STRATEGIES FOR REDUCING REWORKS IN BUILDING CONSTRUCTION PROJECTS IN GHANA

By

Johnson Oteng Ampofo

(BSc Quantity Surveying and Construction Economics)

A Thesis submitted to the School of Graduate studies and Department of Construction Technology and Management, Kwame Nkrumah University of Science and Technology, Kumasi in partial fulfilment of the requirement for the award degree of

MASTER OF SCIENCE IN CONSTRUCTION MANAGEMENT

November, 2019

DECLARATION

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma at Kwame Nkrumah University of Science and Technology, Kumasi or any other educational institution, except where due acknowledgment is made in the thesis.

…… ……..…… ……..

Name of student and ID **Signature** **Date**

Certified by:

…… ……..…… ……..

Name of supervisor **Signature** **Date**

Certified by:

…… ……..…… ……..

Name of Head of Department **Signature** **Date**

ABSTRACT

Rework is defined as the unnecessary effort of redoing an activity that was inaccurately done the first time. In essence, rework and wastages have become recognized as non-value adding endemic symptoms that seriously affect the performance and productivity aspects of construction projects. The aim of this research was to assess strategies to reduce reworks in building construction projects. In order to achieve the aim, the following objectives were set: to evaluate the causes of reworks in building construction projects; to assess the effects of reworks building construction projects; and to assess strategies to reduce reworks building construction projects. A critical review of literature was conducted. The quantitative research strategy was adopted. Questionnaires were used to gather data from contractors as well as consultants in Kumasi metropolis. Purposive sampling technique was adopted. Statistical Package for Social Sciences (SPSS) software was used for the analysis. Descriptive statistics, mean score ranking, one sample t-test and Cronbach Alpha were the analytical tools. From the findings, Non-compliance with specification; Failure to implement Quality management practices; Poor scheduling of construction resources; Poor monitoring and control; Ineffective communication were the severest causes of reworks building construction projects. Wastage of resources; Monetary loss due to the delay of work; Results in human health hazard or equipment failure; Cost overrun; Late site hand over were the significant effects of reworks building construction projects. Effective planning and scheduling; Teamwork effectiveness; Strong qualified supervision; Qualified Contractor; Effective Communication were the significant strategies to reduce reworks building construction projects. It is recommended that employees should be given proper training so that the errors are minimised.

Keywords: rework, building, construction, strategies

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

My first and highest gratitude and thanks goes to God Almighty for His grace to do this masters and project work. I am greatly indebted to my research supervisor Mr. Joe Kingsley Hackman for his critiques, comments and help during and after the writing of this thesis. I am also thankful to his Graduate Assistant Miss Godslove Ampratwum for guiding me to do a successful thesis.

I express my profound gratitude to all my lecturers and colleagues at the Department of Construction Technology Management especially Dr. Ernest Kissi. I would also thank the following, Nana Afena Nketia, (Twafohene of Techiman Traditional Council), Madam Elizabeth Dwamena and all respondents of my questionnaires for their cooperation in spite of their busy working schedules.

DEDICATION

I dedicate this piece of work to Almighty God for his mercies. This project is also dedicated to my wife (Florence Yeboah) and children.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

The construction sector has difficult situations to deal with such as cost overruns in the final execution of construction works. Issues of financial problems and on the part of industry players not meeting the demands of their clients within the specified duration (Simpeh 2012, Sinha and Wayal 2007). This led the comprehensive and extensive criticism of the industry for its meagre performance and its inept productivity. Rework is a fundamental cause to this problem (Fayek *et al.,* 2003; Alwi *et al.,* 2001; Love *et al.,* 1999).

The needless endeavour of repeating an activity that was not performed as expected is defined as rework (Love 2002). In the construction of projects, rework and wastages are noticed as worthless adding endemic symptoms that have dire effect on the performance and productivity sectors (Alwi *et al*., 2002; Josephson *et al.,* 2002). Waste minimization happens to be a core problem that has to deal with, where rework directly is a main factor leading to these waste. This ought to be under checks (Fayek *et al.,* 2003; Alwi *et al.,* 2001; Love *et al.,* 1999).

The act of repeating an activity in order to attain the specified objectives is known as rework, this brings about the usage of extra resources like labour, materials, and facilities exceeding the amount that would have been used if the activity had not been repeated (Simpeh, 2012). According to Love and Sing (2013) undertakings in the field, which have been finished, but were expected to be redone because of some hindering rectification that was relevant to be performed during the project is termed as rework.

