questionnaires were edited. Editing of data was done because according to Yuen (2007) and Neuman (2003), field data needs to be organised prior to the main statistical analysis in order to enhance the data quality and reduce the occurrence of errors and inadequacies which risk undermining the outcome and results of research. All questionnaires were then coded to enhance easy identification and analysis. All data received were also entered into the Statistical Package for Social Sciences (SPSS) version 21. The following sections indicate the various tests applied to the data received to meet the research objectives set in Chapter One of the study.

4.13.1 Respondent's Demographics

Data on years of experience, policy, employee consultation, Health and Safety training programmes were analysed using descriptive statistics. Respondents' demographics were analysed using percentages and presented in the form of chats and tables.

4.13.2 Safety Performance Indicators

Relative Occurrence Index (ROI) and Mean Score Rankings were employed for this section. These tools were used to rank the occurrences of the safety challenges. ROI was calculated using;

$$\mathbf{ROI} = \frac{\Sigma MiUi}{N\,(n)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (1)$$

Where **ROI** = Relative Occurrence Index

M_i= respondents rating of occurrence on criteria on safety performance indicators

U_i= number of respondents placing identical rating on occurrence of safety performance indicators **N** = Sample size

n = the highest weight on the occurrence criteria factors

The overall occurrence levels of the individual indicators were affirmed based on the Mean Aggregate Relative Occurrence Index.

ROI Mean Aggregate = Sum (ROI) / N

Where **N** = the number of factors deliberated under the various sections

Table 4.4: Explanation of the ROI mean values

Relative Occurrence Index (%)	*Level of Occurrence*
1-20	*Never Occurs*
21-40	*Rarely Occurs*
41-60	*Occurs Occasionally*
61-80	*Occurs Frequently*
81-100	*Occurs Very Frequently*

Source: Authors own construct (formulated from Ojo and Oloruntoba, 2012) Data obtained from the study were also ranked according to their mean score. The basis for the ranking was similar to that of Hoe (2006). Hoe (2006) indicated that, a high mean relevance rating indicates that the variable under consideration is significant. A mean value of 3.5 or greater is considered as significant. By applying the mean score ranking, the main Safety problems experienced on MHP inherent in the unique Physical features of Mass Housing Projects were identified.

4.13.3 Impact of Unique Physical features of MHPs on Construction Site Safety

Structural Equation modelling (SEM) is an example of a multilevel Multivariate Analysis. It is a useful technique that puts together complex path models with latent variables (factors). SEM can be seen as a combination of factor analysis and regression. SEM also implies a structure for the covariance between observed variables. SEM enables a researcher reveal certain latent characteristics which are not possible even when using multiple regression. Byrne (2006) stated that, when using SEM, it becomes possible to identify causal relationships between variables over multiple regression, which is only exploratory. Bentler (2005) also makes it known that, SEM helps in analysing one/more independent variable(s) on one/more dependent variable(s) as compared to Multiple Regression which only handle only one dependent variable.

4.14 SUMMARY

The study design and methodology were presented in Chapter Three. The study lies within the positivist type of epistemological study, falls under the realist point of view and is positioned in the value-freedom axiological perspective. Explanatory research design was chosen for the study. The philosophical positions of the study influenced the choice of Deductive research approach, Survey research strategy and Quantitative research method. The method of data collection was the use of questionnaires. Since the study population was undefined, Purposive Sampling became the most appropriate choice of sampling technique. Mean score ranking, Relative Occurrence Index and Structural Equation Modelling were the analytical tools to be used for the study. Based on the SEM, the appropriate sample size was 255. The statistical results obtained from the data are discussed in the next chapter.

CHAPTER FIVE DATA ANALYSIS AND INTEPRETATION 5.1 INTRODUCTION

The analysis of all the primary data collected from the 202 professional construction site managers and health and safety officers operating on sites belonging to registered GREDA firms are covered in this chapter. The Chapter also aims to show the various results from every section of the survey instrument. The results from the analysis were discussed thoroughly by the researcher. The Chapter was organised into three main sections namely;

- Section A considers the respondent's demographics which included the profession, years of experience, formal training and respondent's years of involvement in MHPs.

- Section B considered the challenges with safety performance on Mass Housing Projects.
- Section C dealt with the nature of contribution of unique physical features of mass housing on construction site safety performance.

The details of all data gathered by the researcher from the survey organised were presented in this chapter to come out with an unbiased opinion.

5.2 RESPONSE RATE

A concern about the quality of survey data has been raised by researchers because it is presumed that the greater the rate of response, the more accurate the results (Rea and Parker, 1997; Aday, 1996). Biemer and Lyberg (2003), and Atrostic *et al.* (2001) indicated that, response rates are often used to evaluate the quality of survey data. In order to get the least requirement of 200 responses demanded of Structural Equation Model, the field survey was conducted with nine (9) other field assistants. In addition to this, continuous follow ups were made in the form of telephone calls and emails. As indicated in **Section 4.8.7** a sample size of 255 was considered appropriate for the study and as such 255 questionnaires were administered. A total of 202 responses were received from 35 registered GREDA members representing a response rate of 79%. This can be compared to similar studies by Kwofie (2014) which yielded a response rate of 89% from 248 distributed questionnaires as such a response rate of 79% from 255 distributed questionnaires can be recognised as high and sufficient for the statistical analysis.

5.3 INFORMATION ON RESPONDENT BACKGROUND

This section of the questionnaire comprised questions demanding personal information to provide detailed respondent characteristics (Figure 5.1 to 5.3 and Table 5.1). Data in this section included: respondent's profession, respondents' years of practice, formal training in Construction Health and Safety, respondents whose firm have health and safety policy, employees consulted on health and safety matters, firms that undertake formal health and safety inspections, and the number of firms that keep records of all accidents concerning employees. Bryman (2009) stated that, respondent's demographics is very useful in enhancing the reliability and credibility of the responses and results in a survey. Hallowell and Gambatese (2009) also indicated that, it is very important to assess the background information of participants to a research survey because these indications define the expertise and experience profiles of professionals in construction.

5.3.1 Respondents profession

The purpose of this question was to ascertain the professional background of the respondents in direct relation to managing safety (accidents) on site. Out of the 202 responses retrieved, 67 representing 33.2% practiced Health and Safety as a profession whereas 135 representing 66.8% of the respondents were Construction Site Engineers. From **Figure 5.1** it is seen that safety issues on most construction sites of mass housing delivery firms in Ghana were managed by professionals practicing as Construction Site Engineers.

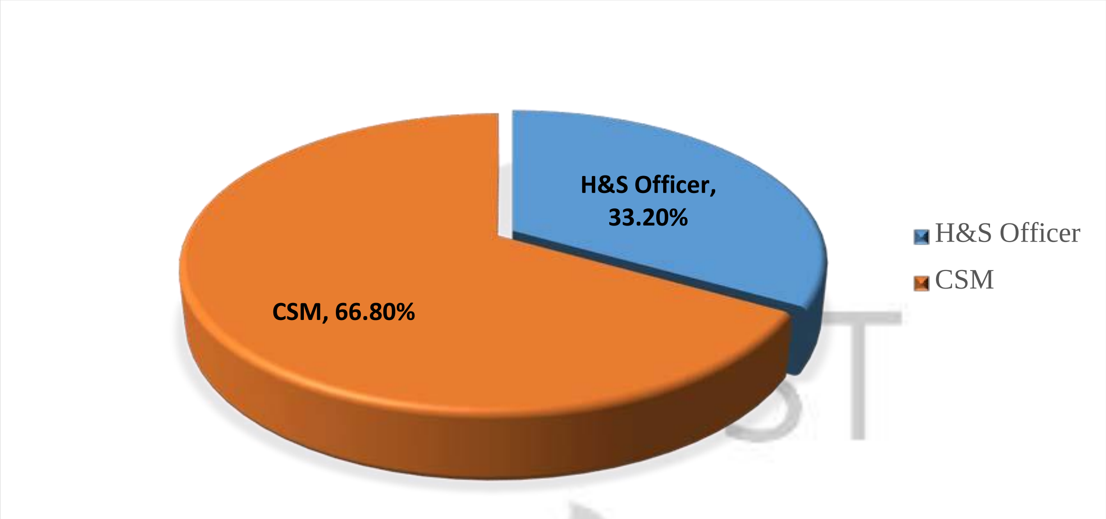

Figure 5.1: Respondents profession

Source: Researchers Survey (2016)

5.3.2 Years of experience in managing H&S on site

In order to ensure that the responses were reliable and valid, it was important to determine the years of experience of the person who answered the questionnaire. As such, respondents were asked to indicate how long they have been managing health and safety issues on site in their current positions. The working experiences of the respondents are shown in Figure 5.2 and the indications are that, 4% of the respondents representing 8 of them have worked over 20 years. About 36.1% of the 202 respondents have been managing health and safety on mass housing project sites for 11 to 20 years. Respondents with 6 to 10 years of experience represented 45.5% whereas 14.4% of the respondents had up to 5 years of experience. This background data acquired on these professionals indicates they are competent, experienced and capable of exercising good judgement and as such the responses to the questions could therefore be considered as true and accurate reflections of the state of health and safety in MHPs in view of their roles in **Figure 5.1** and years of experience in **Figure**

5.2.

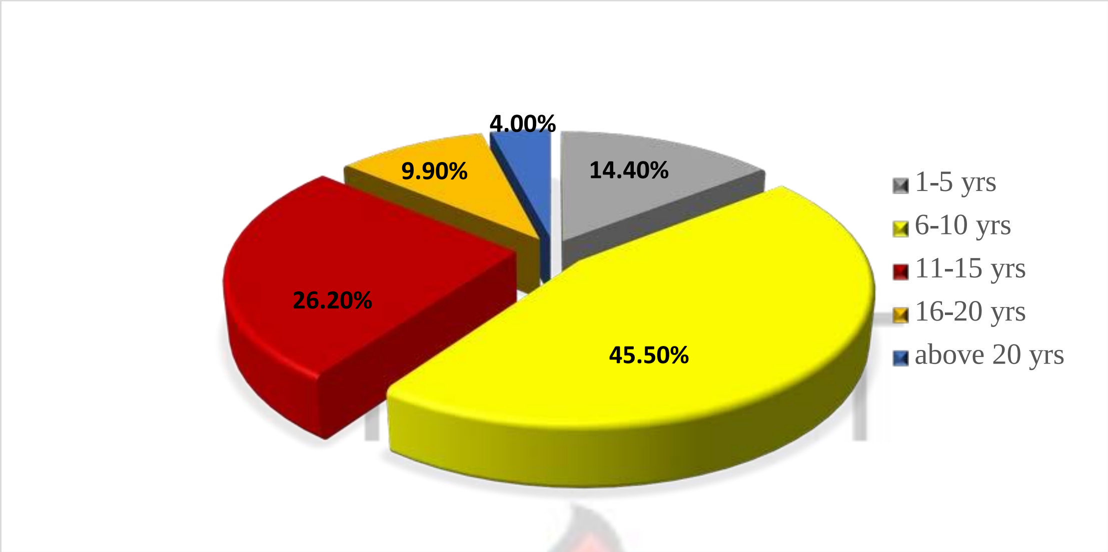

Figure 5.2: Respondents years of experience

Source: Researchers Survey (2016)

5.3.3 Organisational involvement in MHPs

Respondents were asked to indicate the number of years their firm has been involved in the delivery of Mass Housing Projects (MHPs). The researcher needed information on the contribution of the firm to Mass Housing delivery in Ghana and whether responses on the unique physical features of mass housing projects could be considered as accurate or not. The responses are shown in **Figure 5.3**.

