

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
COLLEGE OF ART AND BUILT ENVIRONMENT
DEPARTMENT OF CONSTRUCTION TECHNOLOGY AND MANAGEMENT

**Critical Success Factors for Safety Management on Road Construction Projects in
Ghana: - A Case Study of Sefwi Asanwineso – Akontommra – Boodi Road**

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**A Thesis Submitted to the Department of Construction Technology and
Management
College of Art and Built Environment
in Partial Fulfillment of the Requirements for the Degree of**

MASTER OF SCIENCE

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DECLARATION

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

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ABSTRACT

The construction industry in Ghana contribute higher percentage to the country's economic gross domestic product (GDP), creation of employment, contribute to gross domestic capital formation (GDCF), and also produce capital assets and facilities to increase of other sectors such as hospitals for quality health services. Many civil and building construction workers are injured and killed every year as a results of the activities they perform on site; some also suffer different ill health. Other tress-passers also injured or killed due to the fact that, road construction activities in Ghana are not been properly planned, managed, monitored and controlled. Even though Project Managers and HSE managers and officers in the construction industries, especially, road works division in Ghana are trying their best to minimize accidents that can cause serious ill-health problems or death, but the knowledge on how health and safety risks are managed on Ghanaian building construction and civil engineering sites is limited and need to be improved. The purpose this research study is to identify critical success factors (CSFs) for safety management road construction projects in Ghana of selected D1 and K1 Contractors, case study of Desicom Road Construction Company (DRCC Ltd.) in the Western Region of Ghana. The study set objectives to: *(1) identify the most important factors that affect health and safety management performance of road construction projects in Ghana, (2) identify the challenges encountered during the implementation of health and safety measures on road construction projects sites, (3) identify worker's behavior towards road construction safety management and (4) evaluate the enforcement of appropriate mechanisms and measures to ensure the success of health and safety management on road projects construction sites in Ghana.* Field survey was conducted through a questionnaire and interview. The collected data was analyzed by using Statistical Package for Social Science (SPSS) software. It was recommended that, a greater measure such as induction training and toolbox talks structures should be put in place to improve HSE systems and also to reduce the rate of construction accidents in building and civil engineering industries in Ghana.

Key words: Critical Success Factors (CSFs), tress-passers, Safety Management, ill health, induction, toolbox

TABLE OF CONTENTS

DECLARATION	ii
ABSTRACT	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	viii
LIST OF FIGURES	ix
ABBREVIATIONS	x
ACKNOWLEDGEMENT	xii
DEDICATION	xiii
CHAPTER ONE	1
GENERAL INTRODUCTION	1
1.1 INTRODUCTION.....	1
1.2 BACKGROUND OF THE STUDY	1
1.2 STATEMENT OF PROBLEM	4
1.3 AIM OF THE STUDY	5
1.4 RESEARCH OBJECTIVES	6
1.5 RESEARCH QUESTIONS	6
1.6 SIGNIFICANCE OF THE STUDY	6
1.7 LIMITATION AND SCOPE OF THE STUDY.....	7
1.8 METHODOLOGY	8
1.9 JUSTIFICATION	8
1.10 ORGANIZATION OF THE STUDY	9
CHAPTER TWO	11
LITERATURE REVIEW	11
2.1 GENERAL INTRODUCTION	11
2.2 OVER VIEW OF CRITICAL SUCCESS FACTORS (CSFS) FOR SAFETY MANAGEMENT OF ROAD CONSTRUCTION PROJECTS IN GHANA	11
2.2 THE CONCEPT OF CRITICAL SUCCESS FACTORS (CSFs).....	13
2.3 FUNCTIONAL CLASSIFICATION OF HIGHWAYS	17
2.4 MANAGEMENT MEASURES.....	19
2.4.1 Design and construction strategies to be adopted	19
2.4.2 Conduct site investigation	21
2.4.3 Constructability	21

2.4.4 General conditions.....	22
2.4.5 Special conditions	23
2.4.6 Monitoring and Control.....	25
2.4.7 The Project Materials	25
2.5 MANAGEMENT ORGANIZATION.....	26
2.5.1 The Project Managers Role	26
2.5.2 Designers	27
2.5.3 The construction manager	27
2.5.4 Land Surveyors	28
2.5.5 Project Cost Estimator.....	28
2.5.6 The Quantity Surveyor	29
2.5.7 The program manager	29
2.5.8 Project Consultant	30
2.6 TECHNICAL AND MANAGEMENT PLAN	30
2.7 ACCOUNTABILITY AND RESPONSIBILITY	31
2.8 MANAGEMENT AND HUMAN RESOURCE	32
2.9 SAFETY BEHAVIOR OF WORKERS	35
2.10 SAFETY ENVIRONMENT	41
2.10.1 Recycling.....	43
2.10.2 Energy conservation.....	43
2.10.3 Litter reduction	43
2.10.4 Hazardous substances.....	44
2.10.5 Exposure of Chemicals.....	45
2.10.6 Chemical Substances	45
2.10.7 Forms of Chemical Agents.....	46
2.10.8 Hazardous Substances	47
2.10.9 Effects of hazardous substances	48
2.11 WORKER SAFETY QUALITY	48
2.11.1 Factors That Influence Construction Safety Performance	48
2.11.2 Traffic control plan.....	50
2.11.3 Proper Traffic Control	50
2.11.4 Creation of Separate Work Zones	50
2.11.5 Safety Equipment Usage	50
2.11.6 Create Awareness of the Surroundings	51
2.11.7 Avoidance of Blind Spots	51

2.11.8 Employ Competent Person	51
2.11.9 Safety Meetings and Tool Box Talks	52
2.11.10 Site Safety Programme	52
2.11.11 Stay Hydrated	53
2.11.12 Safety tips for road construction workers.	53
2.12 RISK MANAGEMENT CRITERIA	56
2.12.1 Project Management Approach	56
2.12.2 Risk Assessment.....	60
2.12.3 Safe Road Construction Project Challenges.....	61
2.12.4 Monitoring and Evaluation Tools and Equipment for Road Projects	62
2.12.5 Risk Factors in a Road Construction Site (RFRCs)	63
2.12.6 Contractor’s Ignorance	63
2.12.7 Road Users	64
2.13 DOWNFALL OF FLAGMAN.....	64
2.14 MERITS AND DEMERITS OF ROAD CONSTRUCTION PROJECTS	65
2.14.1 Merits	66
2.14.2 Demerits	66
CHAPTER THREE	67
RESEARCH METHODOLOGY	67
3.1 INTRODUCTION	67
3.1 RESEARCH METHODOLOGY REVIEW	67
3.2 RESEARCH DESIGN	68
3.3 RESEARCH STRATEGY	68
3.4 DATA COLLECTION METHOD SELECTION	68
3.5 DATA COLLECTION APPROACH	70
3.6 PRIMARY SOURCE (FIELD SURVEY)	70
3.7 SECONDARY SOURCE.....	70
3.8 DATA COLLECTION INSTRUMENT (QUESTIONNAIRE)	70
3.9 CONTENT OF QUESTIONNAIRES.....	71
3.10 ADMINISTRATION OF THE QUESTIONNAIRES	72
3.11 RESEARCH POPULATION	72
3.12 SAMPLING	73
3.12.1 Non-Probability Sampling.....	73
3.12.2 Criteria for Selecting Respondents.....	73

3.13 DATA ANALYSIS METHOD	74
3.14 RESEARCH SUMMARY	75
CHAPTER FOUR	76
ANALYSIS AND DISCUSSION.....	76
4.1 INTRODUCTION.....	76
4.2 GENERAL INFORMATION OF THE RESPONDENTS	76
4.3 SOCIO-DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS	77
4.3.1 Category of respondent	77
4.3.2 Respondent’s Years of Experience	78
4.3.3 Level of knowledge in quality assurance and control in concrete production	79
4.3.4 Role of Respondent	79
CHAPTER FIVE.....	91
CONCLUSION AND RECOMMENDATIONS	91
5.0 INTRODUCTION.....	91
5.1 CONCLUSION	91
5.2 REVIEW OF OBJECTIVES.....	92
5.3 SUMMARY OF FOUNDINGS	93
5.3.1 Indicators for CSFs Management in DRCC Ltd Organization:	93
5.3.2 Challenges Encountered During CSFs policies Management Implementation:	93
5.3.3 Implementing CSFs measures and safety Management Policies Among DRCC Ltd.	94
5.3.4 CSFs policies and safety measures Management Techniques implemented in an attempt to achieve Project the research Objectives:	94
5.4 RECOMMENDATIONS AND POLICY IMPLICATIONS.....	95
5.5 FURTHER RESEARCH.....	97
REFERENCES	Error! Bookmark not defined.
APPENDIXES	105

LIST OF TABLES

Table 2.1: Shows the functional classification maps and highway inventory	18
Table 2.2: Shows the New Zealand General conditions sample	24
Table 2.3: Shows management plan to ensure effective and efficient safe road construction project	34
Table 2.4: Shows unsafe behavior of contractors and workers	39
Table 2.5: illustrates behavior strategies	42
Table 2.6: shows Comparison Between ITL and Flagman System	65
Table 4.1: The Category of respondent	77
Table 4.2: Respondents Years of Experience.....	79
Table 4.3: Level of knowledge in CSFs of safety road construction projects	79
Table 4.4: Challenges of critical success factors (CSFs) for safety road construction management.	81
Table 4.5: Effects of challenges of critical success factors (CSFs) for safety road construction	85
Table 4.6: Strategies to have effective critical success factors (CSFs) for safety road construction management.....	88

LIST OF FIGURES

Figure 1.1: Shows the work flow chart of this research study	10
Figure 4.1: Categories of respondents	78
Figure 4.3: The roles of Respondents.....	80

ABBREVIATIONS

AASHTO's	America Association of Highway Transport Officials
AGCA	Associated General Contractors of America
AIA	American Institute of Architects
ANSI	American National Standards Institute's
ASCE	American Society of Civil Engineers
BBSG	Behaviour Based Safety Guide
BLS	Bureau of Labor Statistics
CDCP	Center for Disease Control and Prevention
CM	Construction Manager
CMAA	Construction Management Association of America
CONQUAS	Construction Quality Assessment System
CSFS	Critical Success Factors
CSI	Construction Specifications Institute
DC	Design Criteria
DCC	Department for Compensation Claims
DCP	Design Criteria Program
DOSH	Department of Occupational Safety and Health
ECRTD	European Centre for Research Training and Development
FHAMUTCD	Federal Highway Administration's Manual on Uniform Traffic Control Devices
GDCF	Gross Domestic Capital Formation
GDP	Gross Domestic Product
HSE	Health, Safety and Environmental
HSEM	Health, Safety and Environmental Managers

HSMS	Health and Safety Management System
IJBMR	International Journal of Business and Management Review
IJCEE	International Journal of Civil and Environmental Engineering
ILO	International Labour Organisation
LDG	Labour Department of Ghana
MUTCD	Manual on Uniform Traffic Control Devices
NAMI	National Alliance for The Mentally Ill
NYSDOT	New York State Department of Transport
OSH	Occupational Health and Safety
OSHA	Occupational Safety & Health Act
PMI	Project Management Institute
PMs	Project Managers
PPE	Personnel Protective Equipment
QC	Quality controls
RCPS	Road Construction Projects
RDCE	Road Design Criteria Elements
RFRCs	Risk Factors in a Road Construction Site
RISM	Road Infrastructure Safety Management
SRDC	Safe Road Construction Design Criteria
SSRCPMG	Successive Safe Road Construction Project Management in Ghana
WCL	Workmen's Compensation Law
WHO	World Health Organization

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DEDICATION

I dedicate this work to my lovely wife **Mrs. Ruth Adu-Gyamfi** for her encouragement, moral and spiritual support. Also to my lovely son and daughter, **Dickson Adu-Gyamfi and Cecilia Adu-Gyamfi**, not forgetting my mother, **Cecilia Dede** for her motherly love and care through my entire life.

CHAPTER ONE

GENERAL INTRODUCTION

1.1 INTRODUCTION

This chapter presents the background for the research study. Relevant information on how to identify Critical Success Factors (CFSs) for safety management of road construction projects in the building and civil engineering construction industry are explained, the concept of occupational health and safety are discussed and techniques and tools employed in occupational safety and health management in the building and civil engineering construction industry are examined.

1.2 BACKGROUND OF THE STUDY

In Ghana the construction industry contributes higher percentage to the country's economic gross domestic product (GDP), creation of employment, contribute to gross domestic capital formation (GDCF), and also produce capital assets and facilities to increase production of other sectors. (Ofori 2012). Building and civil engineering construction employees construct roads, houses, workplaces, maintain and repair the nation's infrastructure, these works includes many hazardous tasks and conditions such as work at height, excavations, noise, dust, power tools and equipment, confined spaces and electricity (Center for Disease Control and Prevention, 2009). The construction industry has a poor health record in most of the developing countries including Ghana. The road infrastructure industry is a perilous industry whether in established or growing countries and this gives credence to related incidents on construction sites globally, (Takala, 1999). Construction (road sector inclusive) is broadly viewed as a clumsy industry and it is said to be a sector with a lot of accidents and injuries taking place always (Lingard & Rowlinson, 2005). Most of the workers in the construction

industry suffer ill health due to the work they perform after exposure to hazardous substances and high harsh working which are likely. Despite the greater opportunities and effort being put by Project Managers, Health, Safety and Environmental (HSE) managers, officers and supervisors, construction industry has been noted as the riskiest with high accidents rate and frequent, high ill health injuries and deaths site workers, trespassers and consumers in Ghana. According to Menzel & Gutierrez (2010), the six reasons why Construction is very hazardous and dangerous in nature include but not limited to: (i) development strategies, (ii) nature of the development work operations, (iii) due to the physical environment of the work, (iv) substantial hardware utilized (v) development materials, and (vi) physical properties of the development venture itself. Every year most civil engineering and building construction workers are injured and killed due to the site activities they perform, some also experience ill health.

Problems such as sun stroke. However, are these hazards are not restricted to those site workers alone. Some tress-passers such as children and other of the general public are also injured and killed because of the fact that construction activities have not been adequately planned, managed and controlled. According to *Hughes and Ferret* (2008), health and safety is an essential aspect of employment duties in construction industries. Even though, Ghana as a nation don't have specific health and safety policy regarding construction industry, but the Ghana Labour Act 2003, (Act 651) section 119 to section 120 put an emphasis on health and safety practices in Ghana building and civil engineering industries and its designed to improve safety performance conditions and the Workmen's Compensation Law (PNDCL 187) is also designed to compensate workers for on-the-job injuries if health and safety management practice rules and regulations are not employed on building and civil engineering industry including road construction projects.

Road construction projects, especially large ones, are complex and dynamic thus the need for good practices of health and safety (ILO Encyclopedia of occupational health and hazard construction industry, 2011).

According to *Hughes and Ferret* (2013), the protection of bodies and minds of people from injuries resulting from site activities such as Provision of Personnel Protective Equipment (PPEs) and ware fare for road construction site workers is very important for good health conditions. Provision of health and safety to the employees at the workplace has a motivational dimension as well (Osuala, 2005).

Holt (2005), stated that, non-compliance to occupational health and safety management practices may result to series of accidents on site. According to Concha-Barrientos et al., (2004) statement, people at work face a variety of hazards due to biological agents, chemicals, physical factors, adverse ergonomic conditions, allergies, a complex network of safety risk and other factors, Marmot and Wilkinson (2006, p.1653) also stated that, the working environment and the nature of work itself are both important influences on health. Road construction project site accidents can have major negative effect on the mental health workers and others who are present during the incidents including trespassers and visitors. Health and safety of workers at construction site cost more to the individual workers, their families, employers and the entire country, if not properly managed. According to Abdul-Rashid, et al. (2007), the interest in occupational health and safety management practices among building and civil engineering construction firms among has greatly increased in the past decade. Sawacha, et al. (1999), also stated that in the building and civil engineering construction industry, the fatality risk are five times more likely than any other manufacturing industry, whiles the risk of a major injuries is two a d half times higher.

Health and safety management is an area which deals with the protection of workers regarding their health, safety and welfare to increase production, improve individual health and reduce cost. For this reason, health and safety management practices have been initiated to enhance a safe working environment within building and civil engineering construction industry.

1.2 STATEMENT OF PROBLEM

Around the entire world, building and civil engineering construction industry is one of the most hazardous industries and accident prone area due to its uniqueness of worksites, and a complex mix of different trades and activities which are dangerous in nature. Safety has always been a persistent problem in the construction industry (Alaqqad, 2009).