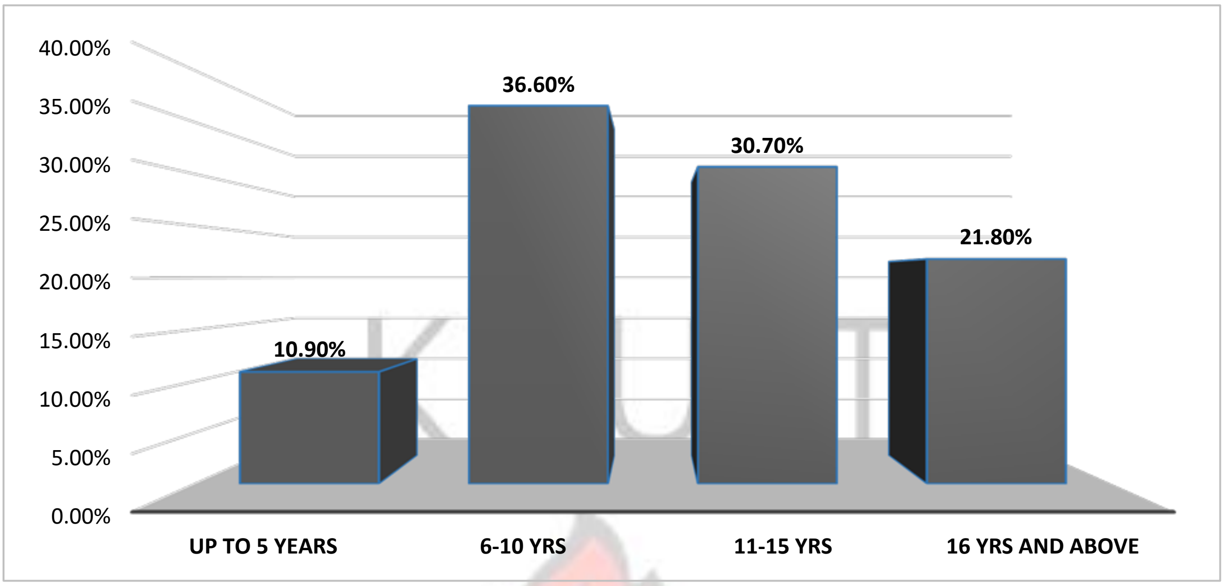

Figure 5.3: Organisation's no. of years of involvement in Mass Housing Projects

Source: Researchers Survey (2016)

Figure 5.3 shows the number of years that the respondents firms have been involved in mass housing projects and the indications are that, 44 of the respondents have their firms involved in MHPs for 16 years and above and 62 (30.7%) of the respondents have their firms involved in MHPs for 11 to 15 years. Majority of the respondents that is 36.6% indicated their firms being involved in MHPs for 6 to 10 years. About 89% indicated their firm's involvement in mass housing development leaving 11% for a maximum of up to 5 years. This indicated that they have been active in mass housing implementation and delivery hence contributes significantly to the study.

5.3.4 Information required of respondents concerning the firm

The Table below (Table 5.1) provides data on the rest of respondent's demographics in the research instrument. Some questions addressed were; whether or not respondent's firm had a written Health and Safety policy; whether firm consults consult their employees on issues of Health and Safety; how many firms undertake training program for their employees in Health and Safety. Table 5.1 shows the responses to these questions.

Table 5.1: Health and Safety practices in Respondents firm

Qu.	Section A: Questions	Number of respondents	Frequency of respondents	
			Yes	No
4	Formal training in CH&S management	202	**143** (70.8%)	**59** (29.2%)
5	Availability of a written policy	202	**152** (75.2%)	**50** (24.8%)
6	Consulting employees on matters of H&S	202	**142** (70.3%)	**60** (29.7%)
7	Availability of a training program	202	**100** (49.5%)	**102** (50.5%)
8	Health and Safety inspection	202	**120** (59.4%)	**82** (40.6%)
9	Accident record keeping on site	202	**89** (44.1%)	**113** (55.9%)

Source: Researchers Survey (2016)

5.3.4.1 Formal training in CHSM

Respondents were required to indicate if they have had any formal training in Construction Health and Safety. From **Table 5.1**, it is seen that, out of the 202 responses, 143 respondents representing 70.8% have had some form of formal training in Construction Health and Safety whiles 59 representing 29.2 had no form of formal training in Health and Safety.

The following are some examples of formal training identified by respondents: Health and Safety Seminar; Fora undertaking in Construction Health and Safety; First Aid Training; Occupational Health, Safety and Environment Management, IPED UK; Job Hazard Analysis; Environmental, Health and Safety Management; A course taken at the 1st Degree level; The Comprehensive Guide to treating casualties; NEBOSH International Diploma in HSE management.

5.3.4.2 Availability of a written H&S policy

Poor safety leads to accidents as well as significant costs for organisation. It is to this that the possession of a health and safety policy is key because it ensures the health and safety of organisations, employees and other people affected by the activities of the organisation. This question intended to explore the existence of health and safety policy among mass housing developers. From **Table 5.1**, 75.2% of the respondents showed that their firms had policies on health and safety whereas 24.8% (50 responses) indicated that their firms did not have health and safety policies. Even though the outcome of this response showed a positive direction towards good health and safety practices, it is indicated in the HSW Act 1974 Section 2 that if any organisation employs more than five people, it must have a written policy on H&S. The vital components of a clearly outlined H&S policy and organisation should include (Hughes and Ferrett, 2005; Lingard and Rowlinson, 2005; HSE, 2007): a copy of written H&S policy statement (specifying H&S aims and objectives) which is dated and endorsed by the most senior person in the organisation, and H&S responsibilities for employees at all levels.

5.3.4.3 Consulting employees on H&S matters

Lingard and Rowlinson (2005) indicated that, Health and Safety is a crossdisciplinary concept that is concerned with protecting the safety, health and welfare of people engaged in work or employment. It is realised from this definition that safety issues on a construction site involves the participation of all parties on the project i.e. from top management to the labourer. The researcher aimed to determine the attitude of employers towards employee specific safety issues by enquiring if Mass Housing Developers in Ghana consult their employees on safety matters. **Table 5.1** shows that 70.3% of the respondents stated their firms consult employees on safety issues while the remaining 29.7% reported that their firms did not consult their workers. It is always important to consult employees about safety because this can result in; joint problem-solving, trust and co-operation, better decisions about safety, and a safer and healthier workplace (HSE, 2013).

5.3.4.4 Availability of a Training program

Respondents were asked to indicate whether they have any formal health and safety programs for their employees. The results are shown in **Table 5.1.** Formal Health and Safety programs are essential for ensuring that health and safety regulations are complied with on construction sites. The results from the Table shows that most mass housing developers in Ghana do not have formal health and safety training programs. Hundred (100) representing 49.2% indicated that they had training programs for employees whereas 102 (50.5%) indicated “No” meaning they did not have such training programs for employees. This shows a bad practice on the path of MHP developers because according to Wilson (2000), firms performing poorly in safety management often leave training in safety to experience on site as indicated in **Table 5.1** which may be inadequate to prevent occupational accidents. Effective training in the construction industry is one means by which safety can be improved requiring the participation of company directors in order to minimise the number of fatalities and injuries. According to Peyton and Rubio (1991), safety training and orientation are necessary elements of an effective safety program. These training programs are especially useful when employees first arrive on the construction site. This training should especially cover the firm and project safety policies, site orientation, site regulations and PPEs.

In most developing countries, training programmes for staff and workers are unavailable resulting in no orientation for new staff or workers; no identification of hazards; and no holding of safety meetings (Kartam *et al.*, 1998). Tam et al. (2004) concurs with this view and suggested that, one of the main contributing factors to poor safety management in China was the lack of training on Safety. This situation can be said to be largely the case with the Ghanaian Construction Industry.

5.3.4.5 Health and Safety inspections

Undertaking a health and safety inspection enables a firm identify potential hazards. With construction site works constantly changing in the construction industry of Ghana, safety risks and hazards may appear. The question aimed at determining firms that undertake safety inspections taking into consideration any arising hazard. **Table 5.1** shows that 59.4% (120 respondents) confirmed not undertaking formal health and safety inspections while the remaining 40.6% (82 respondents) confirmed undertaking safety inspections. This can be attributed to the reason why majority of the respondents did not also keep record of accidents on their sites. The nature of a particular work determines the frequency of inspections to undertake. If the work environment is low risk like in a predominantly administrative office inspection may be less often. HSE (2011) stated that, more frequent inspection should be undertaken on specific activities with high risk on construction projects which changes rapidly.

5.3.4.6 Record keeping on site accidents

Every firm must have a policy which mandates them to create, maintain and file accident reports as indicated by law. It is essential to report accidents which causes injury or illness to workers and events (near-miss accidents) in order to;

- Create a written record of factors that cause injuries and events (near-misses) including property and vehicle damage. A near-miss is an event that could have caused an injury or illness but did not.
- To have the capability to promptly examine incidents and events to initiate and provide corrective and/or preventive action.
- Provide statistical data for use in analysing all phases of incidents and events.

Respondents were asked to indicate whether their firms kept accident records on construction sites. It is again seen from **Table 5.1** that, 89 of the respondents said 'Yes' they had records of accidents and this represents 44.1%. 113 participants indicated that their firms have no records on site accidents. This constituted a percentage of 55.9. A review of project safety record including accident statistics, reports of injuries and safety inspection results is a valuable safety tool. These records pinpoint problem areas that would need more safety attention. For attention to be directed at controlling a particular safety challenge, it is significant to know the causes of accidents. It is therefore essential for management of these mass housing firms to encourage employees to report promptly all accidents/incidents and near misses (HSE, 2003). International Labour Organisation (ILO, 1996) indicated poor health and safety records being maintained in construction projects within developing countries. ILO (2005) confirms the findings from this study by indicating that, there is a problem reporting accidents in developing countries. Davies and Tomasin (1996) gave some reasons why accident records are not kept in the construction industry by comparing the industry to that of manufacturing. They indicated that, factories employ normally a well-ordered working environment, without a significant change in the working equipment and procedures over a substantial period of time. Davies and Tomasin (1996) added that, the manufacturing industry usually maintain a fairly constant labour force. This cannot be said of the construction industry with a changing working environment.

5.4 SAFETY PERFORMANCE CHALLENGES ON MASS HOUSING PROJECTS

The Section B of the questionnaire was used to address Objective One which was ***to identify the main challenges with Construction Site Safety performance on Mass Housing Projects.*** The various variables on the safety performance indicators in Mass Housing Projects were identified from literature (see Layrea, 2010; Lingard and Rowlinson, 2005; Ringen et al., 1995). These variables were then considered under the various themes (Struck By/Struck Against; Contact With; Caught In/Caught Between/Caught On; Fall-Same Level; Fall to Below; Overexertion; Exposure; Repetitive Stress Injury) as identified by Helander (1991). Respondents were asked by the researcher to score on a likert scale of 1-5 the rate at which the following safety problems occur on Mass Housing Projects in Ghana using the likert scale, "Never" ranked 1, "Rarely" ranked as 2, "Occasionally" as 3, "Frequently" as 4 and the highest scale "Very frequently" as 5. Any safety performance indicator that has its ranking having a mean of 3.5 or above is identified as a significant indicator or challenge affecting safety on MHPs whereas a mean score below 3.5 is marked as irrelevant to the safe delivery of Mass Housing Projects. The ROI interpretation adopted is as follows; 1-20 (Never Occurs); 21-40 (Rarely Occurs); 41-60 (Occurs Occasionally); 61-80 (Occurs Frequently); 81-100 (Occurs Very Frequently). **Table 5.2** indicates the various variables with their respective mean score, ROI and ranking.

The mean scores were used to identify variables which needed to be ranked using the ROI. It is seen in Table 5.2 that, mean scores below 3.50 were not ranked using the ROI.

Table 5.2: Challenges of Safety Performance on Mass Housing Projects

S/No	SAFETY PERFORMANCE INDICATORS	Response		ROI (%)	Rank
		Mean	Std. D		
SB	**STRUCK BY (SB)/ STRUCK AGAINST (SA)**				
SB1	Falling of material or debris from heights to injure workers	3.59	0.948	**72**	**1st**
SB5	Workers striking foot against sandcrete blocks	3.54	0.817	**71**	**2nd**
SB4	Step on sharp objects such as nails	3.54	0.835	**71**	**3rd**
SB2	Struck-by a moving heavy equipment e.g. bulldozer	2.61	0.720	**52**	**-**
SB3	Materials drop from a crane onto an employee	1.48	0.617	**30**	**-**
ROI MEAN AGGREGATE				**59.2%**	
CW	**CONTACT WITH (CW)**				
CW1	Contact with underground power cables	3.59	0.822	**72**	**1st**
CW3	Workers coming into contact with hot surfaces	3.55	0.959	**71**	**2nd**
CW2	Contact with overhead high tension lines	2.19	0.687	**44**	**-**
ROI MEAN AGGREGATE				**62.3%**	
C	**CAUGHT IN (CI)/CAUGHT BETWEEN (CBT)/ CAUGHT ON (CO)**				
C1	Collapse of excavations or trenches	3.85	1.013	**77**	**1st**
C4	Overturning of equipment resulting to operator injury	3.65	0.852	**73**	**2nd**
C3	Collision of heavy equipment causing operator injury	3.60	0.952	**72**	**3rd**
C5	Strangulation of a worker caught on running machinery	2.28	0.837	**46**	**-**
C2	An operator is trapped in an equipment on site	1.48	0.566	**30**	**-**
ROI MEAN AGGREGATE				**59.6%**	
FS	**FALL-SAME LEVEL (FS)**				
FS1	Slips due to oily or dusty floors	3.97	1.004	**79**	**1st**
FS3	Trips when something large or heavy is being carried	3.66	0.868	**73**	**2nd**
FS4	Poor lighting system causing workers to fall	3.65	0.898	**73**	**3rd**
FS2	Fall resulting from inappropriate footwear	2.95	0.741	**59**	**-**
ROI MEAN AGGREGATE				**71%**	
FB	**FALL TO BELLOW (FB)**				
FB1	Falling of persons from scaffolds	3.90	0.925	**78**	**1st**

FB3	Slip of ladder causing worker to fall	3.56	0.971	**71**	**2nd**
FB5	Persons overbalance when carrying materials or tools	3.51	0.894	**70**	**3rd**
FB4	Workers slip and fall whiles climbing	3.02	0.967	**60**	**-**
FB2	A worker falling from the roof	2.33	0.825	**47**	**-**
ROI MEAN AGGREGATE				**65.2%**	

Table 5.2 continued

OE	**OVEREXERTION (OE)**				
OE4	Repeated bending at the waist causing injury	3.96	0.943	**79**	**1st**
OE5	Injury from a long term poor posture (sitting or standing)	3.81	0.917	**76**	**2nd**
OE1	Low back pain from pulling	3.77	0.833	**75**	**3rd**
OE2	Strain resulting from heavy lifting	3.68	0.961	**74**	**4th**
OE3	Musculoskeletal disorders from excessive work activities	3.52	1.008	**70**	**5th**
OE6	Long term truck driving causing injury from vibrations	1.79	0.816	**36**	**-**
ROI MEAN AGGREGATE				**68.3%**	
E	**EXPOSURE (E)**				
E4	Lung problems from dust, fumes, gas and vapours	3.85	0.790	**77**	**1st**
E5	Noise Induced Hearing Loss (NIHL)	3.56	0.815	**71**	**2nd**
E3	Exposure to hazardous substances like asbestos which causes cancer	3.53	0.952	**71**	**3rd**
E1	Explosions as a result of inefficient electrical wiring	2.11	0.784	**42**	**-**
E2	Burns sustained from fire outbreaks	1.60	0.735	**32**	**-**
ROI MEAN AGGREGATE				**58.6%**	
RSI	**REPETITIVE STRESS INJURIES (RSI)**				
RSI2	Back injury resulting from the repetitive nature of a work item	3.87	0.809	**78**	**1st**
RSI1	Neck injury resulting from improper manual handling	3.83	1.003	**77**	**2nd**
RSI5	Knee injury from long periods of standing	3.74	0.844	**75**	**3rd**
RSI4	Shoulder injury due to long periods of reaching	3.66	0.796	**73**	**4th**
RSI3	Injury on the upper limb areas of site workers	2.07	0.795	**41**	**-**
ROI MEAN AGGREGATE				**68.8%**	

Source: Researchers Survey (2016)

5.4.1 Struck By (SB)/ Struck Against (SA)

Struck by accident occurs when an object struck a person. With respect to struck by, the force of contact is provided by the object. In the case of struck against, the person rather forcefully strikes an object. Here it is the person or employee providing the force. In New South Wales, these type of accidents were the tenth leading cause of death between the years 1998 to 2002 (see Schmertmann *et al.*, 2004). The Bureau of Labour Statistics undertook a study on the private sector of the construction industry and reported that 18,072 injuries that occurred resulted from workers colliding with construction equipment or other objects (BLS, 2013; CPWR, 2013).

The SB section of **Table 5.2** shows respondents identifying three out of the five performance indicators to be relevant to the safe delivery of Mass Housing Projects. SB1 was ranked first with a mean rating of 3.59 (with Std. Dev. = 0.948). SB1 obtained a ROI of 72% which is to say that, there have been several situations where materials or debris falling from heights to injure workers occurred. Most MHP are Multi-storey structures hence fall from heights are quite pronounce. Materials falling from heights to strike an employee are one of the most deadly hazards found at construction sites. One is exposed to the hazard of falling objects when he or she is working or walking below an elevated work surface. Also, workers or employees on a construction site are exposed to falling objects when materials are being moved overhead. It is appropriate that workers on site keep safe distance from suspended loads. Materials at heights need to be stored properly. The use of debris nets are not mostly used on the site resulting in this type of hazard.

SB4 and SB5 scored the same mean rating of 3.54 but Standard Deviations of 0.835 and 0.817 respectively. As such SB5 was ranked higher than SB4. SB2 and SB3 were scored low by respondents. In relation to Struck By accidents, respondents indicated that employee being struck by a moving heavy equipment occasionally occurs on site whiles materials dropping from a crane onto an employee rarely occurs in MHPs in Ghana taking into consideration the ROI of 52% and 30% respectively. These variables also had mean values below 3.50. With respect to the ROI mean aggregate, SB places 7th out of the Eight (8) safety events identified.

5.4.2 Contact with (CW)

Three forms of hazards were identified under Contact with (CW) which were Contact with underground power cables (CW1), Contact with overhead high tension lines (CW2) and Workers coming into contact with hot surfaces (CW3). Table 5.2 shows that CW1 was ranked highest scoring a mean rating of 3.59 (with Std. Dev. = 0.822) and ROI of 72%. This can be compared to the case of UK where, 2% of all fatalities at work in one-off projects are caused by electric shocks (Huges and Ferrett, 2011).

Poorly maintained electrical equipment, working close to overhead electricity supplies, use of inappropriate safety gear and contact with underground power cables during excavation work are the cause of most injuries and deaths from electricity. CW1 was followed by CW3 which obtained a mean rating of 3.55 (with Std. Dev. = 0.959). Respondents showed from **Table 5.2** that CW2 occasionally occurred in the construction of Mass Housing Projects. CW2 scored a mean rating of 2.19 (with Std. Dev. = 0.687). The standard deviations to all the mean values are relatively small indicating a good fit of the data (Field, 2005).

5.4.3 Caught In (CI)/Caught Between (CBT)/ Caught On (CO)

Collapse of excavations or trenches (C1) dominated the various hazards identified under CI/CBT/CO. This was ranked first with a mean rating 3.85 and a standard deviation of

1.013. Even though C1 scored the highest mean, the responses were wide apart which was evident in the value representing the standard deviation. Working in excavations in the construction industry has traditionally had a higher accident and injury rate than other workers on different work items in the construction industry (Arboleda and Abraham, 2004). According to OSHA (2007), it is recorded that, the fatality rate for excavation works in mass housing is 112% higher than the rate for general construction works. Accidents relating to caught-in events occur by collapse of sides/cave-in of excavations (HSE, 2005). The second highest ranked performance indicator is the Overturning of equipment resulting in operator injury (C4). C4 had a mean score rating of 3.65 (with Std. Dev. = 0.852). Phoya (2012) indicated that, equipment are necessary for undertaking work activities, however, a lot of people die while others get injured due to machines overturning whiles travelling down a steep slope. Operators are at a risk of injury due to overturn and collision.

Respondents indicated the Collision of heavy equipment causing operator injury as the third highest indicator under the CI/CBT/CO section. Blind spots are one of the leading causes of contact collisions between construction equipment (Fullerton et al., 2009; Fosbroke, 2004). Research studies and investigations undertaken on accidents on site indicated visibility-related issues which were created by blind spots cause operators to come in contact with other equipment. Strangulation of a worker being caught on running machinery and operator trapped in an equipment were ranked 4th (mean=2.28 Std. Dev. =0.837) and 5th (mean=1.48 Std. Dev. =0.566) respectively. Unlike the construction industry, incidents of caught/trapped in equipment are rather high in the manufacturing industry. This accounts for the largest portion of deaths in the manufacturing industry. In 1996, almost 19,000 workers in manufacturing suffered injuries resulting from caught in accidents (Windau, 1998).

5.4.4 Fall-Same Level (FS)

Table 5.2 shows FS1 as the most occurring accident in Mass Housing Projects under Fall-Same level (FS). FS1 had a mean score rating of 3.97 (with Std. Dev. = 1.004). Slips due to oily floors scored a ROI of 79% indicating how frequent it occurs on site. Further, participants responded FS3 was the second highest of the type of FS hazards on construction sites of Mass Housing Projects with a mean rating of 3.66 (with Std. Dev. = 0.868). Slips and trips are considered as the most common hazards in the workplace and contribute more than a third of all major injuries (Hughes and Ferret, 2011). Lipscamb *et al.* (2008) affirms the findings in Table 5.2 as his study undertaking in the United States have shown that slips accounted for 18% of all injuries and 25% of the compensation of employees. Issues of slips and trips are mostly related to Site housekeeping. To ensure site safety, good housekeeping is an essential point to consider. It is required of every worker on site to do their part to ensure that the construction site is in order and clean. With a mean rating of 3.65 and standard deviation of 0.898, fall resulting from poor systems of lighting was ranked third. According to Table 5.2, FS2 scored ROI = 59% indicating that, the inappropriate footwear occasionally affects the performance of safety in terms of falling same level.

5.4.5 Fall to Bellow (FB)

Falling of persons from scaffolds on Mass Housing Projects was ranked first by respondents with a high mean rating of 3.90 and a standard deviation of 0.925. In a study undertaken by Afosah (2014), it is seen that, one hundred respondents representing about 84% indicated fall from heights as the greatest hazard in the construction industry. Phoya (2012) also undertook a study where hazards were categorised based on hazards with high consequences by supervisors and workers. Falling from heights emerged as a hazard with highest consequence and was categorised

“A”. In the construction industry in China, falls account for about 51% of fatal accidents (Yung, 2009). This situation is similar to that of Hong Kong where work related falls from heights indicated over 47% of all fatal accidents (Chan *et al.,* 2008). According to Chi and Wu (1997), falls in the Taiwan Construction Industry contributes more than 30% of fatalities on site. Falls stand to be the costliest occupational hazard in many countries.

With a mean rating of 3.56 and standard deviation of 0.971, respondents shows that the second highest hazard to follow falling from scaffolds is the slip of ladder causing worker to fall and get injured. Ladders that are not safely positioned poses the risk of falling to workers on MHP construction sites. Workers can also lose their balance while getting on or off an unsteady ladder. Injuries ranging from sprains to death can be a result of a fall from a ladder. In the Mass Housing Sector of Ghana, falling from roofs as a performance indicator was ranked the lowest with a mean of 2.33 (with Std.

Dev. = 0.825, ROI = 47%).

5.4.6 Overexertion (OE)

This is a concept describing or an accident that occurs due to the use of physical or perceived energy. Overexertion normally connotes a costly or strenuous effort in relation to muscular or physical actions and work. Six performance indicators were identified from literature under Overexertion. Respondents ranked Repeated bending at the waist causing injury as an indicator with the highest occurrence in Mass Housing Project delivery. OE4 had a mean score rating of 3.96 (with standard deviation = 0.943). This is also evident in the ROI value of 79% close to 81% which would have meant it occurred very frequently. The second highest indicator was injuries resulting from long term poor posture i.e. either sitting or standing to undertake a work item. OE5 scored a mean rating of 3.81 (with standard deviation = 0.917). Low back pain resulting pulling was indicated by respondents as the third highest indicator with mean 3.77 and standard deviation 0.833.