In Ghana, just like many other developing countries as stated by Ofori (2012), the construction industry is playing a vital role to achieve the country's socio-economic development goals by providing shelter, infrastructure and employment. According to Danso, (2010), despite the strategic essential of Ghanaian building and civil construction industry and the world at large, it is on records that the construction industry is fraught with health and safety issues. Many civil engineering and building construction work sites in Ghana are injured and killed due to the type of different activities annually. These hazards however are not restricted only site employees, but also other tress-passers such as school children and others are also injured or killed due to the fact that construction project activities are not properly planned, managed, monitored and controlled as the work progresses.

Turkson, 2006, stated that, health and safety management system includes the introduction of design processes to decrease the causes of injury and ill health problems in the employer's operation, and the implementation of a successful system requires the management commitment to health and safety policies, effective resource allocation and employee participation, and the scope of health and safety management system depends on the type and size of activities.

Even though Project Managers (PMs), HSE managers and officers in the road construction project fields in Ghana are trying their best to minimize accidents that can cause serious ill-health problems or death, but the knowledge on how health and safety risks are managed on Ghanaian building construction and civil engineering sites is limited and needs to be improved with new strategic plans and measures including critical success factors for safety management.

1.3 AIM OF THE STUDY

The aim of this research work was to conduct an in-depth study to exploit the Critical Success Factors (CSFs) for safety management of road construction projects in Ghana, by civil engineering contractors, a case study of Desicom Road Construction Company (DRCC) Ltd. in construction industry through the application of appropriate health and safety management measures and plans to minimize accidents occurrences in the civil engineering construction industry in Ghana.

1.4 RESEARCH OBJECTIVES

Below are the objectives for this study:

1. To identify the most important factors that affect health and safety management performance of road construction projects in Ghana.
2. To identify the most challenges faced in the health and safety policies and measures management on road construction sites in Ghana.
3. To identify worker's behavior towards road construction safety management.

1.5 RESEARCH QUESTIONS

The following are the primary research questions for the study based on the above stated objectives:

1. How does HSE officers and Project Managers handle health and safety management in the road construction project?
2. How can the health and safety management practices at civil engineering industry can be improved?
3. What are the challenges involved in the implementation of health and safety management practices in building and civil engineering industry?

1.6 SIGNIFICANCE OF THE STUDY

The main aim of this research study is to assess how the Critical Success (CFSs) for safety management of road construction projects in Ghana, including physical and safety hazards of the construction companies in Sefwi Wiaoso Municipality in the Western Region of Ghana. It is also essential and benefit of civil engineering construction companies to analyzed the situation and identify how the Critical Success

Factors (CFSs) for safety management of road construction projects affecting the implementation of health and safety management practices in building and civil engineering construction industry. Noel, (2010) stated that studies of health and safety practices have been dominated by studies of large companies in developed countries.

It will help Project Managers (PMs), HSE officers or managers and building and civil engineering contractors to take the necessary precautions to manage these Critical Success Factors (CFSs) before its occurrence and adopt appropriate management plans and measures when they occur during the phase of road construction projects to improve the overall health and safety management practices of the company. This will also enhance production, profitability and minimize accidents in the road construction projects phases in Ghana.

1.7 LIMITATION AND SCOPE OF THE STUDY

The limitation of the research is the Sefwi-Wiaoso Municipal Assembly in the Western Region of Ghana. It is hoped that the data to be collected will reflect majority of situation in the country particularly the selected Municipality, since most of the contractors in the Municipality have been executing road construction projects in other parts of the country. The research work has been designed to assess the Critical Success Factors (CSFs) for safety management of road construction projects in Ghanaian civil engineering contractors in the category of D1K1 contractors registered with Ghana Highways Authority and Urban Roads such as Desicom Road Construction Company (DRCC) Ltd working in the Sefwi-Wiaoso Municipal Assembly in the Western Region of Ghana, a case study of Desicom Road Construction Company (DRCC) Ltd working on Sefwi Asanwineso – Akontommra – Boodi road

1.8 METHODOLOGY

The method adopted in this research is the Quantitative research strategy. The methodology for this study comprises of a critical literature review. This helps in the identification of the previous health and safety management practices adopted for road construction projects, contributions made, limitations, criticisms, current findings and its implementations strategies. The literature review concluded in the development of questionnaires, which centered on the aim and objectives of the study to collect data from the field. The questionnaire survey involved building and civil engineering contractors, HSE managers and officers and consultants. The respondents for the study were asked to rate each variable on the Likert scale. The tools for analyzing the data collected consisted of descriptive statistics for ranking the various phenomena identified.

1.9 JUSTIFICATION

This particular research is of much significance to the building and civil engineering construction industry in Ghana as the findings of this study will identify means of improving Critical Success Factors (CSFs) for safety management of road construction project in construction industry in Ghana. Finally, this study will benefit academia as it will serve as a major critical contribution to knowledge and consequently will aid others on to engage in detailed and higher level research on improving success factors (CSFs) for safety management of road construction projects in Ghana, practices in building and civil engineering construction industry worldwide

1.10 ORGANIZATION OF THE STUDY

The study is made up of five chapters. Chapter one which contains a general introduction and background to the study. The problem is well stated followed by the aim and objectives of the study. Research questions were presented preceding the scope of the study. The justification of the study is clearly stated followed by the research methodology adopted for this study. Chapter two detailed out the literature review of the study. Chapter three also examines the research methods adopted. Chapter four also provide details on the analysis and the discussion of the data collected for the study.

Chapter five discusses the summary, conclusion and recommendation for the study.

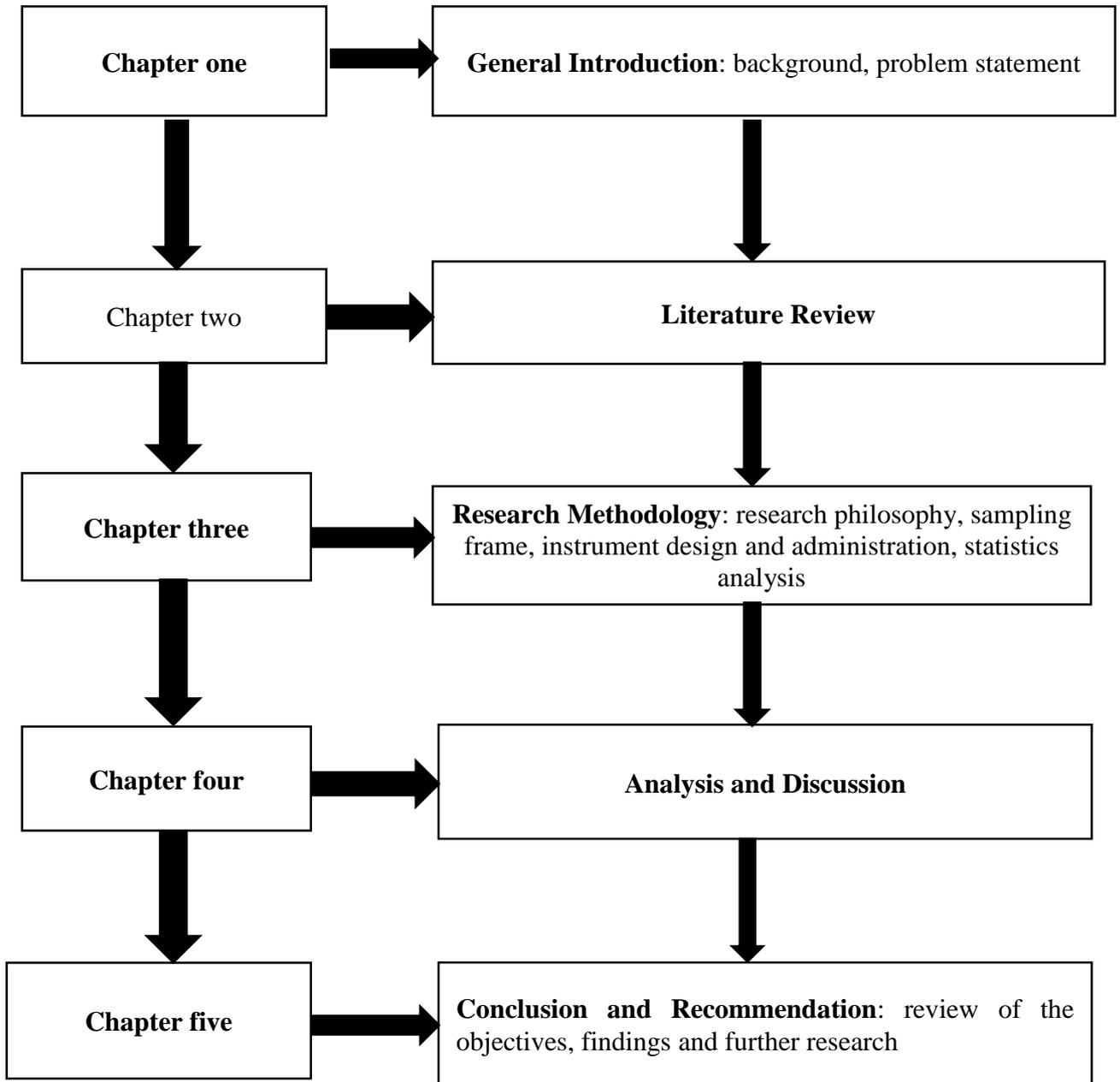


Figure 1.1: Shows the work flow chart of this research study

CHAPTER TWO

LITERATURE REVIEW

2.1 GENERAL INTRODUCTION

Chapter two presents the background for the research study. Relevant information on how to identify Critical Success Factors (CSFs) for safety management of road construction projects in the civil engineering and building construction industry are explained, the concept of occupational health and safety are discussed and techniques and tools employed in occupational health and safety management in the civil engineering and building construction industry are examined.

Recently, road safety management has significantly improved in many developed countries. The Road Safety Annual Report 2013 (OECD/ITF, 2013a) based on the International Road Traffic and Accident Database (IRTAD) shows that the number of fatalities decreased in almost all member countries between 2000 and 2011. Some countries, such as Portugal and Spain, have more than halved their road fatalities. This is remarkable considering that motorization has been steadily increasing during the same period. There are numerous reasons why this positive result for road safety has been achieved, but in short, the three main factors contributing to road accidents - road users, vehicles and the road environment - have each seen considerable improvements where safety is concerned.

2.2 OVER VIEW OF CRITICAL SUCCESS FACTORS (CSFs) FOR SAFETY MANAGEMENT OF ROAD CONSTRUCTION PROJECTS IN GHANA

Gradually, Ghana is moving into industrialized country and this great changes is exhibiting into a high percentage of the road construction project employees to various hazards at the work sites during working on heavy sun and wet areas. In the year 2000,

Labour Department of Ghana reported a total number of 8692 work related accidents to the department of compensation claims and 1999, the figure reached at 4,088. The International Labour Organization (ILO) constitution also highlighted that, the protection of employee against sickness, diseases and injuries raised out of employment is the fundamental elements of social justice.

WHO, (2010) stated that, occupational health and safety (OHS) is human right and decent work eventually is safe work. As stated by Conca–Barrientos et al, (2004) “people at work face a variety of hazards owing to chemicals, biological agents, physical factors, adverse ergonomic conditions, allergens, a complex network of safety risks, and many and varied psychosocial factors” The working environment and the nature of work itself are both important influences on health (p.1653, Marmot and Wilkinson, 2006). According to U.S. National Alliance for Mental Ill, (NAMI, 1999), work is the very core of contemporary life for people, personal identity, providing financial security and opportunity to make a meaningful contribution to community life. *International Journal of Business and Management Review* Vol.3, No.9, pp,60-79, October 2015 Published by European Center for Research Training and Development UK ISSN:2052-6393 (Print), ISSN, 2052-6407 (online) also stated that, work is very essential in human life and provides a number of psychological experience in life experience.

Successive Safe Road Construction Project Management in Ghana (SRCPM) is no successful due to a number of reasons. Some of these is that, success criteria for a specific construction projects are not well defined to guide and measures SRCPM success from beginning to end. The implementation of project management and project success criteria is to deliver Safe Road Construction Projects (SRCP) successfully,

achieve project output, success criteria framework should be developed to track key project objectives define appropriate allocation of project resources.

The study constructs in-order Critical Success Factors (CSFs) system containing seven CSFs: (1) road design criterial, (2) management measures, (3) management organization, (4) technical and management plan, (5) worker safety behavior, (6) safety environment, and (7) worker safety quality, (8) risk management criteria. Among these mentioned factors, management organization is found to be the key factor affecting successful road construction safety management performance, while worker safety behavior is a factor with a direct impact. Implications for practice are proposed. This study aimed to establish CSFs and performance evaluation of safe road construction project management in Ghana.

Safety performance of successful road construction projects can be effectively enhanced by improving the professional competence of safety management organizations by the Project Manager.

2.2 THE CONCEPT OF CRITICAL SUCCESS FACTORS (CSFs)

Critical Success Factors (CSFs): The concept of “success factors” was first developed by Ronald Daniel in the context of the Hindawi Advances in Civil Engineering (2018), stated in the 1960s, article <https://doi.org/> stated the importance of information systems. Generally, success in most industries construction industry is determined by three to six factors. Rockart wrote that “*CSFs criterial are, for any business, the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization.*” Rockart concluded that, CSFs are “areas of activity that should receive constant and careful attention from management studies” Studies in

the field of construction have adopted the CSF approach to examine safety issues. The concept Critical Success Factors (CSFs) in Safe Road Construction Projects are the essential safety and managerial activities that need to be performed well to achieve safe road construction project mission, objectives and goals for the project. Identification of CSFs in SRCP helps to direct and measure the success of ongoing SRCP.

Design Criteria

New York State Department of Transport (NYSDOT) has provided Road Design Criteria Elements (RDCE) and Standard values for Safe Road Construction Projects in USA which are relevant for the construction industry in Ghana to provide road designers with quality and effective methods to enable designers to check independent design criteria program effectively (DCP).

New York State Department of Transport (NYSDOT) has established 17 ROAD DESIGN CRITICAL criteria for highways and bridges design:

Design speed

Vertical clearance

Lane width

Travel lane cross slope

Shoulder width

Road width and structural capacity

Control of access

Super elevation

Pedestrian accommodation

Median width

Sloping sight distance

Horizontal clearance

The Safe Road Design Criteria (SRDC) PROVIDED IN this specific studies are applicable to both new and reconstruction and bridge construction projects on highways with over 500 vehicles. In each project, the specific values established for the applicable design criteria represent Design Criteria (DC) FOR Safe Road Construction Projects in Ghana. NYSDOT also provided separate Safe Road Construction Design Criteria (SRDC), which are also to be provided adjoining highways when they are being reconstructed to join the new main lane. There should be different sets of DC for different road construction projects. DCs are influence by:

Operating speed

Traffic volumes

Terrain

The functional classification

Density and land use

Project type

SRDC are to provide guidance to individuals providing the plans, profiles and cross sections of the road. The DC for the road construction projects are determined during the scoping stage. DC values should be established taking into consideration the Department Context-Sensitivity Solution philosophy that strives for outcomes that meets transportation service and safety needs, as well as environmental, science, aesthetic, cultural, natural resources and community needs, America Association of Highways transport officials, (AASHTOs), A Guide for achieving Flexibility in Highways Design, (2004) provides safe guidance for selecting proposed values that take into consideration the context of safe road construction projects worldwide. The Department is responsible to meet the design criteria values for individual and specific

road construction project. The value to selected should be influence by the DC and other important factors such as:

Future plans for the corridor

Crash potential

Crash history

Cost of construction

Stakeholder and public involvement

Social, economic and environmental impacts

Purpose and project needs

All these SRDC are essential factors to be considered in Ghana when planning and designing of Safe Road Construction Projects.

A Policy on Design Standards, Interstate System

NYSDOT also provides standards for design features specific to interstate highways. The standards outlined in this publication must be followed for projects on the interstate system in addition to the AASHTO geometric requirements in *A Policy on Geometric Design of Highways and Streets*.

A Policy on Geometric Design of Highways and Streets

This policy was developed by AASHTO's Standing Committee on Highways. Guidance included in the policy is based on established practices and is supplemented by recent research. The policy is intended to form a comprehensive reference manual for assistance in administration, planning, and educational efforts pertaining to design formulation. A recommended range of design values for critical dimensions of various types of highway facilities is provided.