From 2003 to 2012, 92% of back injuries were caused by overexertion injuries such as pulling, carrying, etc. In construction trades, back injuries claim for men were reported 21% and only 1% for women. This also explains why the construction industry of Ghana is predominantly male oriented. The physical labour resulting in injuries of overexertion for some women can be unbearable. Strain resulting from heavy lifting and Musculoskeletal disorders from excessive work activities were ranked fourth and fifth with mean scores 3.68 and 3.52 respectively. The only safety indicator under overexertion respondents ranked low with respect to its occurrence was injury from vibrations due to long term truck driving.

5.4.7 Exposure (E)

From Table 5.2, it can deduce that, workers on mass Housing Projects are at a risk of getting exposed to dust, fumes, gas and vapours. Lung problems from the exposure to dust, fumes, gas and vapors was ranked the highest with a mean rating 3.85 and standard deviation 0.790.

The probability of a worker or someone inhaling dust is high when it is introduced into the atmosphere. Dust affects the health of workers when it is harmful. Huges and Ferrett (2011) indicated that the effects can range from minor impairment to irretrievable disease and even some conditions that threaten life. The rate of death is higher in dusty trades due to respiratory diseases, and stomach and lung cancers (Phoya, 2012). Noise Induced Hearing Loss (NIHL) was ranked as the second highest hazard to Mass Housing Project delivery workers in terms of exposure. Occupational deafness is very common among employees on a construction site due to widespread exposure to repetitive hazardous noise levels. Some activities at construction sites are notoriously noisy, for example, rock breakage during demolition work or a jackhammer operation (National Code of Practice, 2004).

Respondents ranked exposure to hazardous substances like asbestos high with a mean rating of 3.53 (with Std. Dev. = 0.952). Exposure to explosions from inefficient wiring and burns sustained from the exposure to fire outbreaks were ranked low by respondents as a challenge that rarely occurs on MHP sites.

5.4.8 Repetitive Stress Injuries (RSI)

Mass Housing Projects involves various multiple standardised unit-designs under each scheme and also repetitive interrelated skill tasks on standardised housing units. These features make the housing sector a repetitive job oriented sector. It is from this notion that certain safety performance challenges were identified from literature. The identified indicators are; RSI1, RSI2, RSI3, RSI4 and RSI5. Respondents indicated back injury resulting from the repetitive nature of work items as the highest occurring indicator in Mass Housing Projects. Smallwood (2008) revealed that 25% of injuries in the construction industry are related to the 'back' and almost 30% of workers in the construction industry complain of back pain that demands thirty (30) days off the construction site. Respondents scored RSI2 mean rating of 3.87 (with Std. Dev. = 0.809). Neck injury from improper manual handling scored the second highest with a mean of 3.83 and standard deviation 1.003. Afosah (2014) also indicated from her study that 73.3 % of respondents ranked manual handling of loads second highest of the type of health hazards on construction sites.

Workers on mass housing projects also suffer knee injuries from long periods of standing (mean = 3.74, Std. dev. = 0.844). Shoulder injuries from long periods of reaching were ranked fourth with mean of 3.66 and standard deviation 0.796.

5.5 STRUCTURAL EQUATION MODEL

Structural Equation Modelling (SEM) is a logical coupling of regression and factor analysis. SEM models are known for its containment of both measured and latent variables. Here in this study, the variables that match with the factors influencing Construction Site Safety performance taking into consideration the physical features of MHPs are the latent variables. Byrne (2006) indicated that, with SEM, measurement error can be effectively dealt with and explicitly considered in the theoretical models enhancing the validity of the models as compared to conventional method such as regression. The study employed the use of SEM which was developed with EQS version 6 to identify the significant key indicators of safety performance being affected by the physical features of MHPs. To achieve the research objective, SEM to be developed for Section C of the research instrument was built with the entire sample data. SEM also involves the estimation of models through employing relevant concepts and expressing them graphically to show the perceived relationship between the variables connected by arrows between the endogenous (dependent variables) and exogenous (independent) variables.

5.6 EVALUATIVE MODEL FOR THE IMPACT OF UNIQUE PHYSICAL FEATURES OF MHPs ON CONSTRUCTION SITE SAFETY PERFORMANCE

This section thoroughly explains the developed model of the influence of unique physical features of mass housing projects on construction site safety performance. In developing an acceptable and agreeable model through EQS, some assessments needed to be made. The findings from the analysis were discussed to inform professionals who manage safety on MHP site. SEM can be said to be a powerful technique that puts together complex path models with latent variables. The use of SEM as an analytical tool is common normally in the behavioural sciences. The focus when employing SEM as an analytical tool is mostly on theoretical constructs. SEM generates certain relationships amongst the theoretical constructs which are represented by path coefficients or regression between the factors or variables. The visualisation of graphical path diagrams stands to be one of the unique features of SEM. Unique physical features were made of three main constructs; MCS, MGL and HUD (see Appendix 1). The modelling was done of MCS and MGL leaving HUD because SEM accepts constructs with a minimum of 4 variables.

5.6.1 Assessment on the SEM Goodness-of-Fit Statistics

According to Hair *et al.* (2013), Kline (2010) and Byrne (2006), model fit assessment should have a criterion of both indexes in incremental and absolute form to integrate chi-square test. Fit indices under SEM do not only consider the fit of the model developed but also its simplicity. Models always fit data if all possible paths between all variables are specified. With the incremental class of fit indices, Comparative Fit Index (CFI) was used likewise the Residual Mean-Square Error of Approximation (RMSEA) used with the absolute class of model fit assessment. One of the benefits of the CFI is that it replicates fit at all sample sizes and measures the comparative reduction in non-centrality (Lei and Wu, 2008).

The goal of measuring the goodness-of-fit is to obtain an index that does not depend on the sample size and distribution of the data. If a model fits perfectly, the fit indices should have a value of 1. Mostly, a value of at least 0.90 is required to accept a model whiles the value which is required to judge the model fit as good is 0.95 or above (Hox, 1995). Models are only approximations of how well a given model approximates a true model. Root Mean Square Error of Approximation (RMSEA) index was then developed. With good approximations, the RMSEA would indicate smaller values (i.e. less than 0.1). In other words, the goodness-of-fit statistics, such as CFI (should be greater than 0.9), and RMSEA (should be less than 0.1). According to Lei and Wu

(2008), a model is aid to adapt well to data and deemed to have an appropriate solution when the individual parameters estimates can be derived and tested for statistical significance validity and reliability.

Table 5.3: Comparison of goodness-of-fit measures of proposed model for Multiple Construction Sites

Goodness-of-fit measure	**Levels of acceptable fit**	**Calculation of measure**	**Acceptability**
Incremental fit			
CFI	x≥0.90 (acceptable), x>0.95 (good fit)	0.91	***Accepted***
Absolute fit			
RMSEA	x≤ 0.08 (acceptable) x< 0.05 (good fit)	0.06	***Accepted***
p-value	x≤ 0.05	0.02	***Good fit***

(Statistical Significance at 5% level)

NOTES: RMSEA, *Root Mean Square Error of approximation*; **CFI**, *Comparative Fit Index*

From **Table 5.3,** the CFI yielded 0.91. According to Bentler (2005), CFI value of more than 0.90 is accepted as indications of good fit. Also, the RMSEA value from **Table 5.3** was 0.06. Lei and Wu (2008) suggested that, a RMSEA value less than or equal to 0.05 are considered good fit whereas values less than or equal to 0.08 are indicators of acceptable fit. The Table shows a *p-value* (significance level) less than 0.05 indicating that the factors considered for the study would significantly affect MCS feature of MHPs.

Table 5.4: Comparison of goodness-of-fit measures of proposed model for

Multiple Geographical Locations

Goodness-of-fit measure	Levels of acceptable fit	Calculation of measure	Acceptability
Incremental fit			
CFI	x≥0.90 (acceptable), x>0.95 (good fit)	0.90	***Accepted***
Absolute fit			
RMSEA	x≤ 0.08 (acceptable) x< 0.05 (good fit)	0.08	***Accepted***
p-value	x≤ 0.05	0.02	***Good fit***
(Statistical Significance at 5% level)			

NOTES: RMSEA, *Root Mean Square Error of approximation*; **CFI**, *Comparative Fit Index*

From **Table 5.4,** it is also seen that the CFI yielded 0.90 which is also accepted as indications of good fit (Bentler, 2005). The RMSEA value from **Table 5.4** was 0.08 which is equal to 0.08 hence shows indicators of acceptable fit. Also with a *p-value* (significance level) less than 0.05 shows that the factors considered for the study would significantly affect MGL feature of MHPs.

5.6.2 Factor loadings, variance accounted for and construct validity of model testing (MCS and MGL)

In explaining the importance and effects of the parameters in a model, it becomes necessary to rely on the co-efficient of determination (R^2) values (Bentler, 2005). The Coefficient of determination (R^2) can be defined as the degree of the model's predictive precision. Kline (2010) indicated that the measurement effect of the R^2 ranges from 0 to 1 with 1 expressing complete predictive accuracy. An R^2 value is described **'substantial'** at a value of 0.75 or more, **'moderate'** when it is 0.50 and **'weak'** when it is 0.25 or less as levels of predictive accuracy (Henseler, 2010). The assessment of consistencies could be gathered from the Cronbach Alpha and the factor loadings (Kline, 2010).

Table 5.5: Factor loadings, variance accounted for and construct validity of model testing (MCS)

Indicator Variable	Standardised coefficient	Z-Values	R Squared (R^2)	Path Coefficient (SE)	Cronbach's Alpha	Significant level at 0.05
SB1	0.688	9.022	0.68			0.000
SB2	0.734	11.833	0.72			0.000
SB3	0.648	7.482	0.65	0.02		0.000
SB4	0.946	20.129	0.89			0.000
SB5	0.582	5.206	0.55			0.000
CW1	0.502	4.904	0.52			0.005
CW2	0.746	6.488	0.63	0.80		0.000
CW3	0.864	17.336	0.85			0.000
C1	0.946	23.024	0.92			0.000
C2	0.604	7.224	0.64			0.000
C3	0.682	8.604	0.67	0.025		0.000
C4	0.510	5.008	0.53			0.004
C5	0.978	25.212	0.98		0.75	0.000
FS1	0.628	9.022	0.68			0.000
FS2	0.734	15.894	0.82	0.83		0.000
FS3	0.668	9.870	0.69			0.000
FS4	0.601	8.602	0.67			0.000
FB1	0.868	18.494	0.87			0.000
FB2	0.762	11.833	0.72			0.000
FB3	0.622	7.224	0.64	0.026		0.000
FB4	0.804	15.892	0.82			0.000
FB5	0.542	5.644	0.56			0.000
OE1	0.761	14.022	0.75			0.000
OE2	0.506	5.644	0.59	0.25		0.000
OE3	0.562	6.202	0.62			0.000

OE4	0.702	13.208	0.74		0.000
OE5	0.860	19.624	0.88		0.000
OE6	0.786	14.438	0.76		0.000
E1	0.782	15.898	0.82		0.000
E2	0.604	7.224	0.64		0.000
E3	0.448	5.206	0.55	0.97	0.000
E4	0.644	9.022	0.68		0.000
E5	0.948	23.024	0.92		0.000
RSI1	0.561	5.929	0.60		0.000
RSI2	0.601	7.224	0.64		0.000
RSI3	0.962	23.862	0.93	0.56	0.000
RSI4	0.498	4.228	0.49		0.011
RSI5	0.632	8.604	0.67		0.000
MCS1	0.443	3.620	0.45		0.020
MCS2	0.508	8.026	0.66		0.000
MCS3	0.845	22.648	0.90		0.000
MCS4	0.628	10.632	0.70		0.000
MCS5	0.294	2.561	0.13		0.104*
MCS6	0.158	1.842	0.11		0.186*
MCS7	0.628	10.632	0.70		

Source: Researchers Survey (2016)

Table 5.6: Factor loadings, variance accounted for and construct validity of model testing (MGL)

Indicator Variable	Standardised coefficient	Z-Values	R Squared (R^2)	Path Coefficient	Cronbach's Alpha	Significant level at 0.05
SB1	0.904	22.072	0.92			0.000
SB2		17.826	0.79			0.000
SB3	0.769	19.942	0.83	0.83		0.000
SB4	0.962	24.555	0.96			0.000
SB5	0.882	21.628	0.88			0.000
CW1	0.452	3.989	0.49			0.000
CW2	0.981	25.214	0.97	0.09		0.000
CW3	0.468	4.688	0.53			0.000
C1	0.680	9.881	0.68			0.000
C2	0.460	3.989	0.49			0.000
C3	0.768	19.642	0.82	0.56		0.000
C4	0.582	5.692	0.58			0.000
C5	0.382	3.001	0.40		0.70	0.018
FS1	0.501	5.208	0.56			0.000
FS2	0.391	3.401	0.44	0.45		0.004
FS3	0.766	14.686	0.72			0.000
FS4	0.388	3.202	0.42			0.000
FB1	0.468	4.208	0.52			0.000
FB2	0.646	9.426	0.67			0.000
FB3	0.778	19.942	0.83	0.70		0.000
FB4	0.986	25.578	0.98			0.000
FB5	0.544	8.244	0.62			0.000
OE1	0.926	22.794	0.94			0.000
OE2	0.882	21.626	0.88	0.61		0.000
0.708						
OE3	0.648	9.426	0.67			0.000
OE4	0.767	14.794	0.73			0.000

OE5	0.458	3.928	0.48			0.020
OE6	0.396	3.202	0.42			0.016
E1	0.399	3.446	0.46			0.000
E2	0.602	9.082	0.66			0.000
E3	0.397	3.219	0.45	0.02		0.000
E4	0.288	2.426	0.28			0.094*
E5	0.502	5.208	0.56			0.000
RSI1	0.881	21.624	0.88			0.000
RSI2	0.762	19.642	0.82			0.000
RSI3	0.787	15.686	0.76	0.80		0.000
RSI4	0.601	9.082	0.66			0.000
RSI5	0.840	20.886	0.86			0.000
MGL1	0.692	10.859	0.69			0.000
MGL2	0.842	20.886	0.86			0.000
MGL3	0.501	5.208	0.56			0.000
MGL4	0.982	25.212	0.97			0.000

Source: Researchers Survey (2016)

From Tables 5.5 and 5.6, the Cronbach's alpha has been reported. This yielded a value of 0.75 in Table 5.5 and 0.70 in Table 5.6. According to Hair *et al.* (2014), the recommended acceptable point for a Cronbach's alpha is 0.700. The values obtained meet the recommended acceptable point. Having the Cronbach's alpha values equal to and above 0.700, it could be said that the model has a good level of internal consistency and reliability (Kline, 2010), suggesting that the indicator variables correctly and adequately define the MCS features construct. The Cronbach's alpha was also indicated to determine the score reliability. The z-value aids in establishing the feasibility of the factor structure and if the structure will work properly. Byrne (2006) acknowledged that, z-values above 1.96 indicates reasonability and statistical significance. The above Tables (5.5 and 5.6) showed that all the z-values were greater than the conventional minimum acceptable limit of 1.96 with the exception of MCS6 which scored a z-value of 1.842 and a *p-value* of 0.186 indicating that factor as insignificant.

5.7 RESULTS AND DISCUSSION OF THE STRUCTURAL MODELS

Wong (2011) stated that the primary importance of a Structural Equation Model relies on how best the model developed is feasible. The graphical presentations of the models developed are shown in Figures 5.4 and 5.5. The model is shown alongside the contribution or influence or impact of the various factors on their respective endogenous (dependent) factors.

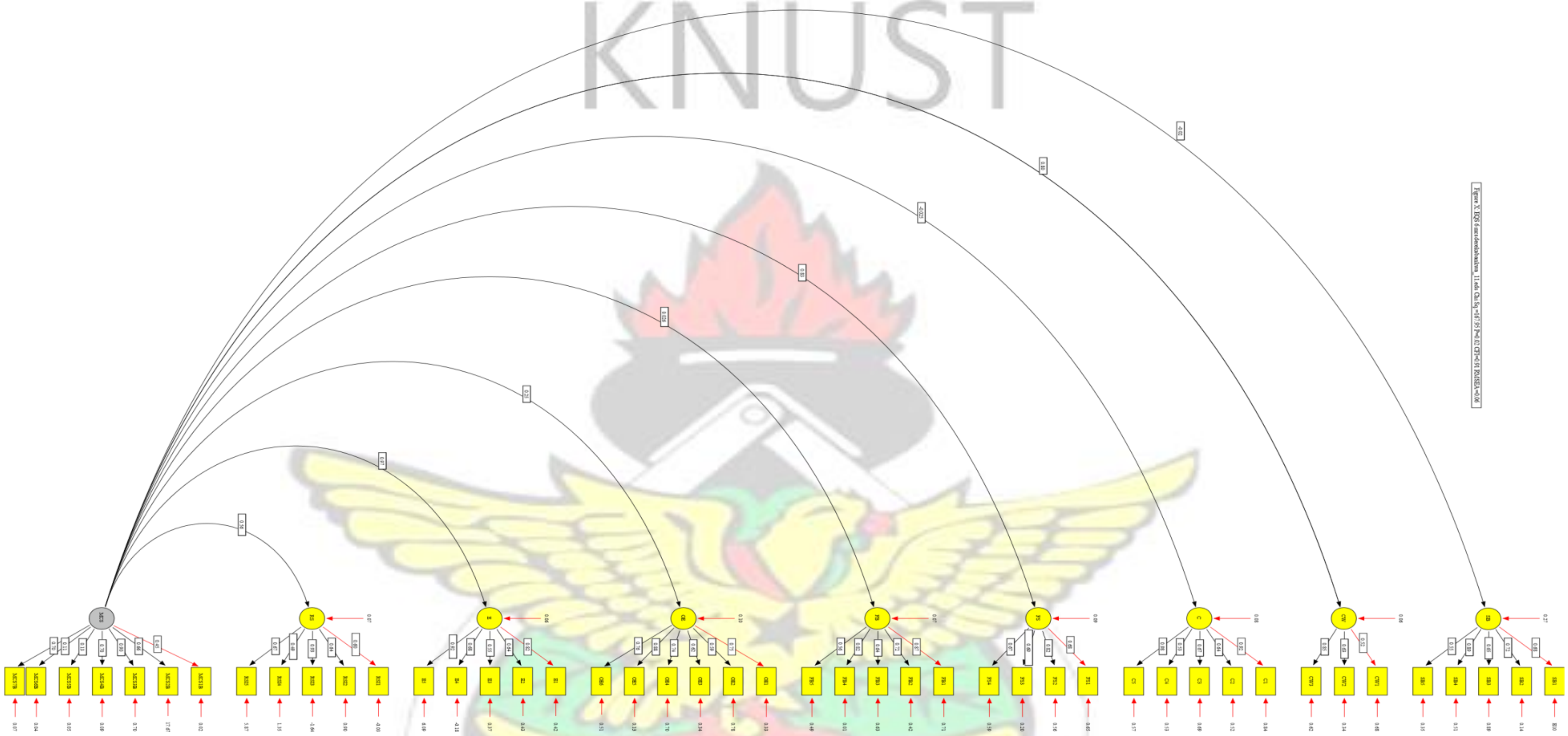

Figure 5.4: The Model resulting from the influence of MCS on Site Safety Performance

NOTES: MCS, *Multiple Construction Sites;* **MCS1B-MCS7B**, *measurement items for MCS*; **RSI**, *Repetitive Stress Injury*; **RSI1-RSI5**, *measurement items for RSI*; **E**, *Exposure*; **E1-E5**, *measurement items for E*; **OE**, *Overexertion*; **OE1-OE6**, *measurement items for OE*; **FB**, *Fall to Below*; **FB1-FB5**, *measurement items for FB*; **FS**, *Fall-Same Level*; **FS1-FS4**, *measurement items for FS*; **C**, *Caught In/On/Between*; **C1-C5**, *measurement items for C*; **CW**, *Contact With*; **CW1-CW3**, *measurement items for CW*; **SB**, *Struck By/Against*; **SB1-SB5**, *measurement items for SB*

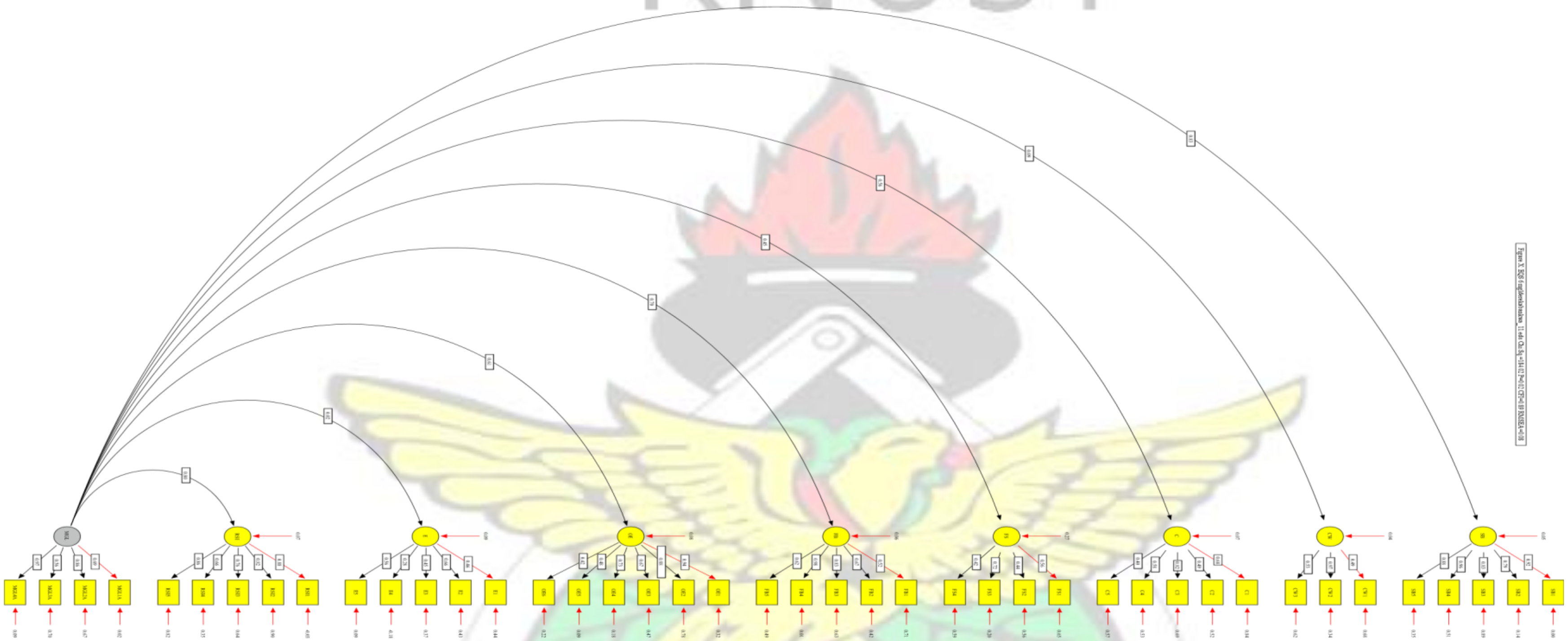

Figure 5.5: The Model resulting from the influence of MGL on Site Safety Performance

NOTES: MGL, *Multiple Geographical Location*; **MGL1A-MGL4A**, *measurement items for MGL*; **RSI**, *Repetitive Stress Injury*; **RSI1-RSI5**, *measurement items for RSI*; **E**, *Exposure*; **E1-E5**, *measurement items for E*; **OE**, *Overexertion*; **OE1-OE6**, *measurement items for OE*; **FB**, *Fall to Below*; **FB1-FB5**, *measurement items for FB*; **FS**, *Fall-Same Level*; **FS1-FS4**, *measurement items for FS*; **C**, *Caught In/On/Between*; **C1-C5**, *measurement items for C*; **CW**, *Contact With*; **CW1-CW3**, *measurement items for CW*; **SB**, *Struck By/Against*; **SB1-SB5**, *measurement items for SB*

5.7.1 Multiple Geographical Locations

From **Table 5.6** and **Figure 5.5**, the path coefficient (SE) is 0.80 for MGL endogenous latent variable for RSI related to site safety challenges. This means that the 4 latent variables (factors); MGL1 (0.69), MGL2 (0.86), MGL3 (0.56) and MGL4 (0.97) contribute to 80% of the variance in Site Safety Performance challenges related to Repetitive Stress Injury. MGL4-*Geographical constraints and challenges due to location influence* and MGL2-*Cultural influence within labour work force due to geographical locations* scored highest R^2 values indicating their great influence on safety challenges due to MGL.