2.3 FUNCTIONAL CLASSIFICATION OF HIGHWAYS

AASHTO's *A Guide for Achieving Flexibility in Highway Design*, 2004, has classified Highways by the character of service they provide, the nature and structure of the road as follows; 1) freeways moves high traffic volumes at high speeds with limited local access, 2) Local roads and streets are intended to avoid over speeding and to increase local access. Classification of a road ways is one of the major factor which determines a specific design criterion. The existing functional classification of the roadway project is determining by the departments Functional Classification Maps and Highway inventory. The roadways should be design in accordance with the design criteria for other freeways in section 2.7.1.2 of ASSHTOs AASHTO's *A Guide for Achieving Flexibility in Highway Design*, 2004, because, different characteristics in nature, rural and urban zones are classified differently It is the responsibility of road construction Project developers and designers to determine some specific design criteria for this classification.

If the road construction project area is within an urban boundary, or rural in nature, and intended to remain rural in nature, the design project life should be according to rural criteria, likewise the urban roadways. Below are indicators for urban character for no free ways

Major commercial driveways

1. Crosswalks
2. Transit stops
3. Sidewalks
4. Bicycle usage
5. Closed drainage system
6. Numerous right of way constraints

7. High density of cross streets

In safe road construction projects, more than one of the is needed to classify a zone as urban, suburban or rural to ensure safe road construction project. The examples below serve as a guide for selecting the required criteria for various road construction projects based on the functional classification as indicated on the Functional Classification Maps and Highway Inventory.

Table 2.1: Shows the functional classification maps and highway inventory

Classification is based on the service the highway is intended to provide		Classification is determined by the designer based on conditions required during the project life cycle design		
Rural		Design Classification	Character Per HDM §2.4	Criteria Section
NYSDOT Highway Inventory & Functional Classification map				
Description	Code			
Urban principal arterial interstate	11	Interstate	Urban and Rural	2.7.1.1
Rural principal arteria interstate	01		Urban and Rural	2.7.1.2
Urban principal arteria – others freeway/express /way	12	Other Freeways	Urban	2.7.2.2
rural principal arteria – others freeway/express \way	02		Rural	2.7.2.1
Urban principal arteria-other	14	Arterial	Urban	2.7.2.2
urban minor arteria	16			
Rural principal arteria -other	04		Rural	2.7.3.2
rural minor arteria	06			
Urban collector/map collector	17	Collector	Urban	2.7.3.1
Rural collector	18		Rural	2.7.3.1
Urban collector	07			
Rural minor collector 3	08			
Urban local 3	09	Local	Rural	2.7.4.1
Rural local 3	19		Urban	2.7.4.2

Source: Functional Classification of Highways - New York State Department of Transport (NYSDOT)

2.4 MANAGEMENT MEASURES

The management of construction is an enterprise that involves many people with diverse interests, talents and backgrounds (Lawrence, 2003). In safe road construction project, the client, the professional and the contractors are the main parties to the project, but others like material suppliers, subcontractors, bankers and others bodies are important to the project team whose roles must be monitored to ensure a successful road construction project.

Throughout the life cycle of the project, from the time the client first launches a construction project to that celebrate time, for some months or years after, when the project is about to use, the tasks to be carried out by the parties vary in type and intercity, (Levy,2007). Therefore, some management measures should be put in place to ensure a successful management of safe road construction project in Ghana. In this research, roles and responsibilities of the parties to the construction life cycle would be considered. The main focus is on the contractor who will carry out the projects lead responsibility for the onsite planning and follow up activities. It is therefore very important to understand how other stakeholders and organizations contribute to project success factors.

2.4.1 Design and construction strategies to be adopted

Highway infrastructure becomes old and congestion after years of construction, it is therefore important for transportation agencies to find a means to of reconstruction roads and bridges for minimum impact public users. Many designs and construction technologies and strategies should be adopted reduce time and cost overrun, and provide safer, better driving experience during the construction phase of the project.

The following are examples of the strategies for road design and construction:

Accelerated Construction: Accelerated construction plans includes various techniques and strategies to aid reduce construction time overrun and maintain safety and quality of the project.

Road Projects Coordinating: Effective Road construction project coordination between utilities, transport agencies and other agencies that have to undertake the construction project can provide benefits such as cost savings, earlier risk identification to manage traffic disruption from road works and best quality road surface.

Over time/Night Work: Overtime and /night work means that, work should be scheduled at lower traffic volume period to reduce the impact of traffic, employee's exposure to heavy traffic as well as drivers.

Positive Protection: Provision of positive protection will decrease risk to employees and tress passers with the use of vehicle direction devices, and minimize the risk the risk of vehicles disruption into the working area.

Road and lane closure: Road closure during the construction is an approach to be designed to minimize motorist's exposure to work zone and employees to heavy traffic by closing a road temporarily for working condition.

Exposure Control Techniques: Various exposure control techniques are then summarized and discussed to indicate how effective it is and how it can improve worker's safety in the work area.

2.4.2 Conduct site investigation

In line with other initial planning for safe road construction projects, project site investigation is conducted at various phases of the project at different stages for details. When more alternatives are under consideration, the various sites should be studied from the stand point of general soil conditions, topography, access and cost, Bennett (2003).

It is the responsibility of the geotechnical specialist to provide various soil conditions that will influence the foundation types identified, especially, environmental aspect of the project site, which includes underground conditions, waterlog lands problems must also be considered for studies. Project site investigation also provide detail methods for existing vegetation preservation and different means for accessing the site, movement of people and vehicles on site. Moreover, property surveys should be also considered to indicate boundaries and corners of the site, records may also be required to enable identification of land owners entitle to the land.

2.4.3 Constructability

It is very important to put in pace some measures to identify proposed alternatives that can be adopted efficiently to produce quality results. According to DeWitt, (1999), constructability analysis is the process of utilizes experienced construction personnel with extensive construction knowledge early in the design stages of the construction projects to ensure that, the projects under consideration is buildable, cost effective, biddable, maintainable and coordination. **Constructability** is the act of determining the type of structural system based on the anticipated start of construction, providing the knowledge to plan, design, procure and execute the most cost effective, highest-quality overall project objectives Levy (2007).

2.4.4 General conditions

All the project contract materials including the drawings, defines the project professional designer's knowledge and experience to the road construction project. The term specification referred to the requirements for the projects technical details and its written by design professionals Clough and Sears (1994). It has become customally to include the bidding and contract documents together with the specifications. The whole document is also known as project book, project manual, construction document book or specification and the most important document is the general condition of contract. The general condition of contract detailed out the rights and responsibilities of both the client and contractor and surety bond providers the power and responsibility to contribute to the design through their professionals and the project requirements binding both parties to the contract. Many road construction organisations have produce their own standard documents which includes the general condition of contract. The New Zealand conditions of contract for Building and civil Engineering Construction (Standard New Zealand Paerewa Aotearoa, 1998) have included 15 sections which includes topics as the contract, engineers power and duties, general obligations, completion time, terms of payments and dispute resolution procedure. Robbins, (1996) outlined the various provisions in the typical general conditions and some are shown below:

Bidding requirements

Scope of the work

Definitions and abbreviations

Control of the contract and subcontract

Damage claims

Laws and regulations

Legal and public relations

Explosives

Sanitary provisions

Property damage

Public utilities

Accident prevention

time of completion

suspension of work

2.4.5 Special conditions

If the general conditions could apply to any road construction project of the type being designed and built, there will surely be some special circumstances associated with the non-technical aspects of other road construction project. The *special conditions*, variously known as special provisions, supplementary general conditions or particular conditions, cover these project-specific matters.

The New Zealand Conditions of Contract for Building and Civil Engineering Construction manual (Standards New Zealand Paerewa Aotearoa, 1998) provide, as its first schedule, *Special Conditions of Contract*, with each section numbered to coincide with the relevant general conditions. Among the special conditions are the following:

Table 2.2: Shows the New Zealand General conditions sample

Division number	Division title	Sample sections
1	General requirements	Quality co Standards New Zealand Paerewa Aotearoa, 1998 (QCs), temporary structures, startup and commissioning
2	Site work	The site materials and methods, earth work, tunneling
3	Concrete	Forms, reinforcements, cast in place, pre-cast, grouts
4	Masonry	Masonry units, corrosion resistant
5	Metals	Framing, joist, metal finishes, rail road track
6	Wood and plastics	Rough carpentry. Fasteners, and adhesives, plastic fabrications
8	Finishes	Plaster, gypsum, tile, terrazzo, wall finishes
9	Specialties	Display boards, pedestrian control, devices, toilet and bath, accessories
10	Equipment	Maintenance equipment, library equipment, security and vault equipment
11	Furnishings	Casework, earthwork, rugs and mats, furniture, seating
12	Special construction	Air-supported structures, ice rinks, lifts, solar energy systems
13	Conveying	System dumbwaiters, elevators, lifts, scaffolding
14	Mechanical	Piping, plumbing, fixtures, heat generation equipment, air handling
15	Electrical	Wiring, electric power, lighting, communication
16	Thermal and moisture protection	Damp proofing, waterproofing, vapor and air retarders, Insulation

Source: Standards New Zealand Paerewa Aotearoa, 1998

2.4.5 Technical Specifications

Technical specifications are the portion of the condition of contract document that a lay person normally considered as specification. It contains the detailed technical information related to construction and installation of various portions of the work and materials to be included in. The Construction Specification Institute (CSI) (Construction Specification Institute, (2001) and Construction Specification Institute (CSI) (Construction Specification Institute (CSI) Canada-Davis du Construction

Canada,2001) have developed technical specification format that suits the building construction projects and has being tried on many construction projects, such as heavy road construction projects in Ghana.

2.4.6 Monitoring and Control

In every organisation, the project contractor is responsible to plans for the management of the project for a successful completion on time, quality, health and safety and environment. It is very important to compare the actual performance of the with the designed plan during ng the construction project operation phase to enable immediate action to be taken when deficiencies are noted by Project Management team. This responsibility is termed *monitoring and control*, where *monitoring* refers to methods for comparing actual with planned performance and *control* denotes the actions taken to attempt to bring deficient aspects of the project into conformance (Bennett 2003).

2.4.7 The Project Materials

The contractor is responsible to purchase materials for the project, and all materials brought to site should be checked to comply with the specifications requirements and the information is noted on a specified inspection check list. Materials shall be stored and handle with care to avoid damage contamination. It is the responsibility of the contractor to design effective plans to meet with the specifications of which includes samples of its proposed inspection check list. The contractor's quality performance may be evaluated and rewarded or penalised under a scheme originated in Singapore 1989.

2.5 MANAGEMENT ORGANIZATION

The management of safe road construction projects that involves construction experts with high knowledge and experience backgrounds to produce quality results Bennett, (2003), stated that, the client, design professionals, and the contractor are the primary triad of parties, but others like material suppliers, subcontractors, and other public officials are essential stakeholders of the construction project team with high influence roles that need to be coordinated to ensure safe and successful road construction project. Throughout the life cycle of the road construction project, from the time the client first launches a construction project to that celebrate time, for some months or years after, when the project is about to use, the tasks to be carried out by the parties vary in type and intercity, (Levy,2007). Therefore, some management measures should be put in place to ensure a successful management of safe road construction project in Ghana. In this research, roles and responsibilities of the parties to the construction life cycle would be considered. The main focus is on the contractor who will carry out the projects lead responsibility for the onsite planning and follow up activities. It is therefore very important to understand how other stakeholders and organizations contribute to project success factors.

2.5.1 The Project Managers Role

In every construction project organisation, there is Project Manager (PM), either directly employed by the client, the contractor or the design firm. It is the responsibility of the PM to manage all the aspects or phases of the construction for his or her organisation. the PM controls scoping, budgeting, controls the scheduling, controls cost, awards of contract and the only representative of the design firm. For the owner, a project manager is similarly responsible for all phases of a project and may also

participate in architect/engineer selection and is the representative of the owner in connection with any business concerning the project. The project manager is the person assigned by the performing organization to lead the team that is responsible for achieving the project objectives (PM BOK GUIDE 6, 2017). The project manager and his team form integral team members in the design firm. Levy, (2007) pointed out that, it is likely that, PM should be engaged early in the project planning process and will serve throughout the life cycle of the project. A PM can also be employed after planning and project analysis is fully completed. It is the responsibility of the project manager to manage the risk of injury from road construction projects activities in the performing organisation, therefore effective HSE management principles, procedures and practices should be adopted to eliminate or reduce the risk of injury.

2.5.2 Designers

The term ‘design professional’ is often used to refer to the architect and engineer as they perform their planning, design and construction liaison tasks on a construction project. The role played by each of these two professionals varies significantly depending upon the type of project (Edward et. al., 2010). The designer always acts as the leader of the planning and design team, whenever the client intended to construct a new road construction project, he is the first professional to be contacted for decision making.

2.5.3 The construction manager

In America, the Construction Management Association of America (CMAA) value Construction Managers services vital to the hiring firm who produce the result, the project designed by the architect of the firm. Moreover, the context of construction

management process is a construction project delivery process. According to Levy, (2007), unlike the arm's length contract transaction between the client and the main contractor in a design-build system, the Construction Manager (CM) act as the client's representative on his behalf. It is the responsibility of the CM to ensure that, sufficient and qualified professionals are provided and staffed to complete the road construction project on time. The American Society of Civil Engineers (ASCE) refers to this function as professional construction management to distinguish it from the type of construction management practiced by the design/construction management firms. Both the Association of General Contractors (AGC) and America Institute of Architects (AIA) simply refer to this type of contract as construction management.

2.5.4 Land Surveyors

Land surveyors are engaged at the initiation stage of the project to conduct site investigation of the land for the project after it has been selected. Both building and road construction projects, site investigation is conducted and the information obtained is recorded, such activities includes positioning of datum levels, locating corners of the land and boundaries, determine the site contours, slopes and location of existing properties and improvements, obstructions and natural features (Edward et, al.,2010). Underground services are also involving rout layout after the site investigation has been conducted.

2.5.5 Project Cost Estimator

The estimator is the leader and is responsible for pricing the works which form part of the work (Kuragu, n.d). Whenever the fund for the project is limited, the client will desire an accurate cost estimate of the life cycle of the construction project. It is the

responsibility of the project cost estimator for the compiling of this information (Edward et, al, 2010). Project cost estimate is prepared at various phases in details for accurate funding. During the initial stage of the planning phase, normally few information is available but a lot of information is obtained as the project progresses for reviewing. When more designs are available, the project cost estimator develops more cost estimates. There is high degree of accuracy which improves as many details are developed (McCaffer, 2001).

2.5.6 The Quantity Surveyor

Quantity Surveyor as a professional prepares quantities of the elements of various aspects road construction project. Hogg (2007) stated that, in some cases, this activity is conducted in conjunction with the estimator's cost. Quantity survey is done at different phases during design and planning phase, but not at the development of the project documents stage (Robinson and Statham, 2007). McCaffer, (2001) also explained that, quantity surveyors prepare quantities schedule for unit price contracts, while the quantity take-off for lump-sum contract is left to individual tenderers.

2.5.7 The program manager

Program manager applies knowledge, skills, and principles to a program to achieve the program objectives and to obtain benefits and control not available by managing program components individually. A program component refers to projects and other programs within a program (PM BOK GUIDE 6, 2017). The responsibilities of the programme Manager are more and varies from phase to phase of the project. The Construction Management Association of America (CMAA) describe the role the programme manager to assist in the design and construction phases of the project but

he also plans and develop environmental studies and interact with the local, state and public regulatory agencies within and outside the project jurisdiction. the programme manager can be also employed to coordinate multiple owner projects at various development stages (Levy, 2007).

2.5.8 Project Consultant

There is alternative when the client doesn't have experienced and knowledgeable staff in various sections of the project team, one major approach is to design and construct if possible and the client can hire an experience project consultant to act as his agent (Edward et, al, 201 0). The consulting firms are experts in all stages of the road construction project phases. The consultants work hand in hand with the architects during the development of various and also comment on cost of designs and also work with the client during the tendering process and interact with the bidders. The consultants are responsible to review bids, give advice on the contract selection methods. Consultants can be employed to review amendments and assist in dispute resolution process and claim management from the contractor perspective. They normally work on hourly basis.

2.6 TECHNICAL AND MANAGEMENT PLAN

In the construction industry, Technical and management plan form the basis for the management of various sections such as health and safety management. The way occupational health and safety is managing in the construction industry have great impact on the road construction projects and it is the duty of the employer to appoint qualified and competent safety manager to manage all the health and safety aspects of the project, because the employer owe a duty of care to all employees. The

responsibilities of the safety and health manager includes (1) to ensure safe work place throughout the project life cycle, (2) provide safe plant and equipment all the time, (3) ensure safe system of work, (4) provide safe and competent employees to the site to reduce cost of accidents. The number of safety managers required for a specific construction project will depend on the size of the organisation, project duration and the quantity of work to be executed. Safety managers should design a clear policy programme so that every employee associated with organisation is aware of its health and safety aims and objectives Adinyira, (2013). Hughes & Ferrett, (2001) stated that, all the professionals are required to assist the health and safe officers to ensure that, there are satisfactory health and safety standards within the organisation. Safety managers are expected to ensure proper plans and organize their employees they are trained and competent to know and identify safety risk associated with their trade notify their managers and safety representatives (HSE, 2009).

According to Hughes & Ferrett, (2001), the HSE believe that effective management of health and safety of safe road construction projects:

- is vital to employee well-being
- has a role to play in enhancing the reputation of businesses and helping them achieve high-performance teams
- is financially beneficial to business.

2.7 ACCOUNTABILITY AND RESPONSIBILITY

Occupational Health & Safety Act (OSHA) 18001:2007) indicated that, the main goal and objective of the internal accountability and responsibility is to ensure team work of the employees to identify hazards and adopt an appropriate measure to control them to

minimize the negative impact to the project. Below are examples of internal accountability and responsibility the safety manager should put in place:

1. Plan effective responsibility for hazards identification and mitigation at the work site, permit every employee to take part
2. Management and operatives should be encouraging to try their best to identify potential hazards and adopt appropriate techniques to mitigate them
3. Motivate worker to participate in health and safety management policy implementation.

At safe road construction site, each individual is accountable and responsible for safety and should ensure that work related illness and accidents are avoided to minimize cost and increase productivity.

2.8 MANAGEMENT AND HUMAN RESOURCE

The management and human resource department are responsible to provide health and safety requirements and education to its employees to improve safety system within the road construction industry. The management and human resource department is responsible for:

- ❖ Encourage health and safety education at all levels of employees
- ❖ Follow OSHA act and rules and regulations for road construction projects.
- ❖ Effectively and efficiently coordinate health and safety activities on project site.

They must act as leaders and managers of the health and safety committee to:

- ❖ Keep and maintain all records of accidents and incidents
- ❖ Analyze the causes of accidents and incidents and record the results and submit to the top management.

The management and human resource is responsible and accountable for:

- ❖ Provision of safe working environment and safe equipment and tools.
- ❖ Provision of training, supervision and instructions to ensure safety of employees
- ❖ Provision of health and safety manual and consulting committee to coordinate all health and safety issues on work site.

Road Construction project supervisors are also responsible to;

- ❖ Know and comply with health and safety policies, rules and regulations.
- ❖ Coach workers to know and comply with the health and safety requirements of the organisation.
- ❖ Ensure that, employees are submissive under their supervision

Road construction workers are also responsible to:

- ❖ Cooperate with their supervisors, management and the organisations health and safety officers.
- ❖ Practice safety rules and regulations using appropriate safety equipment.
- ❖ Always report accidents and incidents to their immediate supervisor as soon as it occurs.

Organisation's Safety Mangers and Safety Committees are also responsible for:

Identification of hazards conditions at the project work site.

Accept worker's complaints of the work site.

Provide appropriate recommendations to top managers to protect workers against unsafe conditions.

Table 2.3: Shows management plan to ensure effective and efficient safe road construction project

CORE ELEMENTS OF THE RECOMMENDED PRACTICES FOR SAFETY AND HEALTH PROGRAMS IN CONSTRUCTION	
MANAGEMENT LEADERSHIP	<ul style="list-style-type: none"> • Top management demonstrates its commitment to eliminating hazards and to continuously improving workplace safety and health, communicates that commitment to workers, and sets program expectations and responsibilities. • Managers at all levels make safety and health a core organizational value, establish safety and health goals and objectives, provide adequate resources and support for the program, and set a good example.
WORKER PARTICIPATION	<ul style="list-style-type: none"> • Workers and their representatives are involved in all aspects of the program including; setting goals, identifying and reporting hazards, investigating incidents, and tracking progress. • All workers, including contractors and temporary workers, understand their roles and responsibilities under the program and what they need to do to effectively carry them out. • Workers are encouraged and have means to communicate openly with management and to report safety and health concerns or suggest improvements, without fear of retaliation. • Any potential barriers or obstacles to worker participation in the program (for example, language, lack of information, or disincentives) are removed or addressed.
HAZARD IDENTIFICATION AND ASSESSMENT	<ul style="list-style-type: none"> • Procedures are put in place to continually identify workplace hazards and evaluate risks. • Safety and health hazards from routine, no routine, and emergency situations are identified and assessed. • An initial assessment of existing hazards, exposures, and control measures is followed by periodic inspections and reassessments, to identify new hazards. • Any incidents are investigated with the goal of identifying the root causes. • Identified hazards are prioritized for control.
HAZARD PREVENTION AND CONTROL	<ul style="list-style-type: none"> • Employers and workers cooperate to identify and select methods for eliminating, preventing, or controlling workplace hazards. • Controls are selected according to a hierarchy that uses engineering solutions first, followed by safe work practices, administrative controls, and finally personal protective equipment (PPE).

	<ul style="list-style-type: none"> • A plan is developed that ensures controls are implemented, interim protection is provided, progress is tracked, and the effectiveness of controls is verified.
EDUCATION AND TRAINING	<ul style="list-style-type: none"> • All workers are trained to understand how the program works and how to carry out the responsibilities assigned to them under the program. • Employers, managers, and supervisors receive training on safety concepts and their responsibility for protecting workers' rights and responding to workers' reports and concerns. • All workers are trained to recognize workplace hazards and to understand the control measures that have been implemented.
PROGRAM EVALUATION AND IMPROVEMENT	<ul style="list-style-type: none"> • Control measures are periodically evaluated for effectiveness. • Processes are established to monitor program performance, verify program implementation, and identify program shortcomings and opportunities for improvement. • Necessary actions are taken to improve the program and overall safety and health performance.
COMMUNICATION AND COORDINATION FOR EMPLOYERS ON MULTIEMPLOYER WORKSITES	<ul style="list-style-type: none"> • General contractors, contractors, and staffing agencies commit to providing the same level of safety and health protection to all employees. • General contractors, contractors, subcontractors, and staffing agencies communicate the hazards present at the worksite and the hazards that work of contract workers may create on site. • General contractors establish specifications and qualifications for contractors and staffing agencies. • Prior to beginning work, general contractors, contractors, and staffing agencies coordinate on work planning and scheduling to identify and resolve any conflicts that could impact safety or health.

Source: Recommend Practices for Safety and Health Programs in Construction

(2016)

2.9 SAFETY BEHAVIOR OF WORKERS

Most of the road construction workers are ignorant and don't practice appropriate safety management measures on site while working, therefore, the safety management team has the right to institute some punishment and penalties to minimize workers' unsafe behaviors on site. According to Behavior Based Safety guide (BBSG), (2013),

indicated that, various approaches have been adopted to reduce unsafe behaviors in the work place and these approaches include codes and procedures to be followed, workers' guidance and training. The unsafe behavior of some workers control measures is initiated by the employer, health and safety organisations and regulatory bodies from the public since the main aim of safety at work is a safety culture all employers and employees should know. Perdue (2000) described safety culture as a situation where by individual workers holds safety responsibility of themselves and fellow workers. All safety managers must establish some safety approach requirements for their activities which will contribute and have high positive impact on safety culture which may include but not limited to:

1. Establish a strong safety management team to improve and maintain safety behavior of workers.
2. Provision of open safety communication between management and worker groups about all aspect of safety behaviour in the road construction work zones.
3. Perform an open quick feedback.
4. Show effective commitment to improve safety culture among all employees to enable them to consistently lean and grow.
5. An approach to emphasis safe and unsafe behaviors as not only dependence indicators of safety culture.
6. Create awareness cultural practice among all employee of various departments to consider how to do what they supposed to do and why they should do that.

Behavior-Based Safety refers to the use of applied behavior analysis models to achieve continuous improvement in safety performance, Behaviour Based Safety Guide (BBSG), (2013). Thomas Krause stated that, normally, safety behavior programmes plans failed because, they don't actually focus on safety behavior warnings but rely on

safety rules, safety meetings and procedures instead. The following Behavior Safety Processes steps were established by Thomas Krause:

Identify critical problem behaviors. These become action items to work on.

1. Identify root causes. The “basic things” that need to be fixed to eliminate the problem.
2. Generate potential actions. Think of as many solutions as possible.
3. Evaluate possible actions. Choose those that are most productive.
4. Develop an action plan. To carry out the chosen solutions.
5. Implement an action plan. Carry it the change. Limit variables.

Occupational safety and health is relevant to all branches of industry, business and commerce including traditional industries, information technology companies, the National Health Service, care homes, schools, universities, leisure facilities and offices. It is particularly important for the construction industry, (Hughes & Ferrett, 2001). The construction industry is still regarded as high accident prone industry, because of the working environment they are operating in, nature of activities they perform, the materials they are using, equipment and tools and methods they use and the construction project itself, (Laryea and Mensah 2010). Occupational injuries and fatalities within the construction industry have also been associated with considerable financial costs. It has been estimated that such injuries cost over 10 billion USD per year, (Khorsavi et. Al., 2014).

Generally, occupational health and safety and construction safety is very complex issues at site, and has been major essential concern to both practitioners and researcher's worldwide. A lot of managerial approach have been made to investigate CSFs influencing health and safety performance on road construction project sites. As stated

by Mohammed 2003, the construction industry currently recognized as a major economic force and one of the most hazardous industry. Site accidents minimize production, quality, time and have great negative impact on environment and project cost. Mbuya and Lema, (2004) quoted that, in most developing countries, construction health and safety issues in construction project delivery is not given priority, and implementation of safety measures during construction is a budding. Safety and health has been considered as a major parameter to be used along with the motive traditional parameters such as cost, quality and time to measure construction project success in the industry and the motive for this consideration are human factors, registration and financial issues (Adan,2004). Lack of quality information management in the construction industry and experience limit the intervention process of improving healthy and safe working environment in the road construction sites. Construction site safety is influence by a lot of factors vary from section to section in the industry. Khorsavi et. al. 2014, identified some major key factors that may could contribute to unsafe behaviors and accidents on construction sites in the table below:

Table 2.4: Shows unsafe behavior of contractors and workers

UNSAFE BEHAVIOR AND ACCIDENT							
Society	Organization	Work Group	Site Condition	Individual Factors	Contractor	Supervision	Project Management
national culture	policy and plan	group norm and attitude	Hazardous operation	attitude and perception	size	effective enforcement	safety leadership
race or ethnicity	climate and culture	interaction	Unsafe condition	age and experience	interaction	supervision style	commitment and support
education and training	structure and responsibility	team work	Weather	drug abuse	incentives	safety engagement	management style
economy	information management		Welfare service	unintended acts	experience	performance pressure	communicate competency
social support	project and job design		Construction Stage equipment	intended acts	competency	communicate competency	review and feedback
social challenges	contract and contractors			competency and ability	subcontractor climate		
business climate	resource management			psychological features	subcontractor Rate		
				competition			

Source: Khorsavi et al. (2014).

(RPSPC) (2016) identified nine (9) steps that will provide a **Project Manager** a solid base from which he can take to get started with the worker safety behaviour program on safe road construction project site. These steps are:

1. PMs should always set safety and health as their top priority

They should tell the workers to finish the day's work and go home safely. Let the workers be assured that, hazards that could cause ill and injury will be identify and controlled.

2. Always set example

All PMs should practice construction safety behaviors themselves for the workers to imitate.

3.Reporting systems should be implemented

PMs should establish simple reporting approach to enable workers report any accidents, injuries and incidents, hazards health and safety issues to their supervisors and managers without any fears.

4. Induction and Training

All workers should and be inducted and trained to know how to identify and control hazards at site.

5. Site Inspection

PMs should conduct construction site inspection and ask workers to report any findings by the use of checklist and any other available resources.

6. Hazards Control Ideas

All PMs should share safety improvement ideas with workers throughout the life cycle of the road construction project.

7. Hazard Implementation

Each employee should be assigned with a safety task to choose and implement them on site.

Site operatives are normally required to plan and organize their operations, ensure that they are trained and competent and know the special risks of their trade and raise problems with their site supervisor or safety representative (HSE, 2009).

2.10 SAFETY ENVIRONMENT

Management of safety environment of safe road construction projects starts with the environmentally responsible behaviours. Hornik et al., (1995), Porter et al., (1995), Schultz et.al,(1995) stated that, three focus exclusively on recycling, one examines the conservation of resources like energy and water (Abrahamse et al 2005), Huffman et al., (1995) also examines litter reduction and a final review, meter analysis, Osbaldiston (2004) also examine report on several environmentally responsible behaviors including recycling, energy conservation water conservation, efficient transportation and litter reduction. This intervention is emphasis on various target groups such as road construction workers, and adopt a variety of strategies. This study put more emphasis on road construction project workers in Ghana.

Table 2.5: Illustrates behavior strategies

Review	Behavioural Focus	Range of Intervention Strategies
Hornik et al (1995)	Recycling	Extrinsic incentives (eg. monetary rewards, social influences), external facilitators (eg. increasing frequency of collection, increasing proximity of recycling bins), intrinsic incentives (eg. personal satisfaction from recycling), and internal facilitators (eg. knowledge about recycling
Porter et al (1995)	Recycling	Prompting, getting people to make a commitment to recycle, altering the environment, setting goals, providing feedback, rewards and penalties.
Schultz et al (1995)	Recycling	Prompting, getting people to make a commitment to recycle, using social norms, setting goals, removing barriers, providing feedback, and rewards.
Abrahamse et al (2005)	Energy conservation	Providing information, getting people to make a commitment to conserve energy, setting goals, modelling, feedback, and rewards.
Huffman et al (1995)	Litter reduction	Prompting, community interventions and modelling, removing prior litter, environmental design, and rewards.
Osbaldiston (2004)	Various including recycling, energy conservation, litter reduction and efficient transportation.	Providing rewards or incentives, using prompts, providing information, providing rational reasons for change, accessing or making salient pre-existing attitudes or beliefs, using social norms, getting people to make a commitment, setting goals, providing feedback, and manipulating 'structural' variables.

Source: Khorsavi et al. (2014).

2.10.1 Recycling

The act of converting waste material into new materials and projects. It is an alternative to conventional waste disposal that can save materials and help lower waste materials such as plastic waste, glass, paper and metals. Dead plants, fruits and vegetable scraps can be recycled through composting at road construction project sites. It is the responsibility of the Project Manager to examine the effectiveness of interventions designed to increase recycling behaviour.

2.10.2 Energy conservation

It is the effort made to reduce the consumption of energy by using less of an energy services. This can be achieved either by energy more efficiently or by reducing the amount of service used. Abrahamse et al., (2005) described energy conservation as the aim of encouraging households to reduce energy consumption, as well as road construction project sites. Project Manager have to observe conservation of project resources to decide the appropriate strategies to be employed for the ongoing road construction project and encourage individuals to practice such behaviour.

2.10.3 Litter reduction

Litter reduction is the act reducing the amount of waste being generated by individuals or a group of workers for their own benefit. Changing a common behaviour like littering, starts with individuals. Each person must accept responsibility for their actions and influence the actions of others around them at the road construction project site. Project Manager must design a strategic action plan to prevent littering. Spend less on purchasing, disposing of materials, and save some materials for reuse. He can also start with these actions by:

1. Choose not to litter the project site.
2. Educate site workers on the litter laws.
3. Remind others not to litter and why.
4. Get a litter bin to share.
5. Volunteer in the project site to help prevent and cleanup litters

2.10.4 Hazardous substances

On road construction project sites, hazardous waste substances pose a huge contribution into health and safety issues and can result in fatal accidents. OSHA, NIOSH, USCG and EPA, (1985) listed the following as major hazards on construction sites:

Chemical exposure

Fire and explosion

Oxygen deficiency

Ionizing radiation

Biological hazards

Safety and health

Electrical

Heat stress

Cold exposure

Noise

In the construction industry, there are several factors that distinguish hazardous waste site environment from occupational situations that involves hazardous substances. The most essential factor uncontrolled road construction site conditions. Extremely hazardous substances are not harmful to health if well managed and controlled. It is the

responsibility of the Project Manger adopt some appropriate measures to manage hazardous situations based on the information on site. Workers also exposed to physical environment of hazardous working zones. Both conditions reveal hazardous situations that:

- ❖ Could cause immediate danger to health.
- ❖ COULD result in negative change to site activities.
- ❖ May not be identify immediately.

2.10.5 Exposure of Chemicals

The most basic approach to hazards management is the prevention of toxic chemical exposure to the public and reach of unauthorized workers. Road construction project sites contain a lot of toxic chemicals such as liquids, gaseous and or solid in nature and can easily enter the body through ingestion, skin absorption, inhalation and injection which can cause damage immediately at the point of contact or act systematically.