The factor loadings of each of the variables of the unique event of RSIs identified under safety performance challenges is also contained in **Table 5.6** and **Figure 5.5.** The coefficient of determination (R^2) are the composite effect of the path coefficient on the dependent variable which is take to mean as the model's predictive accuracy and thus represents the combined effects of the independent variables on the dependent variables(s) (Hair *et al.*, 2014).

The effect of these variables (loadings) ranges from 0.00 to 1.00. Hair *et al.* (2014) indicated three separate R^2 values and made mention that, an R^2 value of 0.75 describes substantial, an R^2 value of 0.50 describes moderate and an R^2 value of 0.25 describes weak level of predictive accuracy. An R^2 value less than 0.100 is counted as an effect with insignificant impact on the endogenous variable (Frank *et al.*, 2008). This means that, in evaluating the contribution of MGL of mass housing projects to site safety performance, factors MGL1 contributes 69% (0.69), MGL2 contributes 86% (0.86), MGL3 contributes 56% (0.56) and MGL4 contributes 97% (0.97) to each of the total variances of the various events that come under the safety performance indicators. Taking into consideration the path coefficient values on the model representing MGL, the inner model suggests that, SB as a safety challenge is strongly influenced (or impacted) by the MGL of MHPs. From the figure, it is followed by RSI, FB, OE, C and FS. The contributions of the Multiple Geographical Location to CW (Contact With) and E (Exposure) could be seen as the least and hence were not considered in the study. CW and E were indicated as insignificant or weak. The study also considered safety events with variables having a coefficient of determination being 75% and above. The Multiple Geographical nature of MHPs caused indicators under FS to have R^2 values below 0.75. FS is therefore not considered in the next sections of the study.

The first safety event to have the highest impact as a result of the MGL is Struck By/Struck against accidents. The coefficient of determination (R^2) showed the impact Multiple Geographical Locations has on the various factors under the various events. Subsequently, the results of the R^2 with the safety performance challenges revealed; SB4-*Step on sharp objects such as nails*, SB1-*Falling of material or debris from heights to injure workers*, SB5-*Workers striking foot against sandcrete blocks*, SB3*Materials drop from a crane onto an employee*, SB2-*Struck by a moving heavy equipment* all emerging as dominant site safety performance challenges (R^2>0.75) that occurs among Mass Housing Projects because of Multiple Geographical Location of sites.

Repetitive Stress Injuries obtained a path coefficient of 0.80 (80%) making it the second highest safety challenge occurring in Mass Housing Projects due to MGL. The variable under RSI which greatly occurs due to the impact of MGL is RSI1-Neck Injury resulting from improper manual handling scoring a R^2 value of 0.88. This is followed by RSI5 (R^2=0.86), RSI2 (with R^2=0.82) and RSI3 (with R^2=0.76).

Respondents also identified RSI to be the second highest occurring safety challenge in MHPs (see Section 5.4.8).

From Table 5.6 and Figure 5.5, it is also seen that only two variables had great impacts under fall to Bellow type of accidents. These are FB4-*Workers slip and fall whiles climbing* and FB3-*Slip of ladder causing worker to fall.* These variables scored coefficient of determination (R^2) 0.98 and 0.83 respectively.

The coefficient of determination (R^2) showed the impact Multiple Geographical Locations has on the various factors under the various events. Subsequently, the results of the R^2 with the safety performance challenges revealed; OE1-*Low back pain from pulling* and OE2-*Strain resulting from heavy lifting* as variables with great impact or substantially occurring due to Mass Housing Projects being constructed in multiple geographical location. These two emerged as dominant site safety performance challenges (R^2>0.75) that occurs among Mass Housing Projects because of MGL.

Caught In/Between/On accidents obtained a path coefficient of 0.56 (56%) making it the fifth safety challenge occurring most in Mass Housing Projects due to its unique physical features. Based on the specified R^2 value, the indicators under C which greatly occurs due to the impact of MGL is C3-Collision of heavy equipment causing operator injury. C3 scored R^2 value of 0.82.

5.7.1.1 Discussion of Safety Indicators due to MGL

Culture frames the ways in which we express ourselves (Langford, 2000) and how understanding is made from the actions of others. People from different nationalities and ethnic groups express themselves and understand the behaviours of other people in many different ways. This is informed by specific sets of cultural knowledge and agreements. This is a result of the study identifying MGL2 as a factor contributing highly to the occurrence of the safety challenges in Mass Housing Projects. Thus cross-cultural misunderstandings occur which can lead to health and safety problems.

Schmertmann *et al.* (2004) indicated that Struck By accidents were the tenth leading accident events in the Housing Industry in South Wales but that can be said to be different for the Ghanaian Housing Sector since it stands to be the first group of accidents taking into consideration the Multiple Geographical Location feature of MHPs. Comparing findings in **Section 5.4.1** and **5.7.1.1**, it is seen that respondents indicated SB1 (*Falling of material or debris from heights to injure workers*) to be the most occurring accident under SB but considering the physical MGL features, SB4 (*Step on sharp objects such as nails*) is seen to be the most occurring accident. In relation to stepping on sharp objects, Laryea and Mensah (2010) indicated that employees or workers should be informed by Management or supervisors of their responsibility to wear the PPE appropriately, properly look after equipment and report any defects. Dodzi (2014) identified 'Fall from heights' as the leading cause of injury in the construction industry but can be said to be the second leading cause of accidents in Mass Housing Projects resulting from the findings in this study. The US Department of Human Services conducted a study on various accidents in the Housing industry. It was noted from the study that, nearly 800,000 cases of injury as a result of strains, sprains and tear occurs daily. Back injuries formed about half of the cases of which 60% resulted from overexertion. Multiple Geographical Location for housing units under MHPs also poses a great risk of overexertion injuries.

Insufficient recovery time succeeding a completed task, repetition of high tasks, high force requirement of a task and awkward postures have been described as combining factors for developing RSI (Tyler and Shrawan, 2001). Ahadzie *et al.* (2014) indicated that, Mass Housing Projects expand and spread across wide geographical areas as compared to the traditional one off projects and this indeed would present activities that require repetition and high force which would eventually affect workers by posing certain Stress Injuries. IOM (2001) also stated that, nearly 1 million workers have excused themselves from work to treat and recover from RSI resulting from repetitive motion either in the upper extremities or low back as such this makes RSI a key safety performance indicator to look at in the Mass Housing Industry of Ghana looking at the multiple geographical nature of such projects.

5.7.2 Multiple Construction Sites

The results in **Table 5.5** and **Figure 5.4** on the other hand revealed the total effect of the features of MHPs specifically Multiple Construction Sites on construction site safety challenges. In evaluating the contribution of MCS of mass housing projects to Site Safety performance, the factor loadings and effects indicate that the factors MCS1 contributes 45% (0.45), MCS2 contributes 66% (0.66), MCS3 contributes 90% (0.90), MCS4 contributes 70% (0.70), MCS5 contributes 13% (0.13), MCS6 contributes 11% (0.11) and MCS7 contributes 70% (0.70) to each of the total variances of the various events that come under the Safety Performance Indicators. Taking the variables under Multiple Construction Sites, MCS3-*Construction technology and method adopted for repetitive works in housing units* plays a major role in the occurrence of safety challenges on MHP sites. This is followed by MCS7*Quality Management style and approach adopted on housing units* and MCS4*Variation Order procedures adopted on repetitive works* both obtaining a value of 70%. MCS6-*Computer application softwares adopted by project teams on housing units under scheme* emerged as a factor with less influence on the occurrence of the various Site Safety events.

Taking into consideration the path coefficient (SE) values on the model representing MCS, the inner model suggests that, E-Exposure (0.97) as a safety challenge is strongly influenced (or occurs most) due to the MCS of MHPs. From Figure 5.4, E is followed by FS-*Fall Same Level* (0.83), CW-*Contact With* (0.80), RSI-*Repetitive Stress Injury*

(0.56) and OE-*Overexertion*. The contributions of the Multiple Construction Sites to FB (Fall to Below), C (Caught In) and SB (Struck By) could be seen as least and hence were not considered in the study. FB, C and SB were indicated as weak and insignificant. The study also considered safety events with variables having a coefficient of determination being 75% and above.

Considering MCS, Exposure stand out to be the most frequent site safety performance challenge in mass housing projects. The coefficient of determination (R^2) shows the impact of Multiple Construction Sites on the various factors under the various events. Subsequently, the results of the R^2 with the safety performance challenges revealed; E5-*Step on sharp objects such as nails* and E1-*Falling of material or debris from heights to* as the two substantial variables under the event Exposure. E2, E3 and E4 had R^2 values below 0.75 hence were not considered in the study. E5 and E1 emerged as dominant site safety performance challenges (R^2>0.75) that occurs among Mass Housing Projects because of the issue of MCS.

The coefficient of determination (R^2) shows the impact Multiple Construction Sites has on the various factors under the various events. Subsequently, the results of the R^2 with the safety performance challenges revealed; FS2-*Fall resulting from inappropriate footwear* as a variable with great impact or substantially occurring due to Mass Housing Projects being constructed in multiple construction sites.

'Contact with' accidents obtained a path coefficient of 0.80 (80%) making it the 3rd safety challenge occurring most in Mass Housing Projects due to its unique Multiple Construction Sites. Based on the specified R^2 value, the indicators under CW which greatly occurs due to the impact of MCS is CW3-*Workers coming into contact with hot surfaces*. CW3 scored a R^2 value of 0.85.

From Table 5.5 and Figure 5.4, it is seen that the only one variable had great impact under Repetitive Stress Injury type of accidents. This was RSI3-*Injury on the upper limb areas of site workers.* RSI3 scored a coefficient of determination (R^2) of 0.93 (93%).

Considering the MCS, Overexertion least occurs on Mass Housing Project sites due to the physical features of MHPs. The coefficient of determination (R^2) informed on the impact of Multiple Construction Sites on the various factors under the various events. Subsequently, the results of the R^2 with the safety performance challenges revealed;

OE5 (0.88) *Injury from a long term poor posture (either sitting or standing)*, OE6 (0.76), *Long term truck driving causing injury from vibrations* and OE1 (0.75) *Low back pain from pulling* as the three substantial variables under the event Overexertion. OE2, OE3 and OE4 had R^2 values below 0.75 hence were not considered in the study. OE5, OE6 and OE1 emerged as dominant site safety performance challenges (R^2>0.75) that occurs among Mass Housing Projects because of MCS.

5.7.2.1 Discussion of Safety Indicators due to MCS

From the findings of the study, it is noted that, the variables MCS7- *Quality Management style and approach adopted on housing units and overall scheme(s)* and MCS3-*Construction technology and method adopted for repetitive works in housing units* were identified as the main contributors to the overall influence MCS has on the safety performance indicators. The variable MCS6-*Computer application software(s) adopted by project teams on housing units under scheme* was identified by the study to make weak contribution to the occurrence of the safety performance indicators in Mass Housing Projects.

Sotire (1992) stated that, on any construction building site, one common feature especially during a dry season is dust. When workers are continuously exposed to dust on the site, they could have eye problems, respiratory disorders and coughs. Dodzi (2014) identified ‘Fall from heights’ as the leading cause of injury in the construction industry but can be seen here that Exposure is the leading cause of accidents in Mass Housing Projects in Ghana due to its nature of Multiple Construction Sites. This result was settled by Seixas *et al* (1998). His findings specified that the occurrence of accident on sites changes from one site to another depending on the difficulty of the construction project.