2.10.6 Chemical Substances

Chemical Substances are major health hazards in the construction industry which include insecticides, fungicides etc. thus according to the International Labour Organisation (1999). Chemical substances are harmful and emanate from various sources at construction sites. Large portions of these chemicals are dangerous, with a possibility to bringing about harm. These substances must be guided against during construction works.

2.10.7 Forms of Chemical Agents

Transportation of chemicals to road construction sites can be done by the contractor, agent or the manufacturer in various form. The choice of transportation method will depend on the type and form of the chemical. The following are examples chemical agent forms:

Dust: - They are tiny solid substances less heavy than air and usually suspend it for some time and are capable to enter the body through nose and mouth during breathing.

Gasses: - these are substances normally have a temperature above their boiling point. The commonest ones found at road construction sites include carbon dioxide, oxygen, nitrogen, carbon monoxide and must be well managed and controlled because they can be absorbed into the bloodstream to have either positive or negative impact on health of workers.

Vapours: - These substances are very close to their boiling temperature and are in gaseous form. Cleaning fluid is a typical example of vapor.

Liquids: - Liquid substances normally exist at a temperature freezing and boiling and in health and safety regulations is known as fluids.

Mist: - Mist have properties similar to vapours but closer to liquids and can easily enter the body through ingestion with food or skin.

Fume: - These are very small metallic substances which condensed from gaseous state and are generated during welding of metals. The particles can lead to long term permanent lung damage when contacted with the body.

2.10.8 Hazardous Substances

Hazardous substances are classified according to their severity and type of hazards they may pose on construction workers when they are performing road construction project activities. Introduction to health and safety at work has described hazardous substances and their associated health risks into:

Irritant: is a non-corrosive substance which can cause skin (dermatitis) or lung (bronchial) inflammation after repeated contact. People who react in this way to a particular substance are sensitized or allergic to that substance. Many chemicals used as solvents are also irritants (white spirit, toluene and acetone).

Corrosive: - These substances usually attack living tissue by burning the victim and comprises of alkalis or acids. Typical example is kitchen oven cleaners and are corrosive in nature.

Harmful: - Harmful substances are those when swallowed, inhaled penetrates the skin and imposed health risk to the worker. Such kind of health risk can be minimized or removed when workers are trained and inducted on site harmful issues and the use personal protective clothing. The best and basic approach for harmful effect reduction is the labeling the containers that contain harmful substances and categorize them.

Toxic: - Toxic substances oppose the function of organs within the body, especially the kidney liver and heart. They are very poisonous in nature, and includes lead and mercury. The toxic substances have high influence on workers' health and age when it enters the body.

2.10.9 Effects of hazardous substances

The negative effect of hazardous substances on health could be chronic or acute. Acute effects occur shortly and rapidly after exposure to the hazardous substance and its severe immediate hospital treatment but also reversible if treated well and the chronic effects also accumulate over a long period of time when the victim is exposed to hazardous substances, and when the affected person is not diagnosed results in gradual and irreversible illness. Some individuals may experience symptoms others may not.

2.11 WORKER SAFETY QUALITY

2.11.1 Factors That Influence Construction Safety Performance

Construction safety is the most essential aspect of management in the road construction industry and think it's the most critical factor that affect the performance of the construction industry. Researchers have identified a number of ways that construction site managers can help improve the safety performance of the construction projects. According to Priyadarshani et. al. (2013), the non-adherence to the established safety standards, results in incidents and injuries at construction sites leading to low safety performances. In general, the occurrence of construction accidents is largely due to inadequate knowledge of safety principles, inefficient supervision by site supervisors, wrong judgment, lack of safety understanding and sometimes recklessness on the part of construction workers. These factors are not exclusive, the uncontrolled nature of the working environment, the complex nature of the construction project, and the transitory nature of the construction industry all have effect on the safety performance on the construction industry.

As indicated by Priyadarshani, et. al. (2013) states however, most incidents and injuries at construction sites are a direct result of not adhering to the established safety procedures; hence, construction safety performance can be affected by several factors. Sawacha et al., (1999) states that in construction works, 'unsafe conduct' is the most identified factor being the huge reason why construction accidents occur and hence 20 gives proof of a poor safety practice. (Sawacha et al. (1999), further states that safety performance is linked with the following:

- ❖ Psychological,
- ❖ Technical,
- ❖ Procedural,
- ❖ Organizational
- ❖ Environmental issues

The Historical factor is determined by the background and qualities of the individual, for example, age and experience.

The Technical and procedural factors are determined by the handling of safety equipment on site and ensuring that supervisors are trained. As indicated by Priyadarshani et al, (2013) the organizational safety management is determined by the kind of approach that the organisation shows towards site safety. Abdul-Rashid (2007), indicates that many researchers have found other factors that affect safety performance in international write ups.

Road Infrastructure Safety Management (RISM), (2015), described the following plans as useful tools to enhance road safety management plan to be implemented by Project Managers include but not limited to:

2.11.2 Traffic control plan

PMs managing road construction project in Ghana should have safety and quality management plan for transportation system. The plan should be design in a manner that it consists of temporary road traffic plan to safe guide workers conducting their activities traffic controllers on site. The work zone should also have traffic control management plan to enable free movement of vehicles and heavy equipment and machines.

2.11.3 Proper Traffic Control

There should be zoning in the working area and each working zone must have warning signs to alert motorist change their driving conditions using traffic control devices to close lanes and traffic pattern shifts and termination zone to permits traffic to resume back to normal activities.

2.11.4 Creation of Separate Work Zones

All road construction work areas are usually busy due to ongoing several activities which can easily cause accident. Accidents can be managed through the uses of barrels, warning signs and barriers to indicate heavy traffic areas where heavy equipment is being used, parking areas for vehicles, materials storage areas and pedestrian areas.

2.11.5 Safety Equipment Usage

All road construction site workers should wear proper safety protection equipment within the work area to avoid accidents and contact with hazard substances. Personal protective equipment (PPE) such as helmet, reflectors, safety boots and ear plugs

should be used and must meet America National Standard Institute (ANSI) standards and Ghana Highway Authority rules and regulations.

2.11.6 Create Awareness of the Surroundings

Road construction site areas contain a lot activities and all workers should be aware of whatever is going on because regardless duty of care could result in fatal accident and financial lost to the construction firm and the victim. Workers should avoid walking behind the back of vehicles and equipment rather face them. Whenever possible, spotters should be employed to monitor vehicles and equipment when moving backwards operators also should create awareness when moving equipment and vehicles to avoid accident occurrences and other dangers.

2.11.7 Avoidance of Blind Spots

It is possible that, heavy equipment and vehicles may be constantly moving up and down in the work zone, all the operatives should make sure that, visual aids such as mirrors, backup lights and alarms are properly attached to their machines. When walking around moving machines, walk in visual contact with the driver because operatives have limited sight of vision.

2.11.8 Employ Competent Person

Project manager should ensure that competent persons are employed and always available on site in accordance safety requirements. According to OSHA requirements, a competent person is a person “capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures

to eliminate them.” All hazard assessment and inspections on site must be carried out by this person of knowledge and experience. Competent person on site is also essential for the selection of appropriate PPE to use by employees to approve the appropriate types of site traffic control measures and devices. All workers on site should report all unsafe hazards and faulty equipment to the safety manager or supervisor in charge for immediate mitigation measures to be applied.

2.11.9 Safety Meetings and Tool Box Talks

To ensure effective safe working conditions on construction sites, all employees on site should be well inducted and trained, practice the habit of safety meetings and toolbox talks before the start of each day’s activity on site because construction site conditions can change at any period of time, work schedules should be updated regularly and notify workers about the potential hazards involve in their activities.

2.11.10 Site Safety Programme

All road construction projects are different from one work zone to another with specific hazards and challenges to be encountered so it vital for PMs to create different health and safety programmes for each zone for accident prevention. The specific site safety programme to employed should contain information on identification of hazards, mitigation and control management plans, inspection of vehicles, equipment and materials schedules, first aid and emergency plans to prevent accidents and safety and health induction and training for all site workers.

2.11.11 Stay Hydrated

Road construction workers are subject to heat related illness such as sunstroke due to sunrays and asphalt can absorb about 30° F. Therefore, it is important that, road construction workers drink plenty of water and or any drinkable liquids such as coconut water to replace what has lost in the body. PMs should schedule road construction activities in such a manner that, worker can get out of the sun especially on extreme hot situations to avoid dehydration.

2.11.12 Safety tips for road construction workers.

Road construction workers practicing safety culture without the manager's intervention is very difficult task, PMs and other safety managers must first practice and make it a top priority for workers to imitate their steps to build a solid safety culture within the construction organisation. PMs commitment to safety is one of the core principles the firms culture. Kendall Jones (August 9, 2017) developed some strategies PMs can use to improve and build upon safe road construction management safety culture which includes:

1. PMs should make safety their priority: jobsite safety should be placed above everything else: cost, productivity, timelines, etc. your employees are your number one asset, proving to them that, their safety is your top concern on every project instill confidence builds trust.
2. Putting safety first can help reduce cost and improve productivity on the job site. Accidents lead to cost overruns project delays. Improving safety means fewer days lost due to accidents and injuries. A strong safety records can also help reduce insurance cost.

3. Training, properly training your workers is the easiest way to help improve company's safety culture. It shows your workers that you are committed to keep them safe and healthy.
4. Training of workers shouldn't be one off event. Safety training should be a continuous and ongoing effort to help reinforce best practices. Ongoing training will help your workers better retain what they have taught and it keeps safety top of mind.
5. Get your workers involved and invested. Put together a safety committee that includes employees from all levels of your business. They should be involved in reviewing and updating your company's safety program, crafting jobsite-specific safety plans during the preconstruction phase of each project and helping identify potential hazards and safety concerns.
6. Create a corrective action plan with input from employees. Make sure all workers are aware of the plan to ensure that it is properly executed and enforced.
7. Assemble an accident responds team for each job site made up of a few employees who have some basic first aid training. They should know what steps to take in the event an injury occurs to mitigate any hazards and administer first aid to injured workers.
8. Workers who are involved in the process of building and improving your safety culture will feel invested and are more likely to take safety seriously. They are also more likely to communicate their concerns if they feel that their input valued.
9. Hold every one accountable. Everyone who step foot on the job site is responsible for safety, not just your safety managers and those in charge. All

workers should know that unsafe practices put not only them in danger, but around them. Make sure safety rules are clearly defined and explained to everyone on the site and that the consequences for failing to follow the rules will be strictly enforced.

10. You should also empower employees to speak up and report unsafe conditions, near misses or coworkers failing to follow safety protocols. Everyone on site should have the power to order a work stoppage to address and correct any safety issues.
11. Rewards the good and correct the bad. Use incentives to reward workers adhering to safe working practices, attending safety meetings, wearing personal protective equipment (PPE), reporting near misses, making suggestions to improve safety and reporting unsafe conditions or hazards.
12. Be careful about relying on an incentive programme that rewards workers for going so many days without an accident or injury, as it could lead to underreporting. By encouraging and rewarding workers for their proactive approach to safety will result in fewer accidents and injuries.
13. Conduct daily site inspections and safety meetings. All job sites should be inspected before and after each workday to address any safety concerns such as tools left lying around or damaged equipment. Jobsites should also be inspected throughout the day to identify any potential hazards and monitor workers to make sure they are working safely.
14. Hold a brief safety meeting before work begins each day to go over what tasks are scheduled to be performed along with the safety procedures to be followed. Be sure to address any concerns or issues and acknowledge the good practices observed from the prior day.

15. Good or bad, your company has a safety culture, but there's always room for improvement. Having a rock-solid safety culture means making the commitment to put safety first. Instituting programmes and procedures that reinforces that commitment takes time, employee engagement and making adjustments to improve.

2.12 RISK MANAGEMENT CRITERIA

2.12.1 Project Management Approach

Managing risks is a key element of effective project management. A risk is the likelihood of a substance, activity or process to cause harm. A risk can be reduced and the hazards be controlled by good (Hughes and Ferrett, 2001). Risk management is the most essential and difficult aspect of safe road construction project management.

It is the responsibility of the PMs to recognize and identify root causes of the risks and trace these causes through the project to their consequences. Moreover, risk management in the road construction project management context is a comprehensive and systematic way of identifying, analyzing and responding to risks to achieve the project aims and objectives.

A project risk is any uncertain event or condition that, if it occurs, has a positive or negative effect on at least one project objective, such as time, cost, scope or quality, Project Risk Management Participant Guide V1.0, (2009). The use of construction project risk management approach from the early stages of road construction projects, where a lot of major decisions like the selection or choice of specific road construction methods can be influenced is very important. The benefits of the safety road construction risk management approaches include but not limited to identifying and

analyzing risks, and improvement of safe road construction project management methods and effective and efficient use of project resources. (*PMBOK® Guide 6*, 2017) defines Project Risk Management as the process of conducting risk management planning, identification, analysis, response planning, response implementation and monitoring and controlling risk on a project. In safe road construction projects, risk management objectives are to increase the probability and positive impact of the risks and also to reduce the negative impact of risks in order to enhance of effective project success. In order to successfully and safely complete safe road construction project for a specific country requires application of several ad construction project management programmes, tools and project risk management criteria. David et al., (2003) pointed out that, scope, design, cost and schedule management are all regarded as essential for every project. Project risk management and planning are used interchangeably by some PMs to describe a sequence of management and analysis activities which focused on creating a specific project response to reduce risks of new capital facility development. Project Management Institute (PMI) and U.S. Department of Energy as organisations and mission agencies uses similar approaches, slightly different terms to describe their project risk management process. In safe road construction project management, the common set of approaches include but not limited to plan risk management, risk identification, risk assessment, risk analysis, risk mitigation, risk allocation, risk monitoring and control and updating of documents.

According to the PM BOK GUIDE 6, identification of risk is the first and most essential step to project risk management to identify a specific source and types of project risks. This includes the identification of potential risk event situations in the safe road construction project management and risk responsibility clarification. Identifying road construction management risk at the earliest stage of the project

improves the foundation for the subsequent steps, analysis, monitoring and control of safe road construction management. To ensure effectiveness of road construction project risk management, PMs should make sure that, project risks are perfectly identify and well defined. In this context, the identification, analysis and mitigation of road construction project risks are very crucial steps in managing safe road construction projects in Ghana. The PMBOK Guide defines a project risk as an uncertain event or condition that, if it occurs, has a positive or negative effect on at least one of the project objectives”. In road construction projects, a lot of possible risks when occurs could lead to the failure of the project are present and even throughout the life cycle of the project, it essential to know what successful risk factors are simultaneously acting at that particular point. In Ghanaian construction industry, there are numerous project risks which are undesirable events that causes road construction projects delays which includes: mismanagement of project resources, allocation of project funds, shoddy works and unsatisfactory project results.

According to the PM BOK GUIDE 6, 2017, Project Risk Management processes include but not limited to:

Plan Risk Management: The process of defining how to conduct risk management activities for a project.

Identify Risk: The process identifying individual project risks as well as sources of overall project risk and documenting their characteristics.

Risk Assessment: -The process of quantifying the risk events documented in the preceding identification stage.

Perform Qualitative Risk Analysis: -The process of prioritizing individual project risks for further analysis or action by assessing their probability of occurrence and impact as well as other characteristics.

Perform Quantitative Risk Analysis: The process of numerically analyzing the combined effect of identified individual project risks and other sources of uncertainty on overall project objectives.

Plan Risk Response: The process of developing options, selecting strategies and agreeing on actions to overall project risk exposure as well as to treat individual project risks.

Implement Risk Response: The process of implementing agreed upon risk response plan.

Monitor Risk: The process of monitoring the implementation of agreed upon risk response plans, tracking identified risks, identifying and analyzing new risks and evaluating risk process effectiveness throughout the life cycle of the project.

Sources of Risks: Although project risks are interrelated and interdependent, most risks spring from a definite origin. David et al.2003 identified the following as sources of road construction management project risk:

1. Performance, scope, quality, or technology issues
2. Environment, safety, and health concerns
3. Scope, cost, and schedule uncertainty
4. Political concerns

2.12.2 Risk Assessment

In terms of safe road construction project management in Ghanaian construction industry, project qualitative risk assessment will be suitable to recognize some risks whose occurrence is so likely or serious that further quantitative analysis is permitted. The main purpose of quantitative project risk analysis is to put together the identified and assessed risk effects events into overall road construction project risk estimate. The overall risk assessment can be helpful to the Project Managers to make effective and efficient decision about a specific road construction project. PMs can also use this assessment to view road construction projects from the contractor's side for a better understanding of contractor's project risk. Basically, the overall project risk assessment can be used to determine cost and schedule contingency value and quantify the impact of individual high risk events of the project at hand. The final purpose of the quantitative project analysis is the provision of solid foundation for evaluation of the effectiveness of road construction project risk management or allocation of project risk strategies. A lot of approaches, tools and techniques are available for quantitative assessment for safe road construction project risks. Selection of specific approach will depend on the purpose of the analysis for the project.