In every construction work, falls, trips and strips are frequent injury causing events (Shreevastav, 2008). According to Shreevastav (2008), floors that were uneven, inadequate lighting, poor housekeeping and unsafe working practices were the key factors that lead to such accidents. This study identifies Fall Same Level as the second most occurring accident (after Exposure) in the Mass Housing Industry due to its Multiple Construction Site nature. Falls can end a worker’s career, from suck injuries as broken bones, traumatic brain injury, spine injuries and others. Carol, William and Charles (2001) mentioned that same level falls are generally slips or trips and as such a high coefficient of friction between the shoe and walking surface is needed. Carol, William and Charles (2001) again stated that, adequate lighting at the workplace with good housekeeping practices contributes to the performance of safety and fall prevention. Two percent of all mortalities at work are initiated by electric shocks in the UK, for example, (Huges and Ferrett, 2011). Most grievances and deaths resulting from electricity are due to; the poor use of well-looked-after electrical equipment, undertaking work close to overhead high tension lines, coming into contact power cables in excavations and the use of improper safety gear during work. The findings from the study also show that, the Mass Housing Industry of Ghana experiences a lot of Contact With accidents with respect to the Multiple Construction Sites feature of MHPs.

The outcome from the SEM analysis generated support for the second objective set for the study (see Section 1.3), and further suggested that, the experience of Site Safety challenges in mass housing project due to Multiple Geographical Location is greater as compared to that of Multiple Construction Sites. The general results conclusively suggest that unique physical features of mass housing projects (exogenous variables) significantly impact the endogenous variables (site safety performance indicators). Byrne (2006) indicated that, SEM analysis can evaluate any direct or indirect effect and total effect. The objective set for the study was to evaluate the direct influence of the latent variables on site safety performance due to physical features of MHP. The presented valuation gives an observed account of the extent of direct impact of the physical features of MHPs on the site safety performance challenges. The indirect impact of physical features of MHPs on Construction Site safety was not assessed because it was outside the scope of the study. From her, the decision to maintain these variables to design an indirect effect would be most inappropriate if it is not based on an empirical evaluation (Bentler, 2005). Paying attention to the extent of effects or influence of the various variables (see Tables 5.5 & 5.6), the conclusion made was that, the variables making insignificant and weak inputs were subsequently dropped to refine the evaluative models. This refined model was developed into a proposed framework on challenges of site safety performance on mass housing projects. This is presented in the next section.

5.8 PROPOSED FRAMEWORK FOR MANAGING SITE SAFETY PERFORMANCE ON MHPs

Sinclair (2007) indicated that, what a framework seeks to achieve is capturing and explaining concepts, factors and variables in a study and presenting it in a graphical form. The purpose of the framework was to establish the relationship between the main concepts identified in the study. Mass Housing Projects provides certain unique characteristics which are established in its operational, organisational and physical features (Adinyira *et al.,* 2013). The focus of this study was on the impact of the physical features on construction site safety as such the various concepts under the physical features were identified. The previous section identified the influence of these features on CSP indicators. Addressing the substantial indicators of safety performance identified through the Structural Model would help improve the performance of construction safety in Mass Housing Projects when considering the physical features. The relationship between the major concepts and the substantial findings identified from the model are presented in **Figure 5.6**.

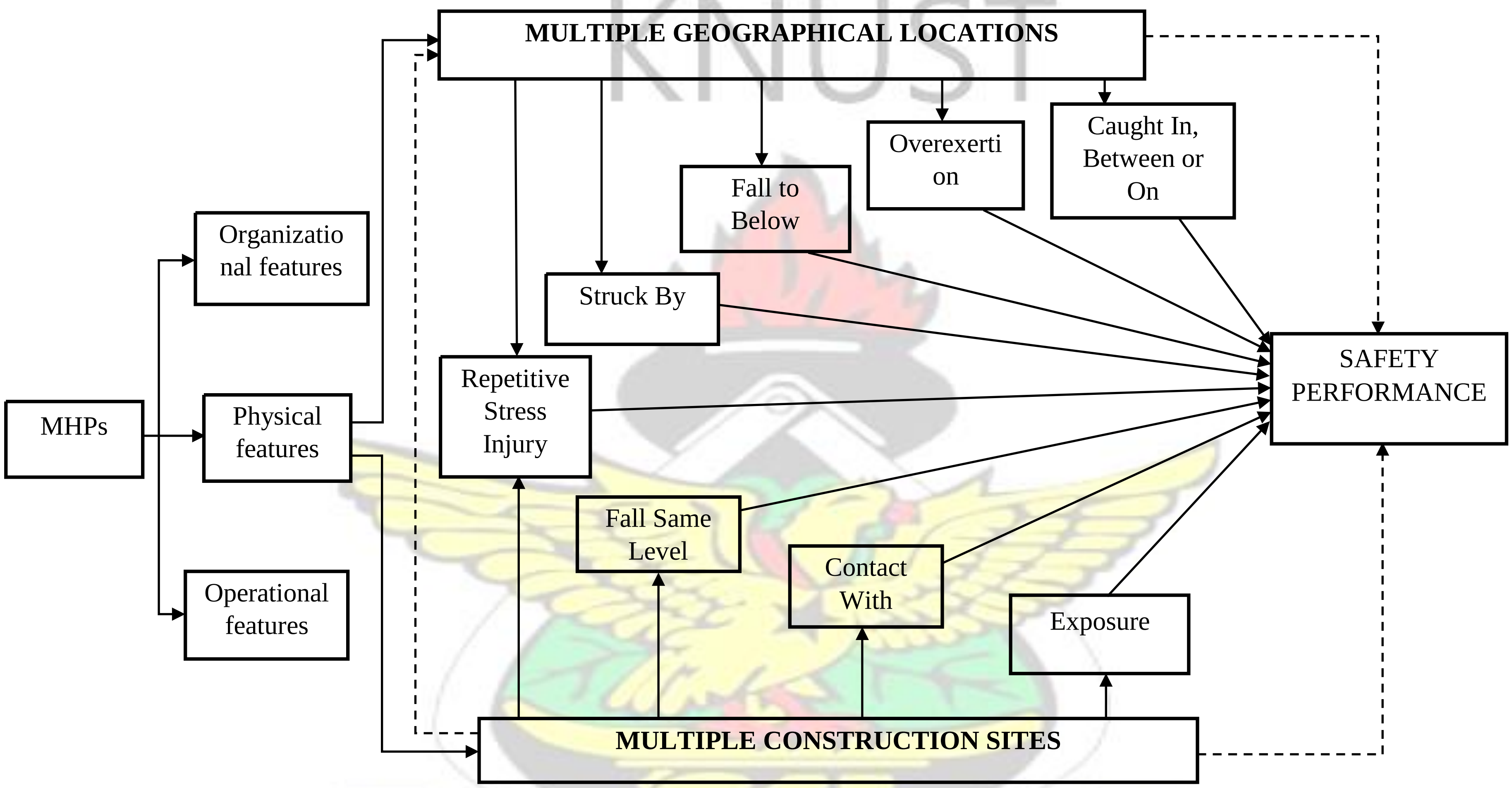
MULTIPLE GEOGRAPHICAL LOCATIONS
Organizational features
Physical features
Operational features
MHPs
Fall to Below
Overexertion
Caught In, Between or On
Struck By
Repetitive Stress Injury
Fall Same Level
Contact With
Exposure
SAFETY PERFORMANCE
MULTIPLE CONSTRUCTION SITES

Figure 5.6: Framework capturing the substantial influence of the physical features of Mass Housing Projects on construction site safety

Kwofie *et al.* (2014) defines Mass Housing Projects as the ***design*** and ***development*** of standardised several domestic house-units mostly in one or different geographical locations, undertaken within the same scheme of project by one management body and contract. This definition considers the three key aspects of mass housing projects which are the physical, organisational/managerial and operational. Knowing the nature or attributes of various project typologies is essential to managing its delivery. It is therefore unmistakeable or unquestionable that a clear understanding of the nature and features of projects is required towards an effective management style to ensure successful delivery of projects (Kipp, 2008).

Mass housing projects (MHPs) share attributes that are significantly different from "one-off" construction building projects (see Adinyira *et al.*, 2012; Ahadzie, 2007). Syed *et al.* (2010) indicated in his study that the uniqueness of multiple sites for various units of MHPs embodies the approach to site management, methods of construction and adopted technologies, management concept of health and safety and the location of site for the housing units. The most interesting area in handling MHP by far, as indicated by Hashim and Chileshe (2012) is the multiple project environment (MPE) which falls under the physical features of MHPs. Managing Multiple Project Environments (MPEs) poses a lot of challenges to the delivery of MHPs hence the focus of the study.

The Physical features of MHPs are Multiple Construction Sites and Multiple Geographical Locations (see Kwofie, 2015). There is link between these two features as shown in **Figure 5.6** because with the development of Mass Housing Projects there could be multiple construction sites in a particular geographical location. The various key safety events management should look out for in managing safety performance on

Multiple Geographical Locations are: Repetitive Stress Injury, Struck By, Fall to Below, Over Exertion, Caught In or between. With respect to Multiple Construction

Sites, management should pay attention to these safety events: Fall Same Level, Contact with, Exposure, Repetitive Stress Injury. The proper management of these safety events would increase the performance of safety. The two constructs that come under the physical features (MCS and MGL) are indirectly linked to safety performance as Adinyira *et al.* (2013) indicated that the various unique attributes of construction projects significantly impact communication, health and safety, effectiveness of management and performance of projects.

5.9 SUMMARY

In Chapter Five, the researcher assessed the impact/influence of the physical features of MHPs on Construction Site Safety. Respondent's demographics showed competence, experience and capability of exercising good judgement towards responding to the survey instrument. Under the various events of safety indicators, it was indicated that; falling of material from heights to injure workers, contact with underground power cables, collapse of excavations or trenches, slips due to oily/dusty floors, falling of persons from scaffolds, repetitive bending at the waist causing injury, lung problems from dust, back injury resulting from the repetitive nature of a work item occurs most in MHPs.

With respect to Multiple Construction Site physical features causing safety issues, quality management style and construction technology and method affects safety most. Cultural influence also showed high impact on safety due to multiple Geographical Location nature of MHPs. Both the CFI and RMSEA values identified in this study showed indication of good fit. This meant that, the model developed from the data is reliable and trustworthy.

CHAPTER SIX CONCLUSION AND RECOMMENDATIONS 6.1 INTRODUCTION

In Chapter Six, the findings confirmed from the analysis of the data in Chapter Five have been related to the various objectives which were set for this research study. The research study has evaluated the influence of unique physical features of Mass housing Projects on Construction Site Safety performance. Out of this, the significant contributing features to safety performance as well as dominant safety challenges in Mass Housing Projects were identified. Summary of the entire study, conclusions and recommendations are presented in this final chapter.

6.2 CONCLUSION ON THE VARIOUS OBJECTIVES (FINDINGS)

The aim of the study was to evaluate the influence of the unique physical features of mass housing projects (MHPs) on construction site safety in the Ghanaian Construction Industry. Three key objectives were then devised from the aim of the study. The next section gives an account of the findings from the various objectives.

6.2.1 *Objective One: Identify the main challenges with Construction Site Safety performance on Mass Housing Projects*

Contextual definitions of MHPs and H&S were explored. Relevant literature on construction site safety, and mass housing projects were thoroughly and comprehensively considered to identify; characteristics of mass housing projects to traditional 'one-off' construction projects, economic significance of mass housing projects, risk management in construction, construction accidents, hazards and risk evaluation. The benefits and challenges associated with the implementation of H&S practices on MHPs were also ascertained. Unique physical features of mass housing projects were identified through examining related and relevant literature. The physical features of "one-off" projects and mass housing projects were distinguished. In addition, structured questionnaires were designed and administered to the various respondents on MHPs in the public sector (GREDA). The impacts identified were ranked based on the level of it severity. It was found that falling of material from heights to injure workers, contact with underground power cables, collapse of excavations or trenches, slips due to oily/dusty floors, falling of persons from scaffolds, repetitive bending at the waist causing injury, lung problems from dust, back injury resulting from the repetitive nature of a work item occurs most in MHPs.

6.2.2 *Objective Two: Evaluate the impact of the Physical Features of Mass Housing Projects (MHPs) on Construction Site Safety performance*

A quantitative questionnaire was developed on how MHP unique features influence H&S based on the reviewed literature. Data gathered were first entered into the Statistical Packages for Social Sciences (SPSS) which were then transferred into the EQS version 6 for the development of the structural models. Structural Equation Modelling (SEM) was employed as the analytical approach to exploring the relationship between the variables from the data collected. In line with deductive research, the findings from the SEM underpinned the development of a model of the causal influence of the unique physical features of MHPs on Construction Site Safety.