In safe road construction project management, these criteria will help PMs to select a suitable quantitative project risk technique for their projects and include but not limited to:

1. The methodology should include the explicit knowledge of the project team members about the project site, design, political conditions and project methods.
2. The methodology to be used should permit quick response to changing market factors, price levels and allocation of contractual risk.

3. The selected methodology should help them to determine project cost and schedule contingency.
4. The selected method should be clearly defined, understandable and easy to use.
5. Selected methodology should enhance project communication among the project team members, between the team and higher management and stakeholders about project uncertainties and their impacts.

2.12.3 Safe Road Construction Project Challenges

There are several challenges during the construction phase of road construction projects that have both positive and negative impacts on the projects. PMs must design an appropriate action plans to mitigate the occurrences of these challenges to produce the expected ultimate project results. The following are some of the challenges faced during the construction of safe road projects:

- Maintenance, especially during the rainy season swampy areas;
- Huge compensation to property owners
- Accumulative deteriorating services network due to insufficient allocation of funds.
- Lack of adequate tools and equipment due to available limited funds
- Insufficient and delayance of road infrastructure funds allocated for the project;
- Health and safety policies
- Delays in certificate preparation
- Inadequate own funding allocated for the project
- Restrictions on the bank loans for the project
- Additional road projects without provisions for adequate resources to maintain additional services

- Transportation of materials to project site of competent operators due to inadequate funding
- Transportation of materials to project site

2.12.4 Monitoring and Evaluation Tools and Equipment for Road Projects

Effective project monitoring and evaluation is one major aspect of road construction project life cycle, the SANRAL plays oversight role for overlooking and monitoring the national roads (SANRAL, 2010).

Ghana Highway Authority (GHA) and Urban Roads (UR) also make use of the under listed mechanisms to monitor and evaluate construction and maintenance of road construction projects in Ghana.

Project Cost Management: This mechanism helps GHA and UR to ensure that the road construction and maintenance projects are completed within the approved budget.

Project Risk Management: These mechanisms are used to identify, analyse, prioritize and responds to road construction risk.

Inspection: GHA and UR should inspect every completed road project to access its quality and durability before handed over to the state to ensure accountability, an inspector should also be sent to evaluate the completed project.

A WBS is an effective and efficient mechanism used to monitor and evaluate road construction projects to ensure that, the project is undertaken as planned and will be completed as scheduled.

2.12.5 Risk Factors in a Road Construction Site (RFRCs)

According to the Department of Occupational Safety and Health (DOSH), the road construction safety rules and regulations, effective and efficient safety measures and policies have been usually considered as all means to ensure safety of road construction project employees. Ignorance of the road safety management rules and regulations results in fatal road accidents for road construction workers and end users. It is essential that PMs maintain safety culture and smoothness of traffic flow on every road construction project site for workers and user's safety, they should adopt traffic controller or flagman approach. This approach is essential to be practiced, because it is effective mechanism for accident minimization on road construction project work areas. International Journal of Civil and Environmental Engineering (IJCEE), (vol:2, No:10,2008), has categorized the causes of safety regulations ignorance on road construction work sites into user ignorance and contractor ignorance.

2.12.6 Contractor's Ignorance

According to IJCEE, (VOL. 2, No:10,2008), many road construction project contractors have less experience and don't follow safety rules and regulations during the road project construction phase. The Department of Occupational Safety and Health (DOSH), who established these regulations is responsible authority and that, all information contain in the document is legal requirements for safety of all construction project activities to ensure that, all road construction workers at their work zones and the entire public is safe if only the responsible contractors follow the regulations it contained. Aside this, there are several contractors who often neglect the rules and regulations established by Ministry of works, OSHA and DOSH. Those health and safety agencies have provided all contractors that, at least, 10 minimum alert sign

boards should be placed at vantage points at the road construction project sites for safety purpose and in many occasions, some road construction project contractors take these safety regulations for granted, they don't obey which is contrary to the health and safety rules and regulations. It is therefore essential that, PMs in road construction companies put more emphasis on these safety rules to protect their workers.

2.12.7 Road Users

DOSH statistics indicate that, most of the road users such as drivers are carelessness and their behaviors causes a lot of accidents on road construction project sites. Both the health and safety agencies states that, PMs should employ a flagman to direct road traffic around road construction project site with highly visible deflatable vests to hold frags or Stop and Go signs to alert drivers how they should act through the single lane by pass, but several reckless drivers ignore these instructions which normally results in fatal accidents.

In Ghanaian construction industry as an example, there are numerous problems PMs faced during the road work construction phase on ignorance of road users to follow safety rules, therefore drivers and other road users must comply with these safety rules and regulations for their own safety, follow workers and other road users. All road construction project sites should be categorized into work areas or zones as well as the associated risks for quality health and safety management.

2.13 DOWNFALL OF FLAGMAN

There are some factors affecting the activities of flagmen that makes this proposed approach less reliable as compare to the Intelligent Traffic Lights (ITL) usage which is the best approach to control traffic in zones on road construction sites in Ghana. The

ITL approach system can replace more than one flagman during closures of lanes for safe road construction projects. The ITL is portable traffic control light system which is temporary positioned at vantage point to control the traffic on single lane closure for both long and short durations. The merits for employing the ITL system approach is that, there is cost minimization and the use of human flagman is eliminated to prevent accident occurrences. This approach is very effective and applicable on both private and public funded road construction projects that requires 24-hour road closure traffic control system in different weather conditions. (IJCEE, vol:2, No:10,2008). The table below shows the factors that affecting the usage of ITL system approach and flagman usage.

Table 2.6: shows Comparison Between ITL and Flagman System

FACTORS	ITL SYSTEM	FLAGMAN
Working hours	Unlimited	Limited
Weather conditions	Reliable	Not Reliable
effectiveness	Consistence	Vary
Fatal risk	Low	High
Costing	Low	High

2.14 MERITS AND DEMERITS OF ROAD CONSTRUCTION PROJECTS

Tszmokawa and Hoban (19917) stated that, roads are agents of age and can be responsible for both benefits and damage to the existing balance between people and their environment. Every road construction projects have both metis and demerits and below are some of them:

2.14.1 Merits

1. Effective safe road construction programs such as schedules reduces cost of vehicle and equipment cost.
2. Effective training and induction programmes minimize fatal accidents on road construction sites.
3. Quality road construction projects results in long term savings on rehabilitation of pavements.
4. Effective supervision and management improve productivity.
5. Regular maintenance also increases agricultural production in rural communities for economic growth.

2.14.2 Demerits

1. Aged road contributes to road congestion, traffic congestion becomes burden to drivers and other road users during peak hours.
2. Aged roads also pollute the environment there by reduce socio economic development.
3. Shoddy road projects disturb the natural environment which includes soil erosion, change to stream and rivers directions and positions, animals, underground water etc.
4. Energy vehicles are negatively affected when there is road closure in their project zones.
5. Poor road construction project management projects water and electricity lines to nearby communities, during maintenance which results in shortage of distribution such services.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter of the research study describes the research method to be adopted for the research work. It describes the method to be adopted for selection of the sample size. Data collection method and instrument to employed and how the data would be handled. It also describes the process for sampling the design and development of questionnaire. This chapter also provides steps and activities involved in the data collection. This chapter includes the methodology and plan adopted for the research work. The research is to be conducted and carried out systematically and in stages to achieve the required results and conclusion of respondent rate.

3.1 RESEARCH METHODOLOGY REVIEW

Hussey et al., (1997) pointed out that, some of the writers use the term research methodology and methods interchangeably. These writers revealed that, the term methodology refers to the overall process taken, as well as to the theoretical basis from which the researcher comes, and that is the various means by which data for the study is collected and analyzed (Hussy et al, 1997). Furthermore, Mason, (2006) also separated the methodological strategy from the term method, while noting that, a particular will be a part of the research strategy. In line with these writers, the approach employed here is to include all facets of research process under the overall heading of methodology. Therefore, the method to be used, the research design, the particular data collection method selected and the process of analysis are considered, to be part of the research methodology. And in the subsequent sections, the methodology has been set out. The research plans will determine particular research method to be adopted. Marsh

et al. (2002), stated that, the researcher's stance on the state of nature and knowledge acquired will consider all the research process, theoretic approach to theory and methods. These stances the researcher used are pivoted to his/her research, as they shape process to theory and methods utilized, (Marsh and Furlong,2002)

3.2 RESEARCH DESIGN

Several research approaches to data collection exist including: semi structured interviews, questionnaires and field observation. In this research, design questionnaire and field observation method for collecting data will be adopted. DIKI contractors are considered as the main sources of information as far as this study is concerned. Category DIKI local contractors are more emphasized in terms of Critical Success Factors (CSFs) for safety management of road construction projects in Ghanaian construction industry, because there is a high percentage of low performance among them during road construction processes.

3.3 RESEARCH STRATEGY

Research strategy can be taken to mean the way in which the research objectives are questioned (Bouma et al.1995). They further stated that, there are two main types of research strategies, the qualitative and quantitative research. To decide the specific suitable research strategy is determined by the purpose of the study and the required information available for the research.

3.4 DATA COLLECTION METHOD SELECTION

In research study, every field of study requires specific method for collecting data. Some field of study may require a combination of data collection methods,

(quantitative and qualitative methods) while Only one method may be suitable for others and there are several factors which influence the data collection method to be adopted for each field of studies which include duration of study, availability of resources, availability and location of respondents; because the choice of research method is very essential.

For the purpose of this research, the quantitative research method was adopted and questionnaire survey techniques was used for the data collection. Creswell, (1994) described quantitative research method as an inquiry into human based problem on testing a hypothesis or a theory composed variables, measured with numbers and analyzed with statistical procedures in order to determine whether the hypothesis or theory holds true. Quantitative data is therefore not abstract, they are hard and reliable, they are measurements of tangible, countable, sensible feature of the world, (Bouma et al, 1995). According to Burns et al, (2001), it is structured tools to generate numerical data and uses statistics to interpret, organise represent the collected data.

Questionnaires are more effective and efficient way of collecting field data, since the method permit the researcher to ask questions to which respondents give answers to which objectives are easily to be achieved. It is easier for the researcher to give detailed explanation if the respondents are not clear about any of the survey questions and the administration of questionnaires can be done either personally, telephone, what sap. Internet or mailed to the respondent. This research method, interviews and questions used were precise, brief, straight forward, and unambiguous and to the desire point, demanding exact and straight forward answers. The questions and interviews were short, clear straight to the point and specific.

3.5 DATA COLLECTION APPROACH

Two approaches to data collection are available: - fieldwork (primary data collection) and desk study (secondary data collection), Naoum (2007). Patton, (2002) emphasis that, using more than one data collection instrument strengthens and gives credibility to the study. In this research study, the researcher adopted both primary and secondary data collection approach because of added benefits.

3.6 PRIMARY SOURCE (FIELD SURVEY)

The field survey was conducted in the Western Region of Ghana for primary data collection to determine whether the Project Managers, Engineers, Consultants, Architects, Supervisors, Surveyors and other Managers in construction firms in the region are implementing critical success factors (CFSs) criterial for safe management of road construction projects measures in their field. The primary source of data collection was effective done by informed interaction with Project Managers, Engineers, Consultants, Architects, Supervisors, Surveyors and other Managers and the management team within the context of the available resources.

3.7 SECONDARY SOURCE

The secondary source of data collection (desk survey) for this research study was collected by reviewing existing literature and other available documents.

3.8 DATA COLLECTION INSTRUMENT (QUESTIONNAIRE)

A survey questionnaire is a printed paper designed by the researcher to obtain data collection of information from various respondents from various firms of the subject studied. The interviews and questionnaires information are almost the same, but

questionnaires were preferred to interviews because it is easily to administer and the respondent's names are not required on the completed questionnaires because of time and financial factors. Time consumption is avoided and comparative of questionnaire is possible, because the contents in the questionnaire are the same.

3.9 CONTENT OF QUESTIONNAIRES

The objective of the questionnaire was to design and obtained data from various project managerial team registered with the Bibiani District and Sefwi Wiaoso Municipalities in the Western Region. The questions were based on *Critical Success Factors (CSFs) criterial polices implementation, road design criterial, management measures, management organization, technical and management plan, worker safety behavior, safety environment, worker safety quality and risk management criteria* practices and the challenges facing the implementation of Critical Success Factors (CSFs) criterial polices by various managers in construction industry. The questionnaire was to solicited information on firm's commitment to Critical Success Factors (CSFs) polices and safe management of road construction project in Ghana and the challenges encountered during the implementation of Critical Success Factors (CSFs) criterial polices.

Thirty structured questions were prepared to be administered to the consultancy firms and local contractors within the said Region. They were categorized into three parts.

- 1) Part one consist of general questions to solicit information on the respondent's positions, background of the firms on their commitment to designed Critical Success Factors (CSFs) criterial polices and its effective implementation in safe road construction projects in Ghana.

- 2) Part two solicited data on firm's Critical Success Factors (CSFs) critical measures implemented to ensure safe delivery of road construction projects.
- 3) Part three tries to identify the challenges facing the consultancy and construction firms during the implementation of Critical Success Factors (CSFs) critical policies and safe road construction projects.

3.10 ADMINISTRATION OF THE QUESTIONNAIRES

The researcher designed, developed and administered the questionnaires to construction experts such as project managers, consultants, engineers, construction managers, designers and other prominent personnel as pilot test for category Project Managers, Engineers, Consultants, Architects, Supervisors, Surveyors and other Managers and DIKI contractors within the Western Region of Ghana. Project Management team, consultants and DIKI construction firm's managers were targeted. The questionnaires were fully explained to the respondents to enable accurate and precise data to be achieved. Several measures were considered to ensure effective and efficient rate of response such as shorter questionnaire in both parts.

3.11 RESEARCH POPULATION

Polit et al. (2006) defined a research population as the totality of a well-defined collection of individuals or objects that have a common binding characteristics. This research covers a population of eighty respondents made up of project managers, consultants, construction managers, engineers, and designers from the construction firms in the Western Region of Ghana. The main motive for adopting category of registered construction firm is that, all their project activities are either directly or

indirectly contribute great impact to safe road construction project management of road construction projects executed in Ghana.

3.12 SAMPLING

Bourna et al. (2001) described sampling as a method of selecting a portion of the population to represents total population and the findings from sample represents the rest of the entire group. Polit et al, (2006), burns et al. (2001) also explained that, the selected sample should therefore have similar characteristics to the population under the study to allow generalize ability of the results to represent the entire population. Selecting sample data from a large group of respondent.

3.12.1 Non-Probability Sampling

The sampling method used was Non- probability sampling technique while as the process does not permit individuals equal chances from the population selected. It was selected based on the purpose of study, the required data and the knowledge of the population. The best useful method to be adapted in a situation where the researcher need to arrive to the targeted sampling quickly and where sampling for proportionality is not the main problem is the non-probability sampling. Purposive sampling was used because the researcher's time, money and workforce were limited that made it impossible to used random sampling for this research study.

3.12.2 Criteria for Selecting Respondents

Quota sampling, purposive sampling, snowball sampling, and convenience sampling are all non-probability sampling techniques used in research study. The purposive **sampling** technique was adopted reach category of Project Managers, Engineers,

Consultants, Designers, Supervisors, Surveyors and other Managers of DRCC Ltd, workers of Sefwi Wiaoso Municipality in the Western Region of Ghana purposely for this study.

The data collected from the survey was duly analyzed to determine the average response to each of the structured question, using SPSS and Microsoft excel.

The researcher employed quantitative analysis approach in the data analysis and interpretation. The collected data was summarized in the form of charts and table by the use of weighting and percentages. They were categorized and ranked to each various conclusion to achieve the objective of the study.

3.13 DATA ANALYSIS METHOD

DATA ANALYSIS

The completed questionnaire was carefully edited to ensure that, it is well completed, consistence and readable. The also was checked and arranged in a format to enable easy analysis. Statistical package for social science (SPSS) was adopted because of its user friendly. Mean score statistical technique was employed for the data analysis.