With respect to Multiple Construction Site physical features causing safety challenges, '*Quality Management Style'* and '*Construction Technology and Method'* affects safety most. Safety Events occurring most due to the unique Multiple Construction Sites are; Exposure, Contact With, Fall Same Level and Repetitive Stress Injury.

Cultural influence also showed high impact on safety due to Multiple Geographical Location nature of MHPs. Safety Events that were identified to be mostly affected due to Multiple Geographical Locations are; Repetitive Stress Injury, Struck By, Fall to Below, Overexertion and Caught In accidents. From this it can be seen that, attention must be given to accidents that fall under the event Repetitive Stress Injuries when considering the physical features of Mass Housing Projects.

6.2.3 *Objective Three: Propose a framework for the management of Construction Site Safety performance on MHPs.*

A framework was developed based on the findings from the Structural Equation Modelling that was undertaken. In developing the framework, the relationship between the major concepts and the substantial findings identified were considered. The objective of the proposed framework developed is to serve as a guide to the understanding of the relationship between the physical features of MHPs and construction site safety performance. The framework shows the construct that should help further explore the issue to allow for better management.

6.3 LIMITATIONS TO THE STUDY

Limitations to the research study identified were;

- The collection of the data was done in one major region of Ghana. It will be necessary to replicate this study in the other nine regions of Ghana which could give ability to better generalization of the findings of the study.
- Future research studies should consider a larger sample size to also ensure appropriate generalisation of the findings of the study. A sample size of 202 in Greater Accra as compared to the entire target population of H&S officers and Construction Site Engineers is quite small.
- During the administering of the survey instrument, some challenges were encounted. Some challenges found were in persuading the respondents to actually participate in the research survey. This led to the difficulty in retrieving all 255 questionnaires administered which led to the collection of 202 responses.

- This research study employed solely the quantitative research method hence making the study restrictive. More qualitative methods should be employed on the areas of study in order to provide a wider perspective to the present study.

6.4 CONTRIBUTION TO KNOWLEDGE

Safety studies in the construction industry tend to focus on building 'one-off' projects. There has been enough past and present literature and studies on managing Construction H&S and the impact of Health and Safety on Construction project features. However, no research study has paid particular attention to safety performance in MHPs considering the unique features of these forms of project deliveries. In the context of the Ghanaian Construction Industry, there has been no or little study in the subject areas. This study goes ahead to develop an equation model in an attempt to bridge that gap. The model developed proves the relevance of considering the unique physical features of MHPs when managing safety in delivering MHPs by showing actual statistics on the impact the physical features of MHPs has on the various site safety events. This research study thus adds significant contribution to the already existing body of knowledge in the field of safety performance in the construction industry in the area of MHPs. The proposed framework is a significant contribution of the study because when further developed through some validation process can serve as the basis to conduct studies aimed at improving construction site safety performance on MHPs.

6.5 RECOMMENDATIONS

The following are recommendations drawn from the findings of the study to promote safer working practices and to achieve improved safety of construction workers.

- Every firm delivering Mass Housing Projects must ensure there is the availability of a training program for the workforce. Training programs should be developed based on the suggested framework.
- Mass housing delivery firms need to keep record of accidents on site. Records on injuries, accidents and dangerous occurrences need to be kept to serve as a guide in managing efficient site safety. This will also enable management know where and how risks arise and to scrutinise construction activities to discover work conditions that might lead to serious accidents. The framework proposed should guide the type of records to keep.

6.6 FUTURE RESEARCH

This research study concludes in this section by suggesting areas where some future works will be required.

- Similar studies should be conducted with firms not registered with Ghana Real Estate Developers Association (GREDA) as they might be the ones more prone to paying less attention to health and safety rules.
- Future works need to consider accessing the impact of the unique operational features of Mass housing Projects on Construction Site Safety performance.
- Other works should also take into consideration the influence of the unique organisational features of mass housing projects on construction site safety performance.
- Future research works should also consider looking at the health implications MHPs pose taking into consideration its unique physical, organisational and operational features.
- Undertaking research in this area of study, one can also consider looking at the Environmental Protection aspect of Safety in Mass Housing Project delivery.

This will explore the effect of MHPs on not only the workers but other parties in the project environment.

- Future studies need to consider validating the proposed framework to serve as a practice guide for MHP developers in relation to Construction Site Safety performance.

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APPENDIX 1 KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY,
KUMASI

COLLEGE OF ART AND BUILT ENVIRONMENT

DEPARTMENT OF BUILDING TECHNOLOGY

QUESTIONNAIRE ON CONSTRUCTION SITE SAFETY

As part of a Master of Philosophy research investigating into ***the impact of the unique physical features of mass housing projects on construction site safety***, this questionnaire survey was prepared. This is an on – going research under the supervision of Dr. Emmanuel Adinyira of the Department of Building Technology in Kwame Nkrumah University of Science and Technology, Kumasi.

The study seeks to draw on your experience from your involvement as a professional working with organisations delivering Mass Housing Projects on the influence or impact Physical Features of MHPs have on Construction Site Safety. This study is of value to Mass Housing Project developers and the construction industry as a whole. This study will enable developers know the safety issues regarding the development of Mass Housing Projects and also provide them with a guide on how to manage Safety performance on Mass Housing Project sites.

The questionnaire is in three sections. **Section A** requests information on the background and experience of the respondents in Mass Housing delivery. **Section B** then focuses on mass housing projects and the challenges of safety performance. **Section C** which is the last section focuses on the potential of the unique features of mass housing projects to influence Construction Site Safety. The questionnaire takes approximately **20 minutes** to answer. If you have any questions, please contact Derek Asante Abankwa using the information below. Thank you very much for your time.

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SECTION A: INFORMATION ON RESPONDENT BACKGROUND

1. Which of the following best describes your profession?

   Health and Safety officer ☐ Construction Site Manager ☐

   Other please specify ………………………………………………………….

2. How many years of experience do you have in managing Health and Safety issues on site?

   1-5 years ☐ 6-10 years ☐ 11-15 years ☐

   16-20 years ☐ Above 20 years ☐

3. How long has your organisation been involved in mass housing projects?

   Up to 5 years ☐ 6-10 years ☐

   11-15 years ☐ 16 years and above ☐

4. Have you had any formal training in Construction Health and Safety management?

   Yes ☐ No ☐

   If "Yes" kindly specify the type (s) of training

   ……………………………………………………………………………………

5. Does the firm have a written Health and Safety policy?

   Yes ☐ No ☐

6. Does the firm consult its employees on Health and Safety matters?

   Yes ☐ No ☐

7. Does the firm have a formal Health and Safety training program for all employees?

   Yes ☐ No ☐

8. Does the firm undertake formal site Health and Safety inspections?

   Yes ☐ No ☐

9. Does the firm keep records of all accidents concerning employees?

   Yes ☐ No ☐

<u>SECTION B: MASS HOUSING PROJECTS AND THE CHALLENGES OF SAFETY PERFORMANCE</u>

Taking into consideration your position/profession in your construction firm, kindly score by ticking [✓] on a likert scale of 1-5 the rate at which the following Safety problems occur on Mass Housing Projects undertaken by your firm. The scale for response is indicated below:

1. Never 2. Rarely 3. Occasionally 4. Frequently 5. Very Frequently

S/No	SAFETY PERFORMANCE INDICATORS	Frequency Level				
		1	2	3	4	5
SB	**STRUCK BY (SB)/ STRUCK AGAINST (SA)**					
SB1	Falling of material or debris from heights to injure workers					
SB2	Struck-by a moving heavy equipment e.g. bulldozer					
SB3	Materials drop from a crane onto an employee					
SB4	Step on sharp objects such as nails					
SB5	Workers striking foot against sandcrete blocks					
CW	**CONTACT WITH (CW)**					
CW1	Contact with underground power cables					
CW2	Contact with overhead high tension lines					
CW3	Workers coming into contact with hot surfaces					
C	**CAUGHT IN (CI)/CAUGHT BETWEEN (CBT)/ CAUGHT ON (CO)**					
C1	Collapse of excavations or trenches					
C2	An operator is trapped in an equipment on site					
C3	Collision of heavy equipment causing operator injury					
C4	Overturning of equipment resulting to operator injury					
C5	Strangulation of a worker caught on running machinery					
FS	**FALL-SAME LEVEL (FS)**					
FS1	Slips due to oily or dusty floors					
FS2	Fall resulting from inappropriate footwear					
FS3	Trips when something large or heavy is being carried					
FS4	Poor lighting system causing workers to fall					
FB	**FALL TO BELLOW (FB)**					

FB1	Falling of persons from scaffolds					
FB2	A worker falling from the roof					
FB3	Slip of ladder causing worker to fall					
FB4	Workers slip and fall whiles climbing					
FB5	Persons overbalance when carrying materials or tools					
OE	**OVEREXERTION (OE)**					
OE1	Low back pain from pulling					
OE2	Strain resulting from heavy lifting					
OE3	Musculoskeletal disorders from excessive work activities					
OE4	Repeated bending at the waist causing injury					
OE5	Injury from a long term poor posture (either sitting or standing)					
OE6	Long term truck driving causing injury from vibrations					
E	**EXPOSURE (E)**					
E1	Explosions as a result of inefficient electrical wiring					
E2	Burns sustained from fire outbreaks					
E3	Exposure to hazardous substances like asbestos which causes cancer					
E4	Lung problems from dust, fumes, gas and vapours					
E5	Noise Induced Hearing Loss (NIHL)					
RSI	**REPETITIVE STRESS INJURIES (RSI)**					
RSI1	Neck injury resulting from improper manual handling					
RSI2	Back injury resulting from the repetitive nature of a work item					
RSI3	Injury on the upper limb areas of site workers					
RSI4	Shoulder injury due to long periods of reaching					
RSI5	Knee injury from long periods of standing					

SECTION C: NATURE OF CONTRIBUTION OF THE UNIQUE PHYSICAL FEATURES OF MASS HOUSING ON CONSTRUCTION SAFETY PERFORMANCE

How often on a scale of 1 – 5 does each of the following Indicators of Safety challenges occur due to the unique physical features of Mass Housing Projects?

A. Struck By/Against B. Contact With C. Caught In/On/Between D. FallSame Level E. Fall to Below F. Overexertion G. Exposure H. Repetitive Stress Injury

The response scale is as follows from 1 – 5

1. Never 2. Rarely 3. Occasionally 4. Frequently 5. Very Frequently

Use this Sample Table to answer this Section.

S/No	Physical Features	Frequency Level							
		A	B	C	D	E	F	G	H
VPF1	***Variable one***	***1***	***2***	***3***	***1***	***1***	***4***	***3***	***5***

For writing **1** under **A (Struck By/Against)** means: A never occurs due to Variable one.

For writing **2** under **B (Contact With)** means: B rarely occurs due to Variable one.

For writing **4** under **F (Overexertion)** means: F occasionally occurs due to Variable one.

S/No	Unique Physical Features Of Mass Housing Projects	Frequency Level							
		A	B	C	D	E	F	G	H
MCS	**Multiple construction sites**								
MCS1	Contractor management style adopted on housing units								
MCS2	Site management style adopted on the housing units								
MCS3	Construction technology and method adopted for repetitive works in housing units								
MCS4	Change orders (Variation Orders) procedures adopted on repetitive housing units								
MCS5	Health and safety management techniques adopted for repetitive task construction works on housing units								
MCS6	Computer application software(s) adopted by project teams on housing units under scheme								
MCS7	Quality Management style and approach adopted on housing units								

MGL	**Multiple geographical location**								
MGL1	Influence of Local Development Controls across different geographical locations on housing units								
MGL2	Cultural influence within labor work force due to geographical locations								
MGL3	Influence of customary laws and practices on the tennural lands under scheme in various geographical locations								
MGL4	Geographical constraints and challenges due to location influence on repetitive works and housing delivery								
HUD	**Housing Unit design and contract package**								
HUD1	Composition of housing design in each contract packages under housing scheme								
HUD2	Construction elements and components adopted in design units in contract packages under scheme								

THANK YOU FOR YOUR TIME