MEAN SCORE

The mean is used as a measure of central tenancy. Hoe (2006) explained that, a high mean relevance rating means that, the factor under consideration is very essential. The following formula was employed to obtain the mean scores for the analysis:

$$u = \frac{\sum_{i=1}^5 = 1 f_i}{\sum_{i=1}^5 = 1 f_i}$$

From the formula, (f) is the frequency of score i for the concerned factor under consideration.

3.14 RESEARCH SUMMARY

The main objective of chapter three was to detail out the research methodology, the sampling selection of the statistical procedures used to analyze the collected data and the procedures employed in data collection instrument design. It also provides an explanation.

CHAPTER FOUR

ANALYSIS AND DISCUSSION

4.1 INTRODUCTION

This chapter presents the summary of the analyzed data. The results are presented based on the objectives of the study, which aimed at identify the most important factors that affect health and safety management performance of road construction projects in Ghana, identify the challenges encountered in the management of health and safety measures on road construction projects sites and to identify worker's behavior towards road construction safety management, contracting firm and consulting firm. Descriptive statistics was the statistical tool employed for the analysis.

Tables, pie charts, and bar charts aided the discussions of the results. 60 questionnaires were retrieved out of 80 distributed. This represents a response rate of 75% which is positive. This was due to persistent follow ups.

4.2 GENERAL INFORMATION OF THE RESPONDENTS

The questionnaire was based on the three main objectives, namely; identification of the most important factors that affect health and safety management performance or road construction projects in Ghana, identify the challenges encountered during the implementation of occupational health and safety management policies and measures on road construction project working areas and identify worker's behavior towards roads construction safety management of road construction projects in Ghana. The main purpose was to provide the targeted respondents an understanding of the study. The respondents profile was to ensure confidentiality in the reliability of the data been collected.

4.3 SOCIO-DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

The main purpose was to provide the targeted respondents an understanding of the study. The respondents profile was to ensure confidentiality in the reliability of the data been collected for this particular study of DRCC Ltd.

4.3.1 Category of respondent

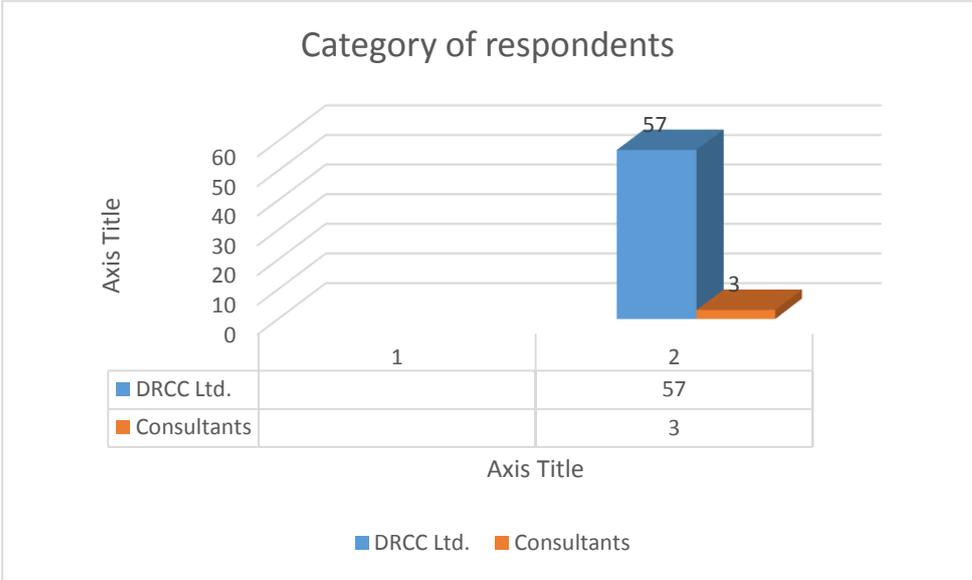
From table below, 57 of the respondents representing 98.2% are with the contracting firm, DRCC Ltd, and the remaining 3 respondents representing 1.8% are with consulting firms which consist of representatives from urban roads and Ghana Highways Authority (GHA). The implication is that majority of respondents for this study are with contracting firms, (DRCC Ltd.).

Table 4.1: The Category of respondent

Statement	Frequency	Percent
Contracting firm	57	78.2
Consulting firm	3	1.8
Total	60	80

The researcher sought to find out that, out of 70 respondents, 57 representing 78.2% came from Contracting firm and 3 representing 1.8% were from Consulting firm. Table 4.1 showed the details.

Figure 4.1: Categories of respondents



4.3.2 Respondent’s Years of Experience

Table 4.2 below shows 5% (3) of the respondents have less than five years of experience, 20% (12) of the respondents have experience between six (6) and ten (10) years. Also 55% (33) of the respondents from the total sample have years of experience between eleven (11) and fifteen (15) years. The rest 20% (12) of the respondents have fifteen (15) years and above of experience. This profile signifies the high levels of experience on which the results of this survey was based. It gives a good indication that the respondents have at least a minimal level of experience with management of road construction projects issue. Moreover, the variety of experience between each group enriched the research with different knowledge and information.

Table 4.2: Respondents Years of Experience

Years in industry	Frequency (f)	Percentage (%)
Less than 5 years	3	5
6-10 years	12	20
11-15 years	33	55
Above 15 years	12	20
Total	60	100

4.3.3 Level of knowledge in quality assurance and control in concrete production

From Table 4.3 below; 4 of the respondents represent 5% have low knowledge, 33 of the respondents representing 41.25% have average knowledge. Furthermore, the remaining 23 of the respondents representing 28.75% have high knowledge. This implies the respondents are well informed on CSFs of safety road construction management projects.

Table 4.3: Level of knowledge in CSFs of safety road construction projects

Staement	Frequency	Percent
Low	4	5
Average	33	41.25
High	23	28.75
Total	60	100.00

4.3.4 Role of Respondent

From Figure below, 3 of the respondents were Project Managers, 6 were engineers, 4 were site managers, 4 are Quantity Surveyors, 3 were consultants, 9 were site supervisors, 4 were designers, 3 were HSE managers and 23 of them were other workers which constitute 60 respondents. This implies the majority of the respondents were staff of DRCC Ltd.

Figure 4.3: The roles of Respondents

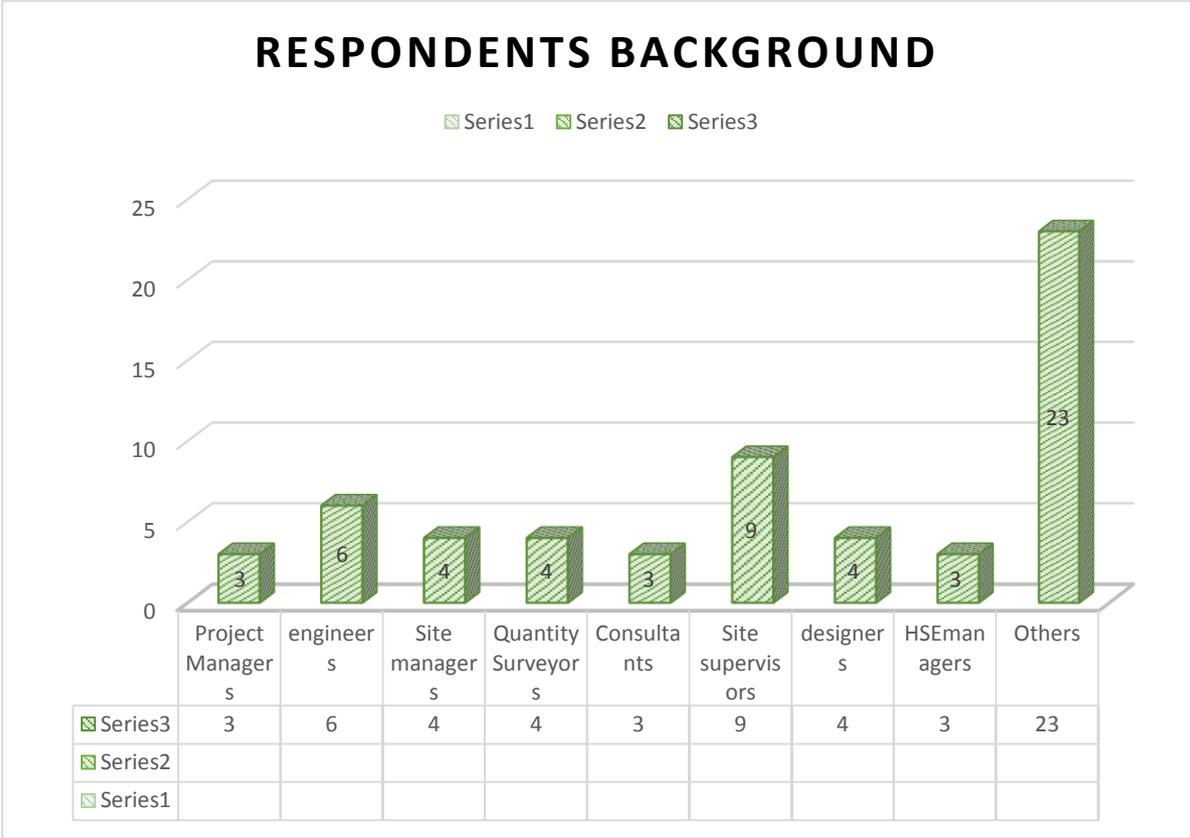


Table 4.4: Challenges of critical success factors (CSFs) for safety road construction management.

No	QUESTION	RESPONDS					Total	Mean	Ranks
		1	2	3	4	5			
1	Make safety the top priority of every firm and be aware of your surroundings	17	16	21	2	5	60	2.4	1 st
2	Incompetence of most of consultants and engineers	16	22	9	6	7	60	2.4	1 st
3	Design criteria deficiencies	16	26	10	6	3	60	2.3	2 nd
4	Effective communication and coordination for employers on site workers	16	21	16	5	2	60	2.3	2 nd
5	Plan and implement risk responses	12	33	10	3	3	60	2.3	2 nd
6	Lack of adequate management and supervision plans	23	20	7	4	7	60	2.3	2 nd
7	Unsatisfactory quality of material ingredients and steel reinforcement	23	15	14	8	1	60	2.2	3 rd
8	Start each workday with a safety meeting	19	18	20	4	0	60	2.2	3 rd
9	Inadequate details for structural members	21	24	10	2	4	60	2.1	4 th
10	Identification of critical behaviors problem and implement a reporting system	20	24	9	3	4	60	2.1	4 th
11	Improper storage of constituent concrete materials for concrete production	18	27	9	4	2	60	2.1	4 th
12	Unqualified personnel by contractors	20	23	12	2	3	60	2.1	4 th
13	Testing of road construction materials quality not carried out where needed	21	21	10	5	3	60	2.1	4 th
14	Worker participation in HSE programme implementation	21	22	12	4	1	60	2.0	5 th
15	Worker's behavior towards road construction	27	20	10	2	2	60	1.9	6 th

5=Strongly disagree 4=Disagree 3=Not sure 2= Agree 1=Strongly agree

Research question one sought to find out the causes of roof ripped-off in Sefwi Asanwineso – Akontommra – Boodi Road Sefwi-Wiaoso. The result from respondents are shown in table 4.4. The average ranking using the 5 point Likert scale shows that majority of the respondents (2.4) strongly agreed that inadequately designed of road formwork. Other factors arranged in order for which they cause challenges for safety road construction management projects in Sefwi Asanwineso-Akontommra-Boodi Road Sefwi-Wiaoso were design errors (4:43); plan and implement risk responses (2.3), lack of adequate management and supervision plans (2.3). However, the respondents were not sure whether workers' behavior towards road construction safety management plans implementation (1.9), causes challenges to road construction management projects. The results are in line with literature because according to Hughes & According to Hughes and Ferret (2008), health and safety is an essential aspect of employment duties in construction industries. Again, Hughes and Ferret, (2013) also indicated that, the protection of bodies and minds of people from injuries resulting from site activities such as Provision of Personnel Protective Equipment (PPEs) and ware fare for road construction site workers is very important for good health conditions. Provision of health and safety to the employees at the workplace has a motivational dimension as well (Osuala, 2005).

Holt (2005), stated that, non-compliance to occupational health and safety management practices may result to series of accidents on site. According to Concha – Barrientos et al, (2004), people at work face a variety of hazards due to biological agents, chemicals, physical factors, adverse ergonomic conditions, allergies, a complex network of safety risk and other factors, Marmot and Wilkinson (2006, p.1653) also stated that, the working environment and the nature of work itself are both important influences on health. Road construction project site accidents can have major negative effect on the

mental health workers and others who are present during the incidents including trespassers and visitors. Health and safety of workers at construction site cost more to the individual workers, their families, employers and the entire country, if not properly managed. According to Abdul-Rashid, et al. (2007), the interest in occupational health and safety management practices among construction companies has greatly increased in the past decade. Sawacha, et al. (1999), also stated that in the building and civil construction industry, the fatality risk are five times more likely than any other manufacturing industry, while the risk of a major injuries is two and a half times higher. Health and safety management is an area which deals with the protection of workers regarding their health, safety and welfare to increase production, improve individual health and reduce cost. For this reason, health and safety management practices have been initiated to enhance a safe working environment within building and civil engineering construction industry.

It is the responsibility of health and safety officers and managers of road construction projects to make sure that, the associated risks to health and safety of every employee is effectively managed and controlled at the project site. The hazards are not, however, restricted to those workers on sites. Some trespassers such as children and other of the public are also killed or injured because of the fact that construction activities have not been adequately planned, managed and controlled. According to *Hughes and Ferret* (2008), health and safety is an essential aspect of employment duties in construction industries.

Even though, Ghana as a nation don't have specific health and safety policy regarding construction industry, but the Ghana Labour Act 2003, (Act 651) section 119 to section 120 put an emphasis on health and safety practices in Ghana building and civil

engineering industries and its designed to improve safety performance conditions and the Workmen's Compensation Law (PNDCL 187) is also designed to compensate workers for on-the-job injuries if health and safety management practice rules and regulations are not employed on building and civil engineering industry including road construction projects.

Road construction projects, especially large ones, are complex and dynamic thus the need for good practices of health and safety (ILO Encyclopedia of occupational health and hazard construction industry, 2011).

According to *Hughes and Ferret* (2013) also indicated that, the protection of bodies and minds of people from injuries resulting from site activities such as Provision of Personnel Protective Equipment (PPEs) and ware fare for road construction site workers is very important for good health conditions. Provision of health and safety to the employees at the workplace has a motivational dimension as well (Osuala, 2005).

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Table 4.5: Effects of challenges of critical success factors (CSFs) for safety road construction

No	QUESTION	RESPONDS							Ranks
		1	2	3	4	5	Total	Mean	
1	Poor quality of finished works	17	21	12	5	6	60	2.42	1 st
2	Reduction in strength of structures	20	16	13	8	4	60	2.38	2 nd
3	Difficulty in replacing defects	20	17	13	6	5	60	2.37	3 rd
4	Frequency delay in project	17	23	11	7	3	60	2.32	4 th
5	Inadequate supply of project resources	19	20	13	7	2	60	2.27	5 th
6	Loss of confidence in managers, supervisors and contractors	20	22	9	5	4	60	2.18	6 th
7	Difficulty in maintaining facility after completion	24	19	10	2	6	60	2.17	7 th
8	Financial loss	17	26	14	2	2	60	2.15	8 th
9	Potential hazard of steel corrosion	21	20	11	4	4	60	2.15	8 th
10	Increase in the risk of making mistakes	20	25	7	5	3	60	2.1	9 th

5=Strongly agree 4=Agree 3=Not sure 2= Disagree 1=Strongly disagree

Research question two sought to find out the effects of challenges of critical success factors (CSFs) for safety road construction management project has on its occupants the Sefwi Asanwineso – Akontommra – Boodi Road Sefwi-Wiaoso. The results from the respondents are shown in table 4.5. The average ranking from the acceptable scale shows that majority of the respondents (2.42) were not sure that poor quality of finished works on the safety road construction management project. Other effects of challenges of critical success factors (CSFs) for safety road construction management projects are arranged in order for which they affect the road construction management projects, reduction in strength of structures (2.38), difficulty in replacing defects (2.37) frequency delay in project (2.32). All these show that the respondents were very severe that these are the effects of challenges of critical success factors (CSFs) for safety road construction management projects. However, the respondents were not severe that, increase in the risk of making mistakes and potential hazard of steel, financial loss are for safety road construction management projects in Sefwi Asanwineso – Akontommra – Boodi Road Sefwi-Wiaoso. From the majority point of view, their results coincide with the findings of, (Hughes and Ferrett, 2001). Risk management is the most essential and difficult aspect of safe road construction project management. It is the responsibility of the Project Manager (PM) must be able to recognize and identify the root causes of risks and to trace these causes through the project to their consequences. Moreover, risk management in the road construction project management context is a comprehensive and systematic way of identifying, analyzing and responding to risks to achieve the project objectives.

A project risk is any uncertain event or condition that, if it occurs, has a positive or negative effect on at least one project objective, such as time, cost, scope or quality, Project Risk Management Participant Guide V1.0, (2009). The use of risk management

from the early stages of a project, where major decisions such as choice of alignment and selection of construction methods can be influenced, is essential. The benefits of the risk management process include identifying and analyzing risks, and improvement of construction project management processes and effective use of resources. (*PMBOK® Guide 6, 2017*) defines Project Risk Management as the processes of conducting risk management planning, identification, analysis, response planning, response implementation, and monitoring risk on a project. The objectives of project risk management are to increase the probability and/or impact of positive risks and to decrease the probability and/or impact of negative risks, in order to optimize the chances of project success.

Table 4.6: Strategies to have effective critical success factors (CSFs) for safety road construction management

No	QUESTION	RESPONDS							Ranks
		1	2	3	4	5	Total	Mean	
1	Adequate details for structural members	3	4	7	23	24	60	4.1	1 st
2	Implements an action programme and Plan	4	1	13	23	20	60	4.0	2 nd
3	Make safety the top priority of every firm and be are of your surroundings	3	6	11	14	27	60	4.0	2 nd
4	Qualified engineers and consultants should be employed	3	5	13	20	20	60	3.9	3 rd
5	Properly control traffic	2	7	13	14	25	60	3.9	3 rd
6	There should be road and lane closure during road construction	2	8	11	19	21	60	3.9	3 rd
7	Develop an action plan for safe road construction project	2	7	8	26	18	60	3.9	3 rd
8	National standards should be developed and adapted	3	4	13	20	21	60	3.9	3 rd
9	There should be adequate management and supervision system	3	3	13	28	14	60	3.8	4 th
10	Project managers should manage the risk of injury from road construction projects activities	3	7	14	24	13	60	3.7	5 th
11	Design and construction works should be carried out by registered firms	6	5	9	29	12	60	3.7	5 th
12	Contractors should use proper equipment and tools	9	3	8	25	16	60	3.7	5 th
13	Project managers should create separate work areas	6	8	9	25	13	60	3.6	6 th
14	Professional training of technical personnel should be intensified	7	8	6	23	17	60	3.6	6 th
15	Improve management system to reduce injury and ill health	4	8	13	31	5	60	3.5	7 th

5=Strongly agree 4=Agree 3=Not sure 2= Disagree 1=Strongly disagree

Research question three sought to find out the strategies to have effective critical success factors (CSFs) for safety road construction management in Sefwi Asanwineso – Akontommra – Boodi Road Sefwi-Wiaoso. The results from respondents are shown in table 4.6. The average ranking from the acceptable scale shows that majority of the respondents (4.1) strongly agreed that adequate details for structural members are major of the safety road construction management. Other strategies are arranged in order of ranking remedy to strategies to have effective critical success factors for safety road construction management; implement an action programme and plan, (4.0), make safety the top priority of every firm and be aware of your surroundings (4.0), national standards should be developed and adapted (3.9), frame work should be design adequately (3.9), properly control traffic (3.5). All these show that the respondents agreed that these are some strategies, to have effective critical success factors (CSFs) for safety road construction management projects. DeWitt (1999) describes constructability analysis (also called constructability review) as a process that utilizes experienced construction personnel with extensive construction knowledge early in the design stages of projects to ensure that the projects are buildable, while also being cost effective, biddable, and maintainable and coordination. Constructability is the act of determining the type of structural system based on the anticipated start of construction or providing the knowledge and experience to plan, design, procure, and execute the most cost-effective, highest-quality overall project objective. (Levy, 2007). However, as Clough and Sears (1994) point out, it has become customary to include the bidding and contract documents together with the technical specifications, the entire aggregation being variously referred to as the project manual, project handbook, construction documents book, or most commonly, simply as the specifications or 'specs'. One essential document in the project manual is the general conditions.

The *general conditions*, sometimes called the *general provisions*, set forth the rights and responsibilities of the owner and contractor and also of the surety bond provider, the authority and responsibility of the design professional and the requirements governing the various parties' business and legal relationships.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.0 INTRODUCTION

This chapter of the research thesis work examines the conclusion and recommendation. It first outlines the conclusion of the challenges the Project Managers are facing during the implementation CSFs and its effect in the civil engineering industry and recommend effective and appropriate measures to be adopted to overcome these difficulties.

5.1 CONCLUSION

The aim of this research work is to conduct an in-depth study to exploit the Critical Success Factors (CSFs) for safety management of road construction projects in Ghana, by civil engineering contractors, a case study of Desicom Road Construction Company (DRCC) Ltd. in construction industry through the application of appropriate CSFs and safety management measures and plans to minimize accidents occurrences in the civil engineering road construction projects in Ghana.

To accomplish this aim, a number of objectives which were being guided by research questions were set. In this chapter, the research questions and the objectives are used to bring into light the extent to which the objective of the study has been achieved throughout the various phases of the study. The chapter also presents recommendations of the researcher based on the findings of the study and states the difficulties that were encountered throughout the study, and recommendations are made for further studies.

5.2 REVIEW OF OBJECTIVES

The first objective was to identify the most important factors that affect health and safety management performance of road construction projects in Ghana. This objective was achieved by undertaking an extensive review on DRCC Ltd. commitment to CSFs for safety management in the delivery of safety road construction projects in the Sefwi Wiaoso Municipality in the Western Region of Ghana.

The second objective was to identify the challenges encountered in the management of health and safety measures on road construction projects sites. The literature revealed various challenges encountered by DRCC Ltd. while implementing CSFs for employee's safety during the execution of safety road construction projects. It revealed that most of the employees of DRCC Ltd, lack an attitude towards commitment to CSFs and safety measures, which has been the major source of problems to the development of the civil engineering construction industry in Ghana.

The third objective was to identify worker's behavior towards road construction safety management encountered by DRCC Ltd., category D1K1 contractor while implementing CSFs management during the execution of safety road construction projects. In achieving these, questionnaires were administered to Project Managers, engineers, designers, quantity surveyors, construction managers, supervisors and other employees of DRCC Ltd. working on Sefwi Asanwineso-Boodi-Akontommra road project. This was also achieved through literature review. This was also achieved through literature review and also, proposed appropriate measures for the implementation of CSFs of safety road construction Management in safety road construction projects in Ghana.

5.3 SUMMARY OF FOUNDINGS

This research revealed the summary of findings by the survey and are presented below:

To achieve safe road construction project, the research study revealed that, CSFs of safety road construction management was the main procedures to be adopted for this effect. The findings are therefore consistent with the U.S. Army Corps of Engineers (2004) definition of construction quality management that emphasizes on time delivery of projects and meeting of quality standards.

5.3.1 Indicators for CSFs Management in DRCC Ltd Organization:

On indicators or measures for safety in the organization, the research revealed that getting more jobs as a result of previous good works done, management commitment to CSFs measures and safety management road construction projects, overall client or customer satisfaction and adherence to certified quality and safety programs such as the ISO 9000 and 14000 series were deemed to be the best measure or indicator of CSFs of safety road construction management project in the survey was confirmed by the DRCC Ltd contacted for this study.

5.3.2 Challenges Encountered During CSFs policies Management Implementation:

The research study revealed that challenges encountered during implementation CSFs and safety measures include drawing an effective CSFs criterial, road safety management plan and effective induction and toolbox talks management programming. It further reveal that, these challenges occur during and after the execution of the road construction projects in the civil engineering industry. Moreover, the research also indicated that, the following as the potential barriers to the attainment of safe road construction project among DRCC Ltd, lack of adequate management and supervision

plans, worker's behavior towards road construction safety management plans implementation, inadequate classification of hazardous substances and their associated health risks, difficult in adhering to CSFs policies in road construction projects and lack of effective communication and coordination for employers on multiemployer worksites and management commitment towards CSFs policies in road construction projects.

5.3.3 Implementing CSFs measures and safety Management Policies Among DRCC Ltd.

In other to implement CSFs measures and safety management policies among DRCC Ltd, the study indicated that, the company's implementation of CSFs measures and safety policies are driven by technology and client satisfaction. However, in terms of adopting strategies, the research survey further indicated that, DRCC Ltd. achieved better result in safety road construction projects, there by promoting health and safety of its employees, value for money and promote good quality projects and records.

5.3.4 CSFs policies and safety measures Management Techniques implemented in an attempt to achieve Project the research Objectives:

It is very essential to note that, to achieve safe road construction project, there should be effective and efficient implementation of CSFs policies and safety measure techniques in the road construction project management. The study revealed that, manage the risk of injury from road construction projects activities, adequate details for structural members effective and efficient communication, developing an action plan for safe road construction project, properly control traffic, effective supervision and

management and training programmes are the effective and better techniques to be implemented by DRCC Ltd. is an attempt to achieve the project objectives.

5.4 RECOMMENDATIONS AND POLICY IMPLICATIONS

The main objective of this study was to identify CSFs of safety road construction management project in Ghana with emphases on D1 K1, DRCC Ltd. Contractor, working on Asanwineso-Boodi-Akontommra road construction project in the Sefwi Wiaoso Municipality. In view of the findings of this research, the following CSFs criteria, safety measures and strategies are therefore recommended for the implementation of CSFs for safety management of road construction projects in the Ghanaian construction industry especially, road construction projects.

In view of the findings of this research, the following recommendations are therefore prescribed as measures and strategies for the identification of CSFs for safety management of road construction projects in the Ghanaian construction industry:

- Civil engineering construction companies such as DRCC Ltd. should create the flexible and conducive organizational atmosphere which encourages the development of CSFs of safety management implementation in all aspect of the road construction projects.
- PMs of the various construction firms should be encouraged to used health and safety management techniques in the execution of road construction projects in Ghana.
- Encouraging the integration of project management practices in the early stage of the project and ensuring safety system are well implemented at the initial stage of every road construction project.

- All road construction companies should employ PMs as part of their integrated teams in the management of their road construction projects.
- Construction firm should institute training, induction and toolbox talks procedures or refresher courses in safe construction management projects as part of their annual plan for their employees.
- Professional institutions in the built environment such Ghana Institution of Surveyors (GHIS), Institution of Engineering and Technology, Ghana (IET, GH) and Ghana Institution of Construction (GIOC) should award scheme for the best road construction firm which adhere to CSFs policies and safety measures implementation as a way of encouraging construction firms to use CSFs and safety management techniques.
- All project managers should make safety the top priority of every firm and be aware of your surroundings to improve management systems to reduce injuries and ill health
- Design and construction works should be carried out by qualified engineers and consultants
- There should be fragmen,Road and Lane Closure during road prject construction phase.
- Project Managers should manage the risk of injury from road construction projects activities and should Create Separate Work Areas.

5.5 FURTHER RESEARCH

There are various research avenues in future as a result of this study. The following are therefore recommended for further research:

- Research into the impact of CSFs of safety road construction project management implementation in the Ghanaian civil engineering construction industry.
- Future research into the framework for predicting the failure and success of CSFs safety management road of construction project innovation in the Ghanaian civil engineering construction industry.

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APPENDIX

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF CONSTRUCTION TECHNOLOGY AND MANAGEMENT
QUESTIONNAIRE

TOPIC: CRITICAL SUCCESS FACTORS FOR SAFETY MANAGEMENT OF ROAD CONSTRUCTION PROJECTS IN GHANA

I am a final year MSc. Project Management student of the Kwame Nkrumah University of Science and Technology (KNUST), School of Built Environment, Department of Building Technology conducting a research On Critical Success Factors for Safety Management of Road Construction Projects in Ghana. The aim of this research is to:

1. identify the most important factors that affect health and safety management performance of road construction projects in Ghana.
2. identify the challenges encountered in the management of health and safety measures on road construction projects sites.
3. identify worker's behavior towards road construction safety management.
4. Evaluate the enforcement of appropriate mechanisms and measures to ensure the success of health and safety management on road construction projects sites.

This is purely for academic purposes and all information will be treated with strict confidentiality. Your response would be highly appreciated for the success of the research. Kindly respond to the question by ticking the appropriate box for each item.

Thank you.

PART ONE: RESPONDENT PROFILE

1. Which of the following categories do you belong to?
 - Contracting firm
 - Consulting firm

2. How many years of experience do you have as a construction professional?
 - Less than 5 years
 - 6-10 years
 - 11-15 years
 - Above 15 years

3. How would you assess your knowledge in Critical Success Factors (CSFs) for Safety Management of Road Construction Projects in Ghana?
 - Low
 - Average
 - High

4. What is your current position in the firm?

<input type="checkbox"/> Project Manager	<input type="checkbox"/> Engineer
<input type="checkbox"/> Site Manager	<input type="checkbox"/> Quantity Surveyor
<input type="checkbox"/> Designer	<input type="checkbox"/> HSE Manager
<input type="checkbox"/> Consultant	<input type="checkbox"/> Supervisor
<input type="checkbox"/> Others	

PART TWO: CHALLENGES OF CRITICAL SUCCESS FACTORS (CSFs) FOR SAFETY ROAD CONSTRUCTION MANAGEMENT PROJECTS IN GHANA

Please indicate the level of severity of the following challenges of critical success factors (CSFs) for safety road construction management projects in Ghana

5=Strongly agree 4=Agree 3=Not sure 2= Disagree 1=Strongly disagree. Please tick (√) in the space provided.

SN	CHALLENGES	1	2	3	4	5
1.	Design criteria deficiencies					
2.	Unsatisfactory quality of material ingredients and steel reinforcement					
3.	Plan and Implement Risk Responses					
4.	Lack of adequate management and supervision plans					
5.	Inadequate details for structural members					
6.	Inadequately designed of road formwork					
7.	Worker's behavior towards road construction safety management plans implementation.					
8.	Identification of critical behaviors problem and implement a reporting system					
9.	Start each workday with a safety meeting					
10.	Worker participation in HSE programme implementation					
11.	Communication and coordination for employers on multiemployer worksites					
12.	Testing of road construction materials quality not carried out where needed					
13.	Incompetence of most of Consultants and Engineers					
14.	Unqualified personnel by contractors					
15.	Improper storage of constituent concrete materials for concrete production					
16.	<i>Any other please state and rank</i>					

PART THREE: EFFECTS OF CHALLENGES OF CRITICAL SUCCESS FACTORS (CSFs) FOR SAFETY ROAD CONSTRUCTION MANAGEMENT PROJECTS IN GHANA

Please indicate the level of severity of the following effects of challenges of critical success factors (CSFs) for safety road construction management projects in Ghana

5=Strongly agree 4=Agree 3=Not sure 2= Disagree 1=Strongly disagree. Please tick (√) in the space provided.

SN	EFFECTS	1	2	3	4	5
1	Frequent delay in project					
2	Financial loss					
3	Loss of confidence in managers, supervisors and contractors					
4	Reduction in strength of structures					
5	Difficulty in replacing defects					
6	Poor quality of finished works					
7	Potential hazard of steel corrosion					
8	Difficulty in maintaining facility after completion					
9	Increase in the risk of making mistakes					
10	Inadequate supply of project resources					
	<i>Any other please state and rank</i>					

PART FOUR: STRATEGIES TO HAVE EFFECTIVE CRITICAL SUCCESS FACTORS (CSFs) FOR SAFETY ROAD CONSTRUCTION MANAGEMENT PROJECTS IN GHANA

Please indicate the level of importance of the following strategies of having effective critical success factors (CSFs) for safety road construction management projects in Ghana

5=Strongly agree 4=Agree 3=Not sure 2= Disagree 1=Strongly disagree. Please tick (✓) in the space provided.

SN	STRATEGIES	1	2	3	4	5
1	Contractors should use proper equipment and tools					
2	Professional training of technical personnel should be intensified					
3	Project Managers should manage the risk of injury from road construction projects activities					
4	National standards should be developed and adapted					
5	Qualified engineers and consultants should be employed					
6	Implement an action programme and plan					
7	Design and construction works should be carried out by registered firms					
8	There should be Road and Lane Closure during road construction					
9	There should be adequate management and supervision system					
10	Adequate details for structural members					
11	Formwork should be designed adequately					
12	Develop an action plan for safe road construction project					
13	Properly Control Traffic					
14	Improve management systems to reduce injuries and ill health					
15	Project Managers should Create Separate Work Areas					
16	Make safety the top priority of every firm and be aware of your surroundings					
	<i>Any other please state and rank</i>					

Thank you