Without considering the source, or undertaking an alteration, not because of the owner's alteration of the scope (Elchaig *et al.,* 2005). The failure of a building element to meet the expectation of customer, or in the event that works finished are inconsistent with the contract documents, rework becomes necessary (Alwi *et al*., 2002; Josephson *et al.,* 2002). The occurrence of either happenings leads to the modification of the object to ensure consistency. Rework would be undertaken in at a particular point in the process of construction if for instance an error occurs. Contrary, identifying a rework is tedious until quality control checks are carried out. According to Love (2002) rework can have internal or external origins.

1.2 PROBLEM STATEMENT

During construction, industry players may experience the following, omissions, errors and alterations frequently which may account for rework at different phases of the construction (Wasfy, 2010). Research has revealed that, in many countries across the globe, rework often lead to increase in cost of diverse works ranging from 3% to 30%, mostly delaying works and increase in the demand for more time to complete the project between 10% to 77%. Moreover, rework frustrate both client and contractor (Wasfy, 2010).

In construction activities, besides overruns in the schedule and cost (Hwang *et al.,* 2009; Josephson *et al.*, 2002), there is the potential risk with regard to quality and safety as a result of rework (Love, 2002). Existing studies have measured the effect of rework on a project in terms of cost, and in addition have delved much into categorising and measuring the causes of rework (Fayek *et al.,* 2004).

The adversative presented by rework constitute the following; decrease in profit, reduced of market shares, injuring of workers, bad reputation, management and employees

turnover increase, low output, increase in cost, high cost of litigation among parties over duty of overruns and delays (Love and Irani, 2002). Rework has a negative impact on a company's reputation and the capacity to attract new clients going at the long run. Rework however is an innate difficulty as little is known about its background. Failure to address the root cause of rework is still a global phenomenon.

In Ghana too, few studies have been conducted on reworks in the construction industry. This study seeks to fill this gap.

1.3 RESEARCH AIM AND OBJECTIVES

1.3.1 Research Aim

This study intends to explore strategies to reduce reworks in the construction industry.

1.3.2 Research Objectives

In a pursuit to accomplish the aim, the following objectives have been considered:

- To evaluate the causes of reworks in building construction projects;
- To assess the effects of reworks in building construction projects; and
- To assess strategies to reduce reworks in building construction projects.

1.4 RESEARCH QUESTIONS

- What are the causes of reworks in building construction projects?
- What are the effects of reworks in building construction projects?
- What are the strategies to reduce reworks in building construction projects?

1.5 SCOPE OF STUDY

The geographical scope of this study was the Kumasi metropolis in the Ashanti region of Ghana. The contextual scope consisted of D1K1 construction firms and project

management consultants in charge of GETFUND educational projects. Kumasi metropolis abounds with many construction activities and its related building activities. It was also chosen because of its proximity to the researcher.

1.6 METHODOLOGY

Research methodology deals with methods and techniques used in undertaking a study (Kothari, 2004). The discussion here bordered on issues such as research design, population and sampling technique, research data sources, data collection instrument and how the data gathered were analysed. Descriptive research design was adopted for the study. This approach measured parameters and examine their effect through statistical analysis. This study was exploratory in nature. Thus, survey method was used in eliciting necessary data for the research. This study made use of the deductive approach. This research approach is used when there already exist theories on the tpic under consideration. In this research approach, it starts with generalizing issues and narrowing it down towards specific issues (Trochim, 2006).

Secondary information was obtained through a review of in-depth literature (journal articles, conferences papers, dissertations, reports, newspapers etc) on stakeholder engagement and project management. The identified variables were strategically compounded into close-ended questionnaires which wereself-administered to D1K1 contractors and consultants. he retrieved questionnaires were analysed using Microsoft Excel 2016 and Statistical Packages for Social Sciences (SPSS) windows version 21. Respondents were asked to rate each variable on a Likert scale. The sample size for the study was determined using the Kish formula. Quantitative method was specifically analysed using descriptive analysis, one sample t-test and Mean Score Ranking. The reliability of the scale was checked by using the Cronbach Alpha Coefficient test.

1.7 SIGNIFICANCE OF THE STUDY

It is in anticipation that the findings from this study would be beneficial to the construction sector as it will serve as a reminder of the effects of reworks in construction works. The findings of this study will identify ways of addressing and minimizing reworks. Furthermore, the Government of Ghana will be one of the vital beneficiaries of this study. In addition, it is in anticipation that, this study is going to add up to existing knowledge on the topic and subsequently spur researchers to perform further studies on reworks in the construction industry.

1.8 LIMITATIONS

Similar to any other research conducted, this research faced unavoidable limitations. Some of the limitations encountered in this study included getting access to data, human errors in the analytical performance of data collected, insufficient finances, and a very limited duration for the conduct of the study. However, it is in anticipation that recommendations to be proposed from the study for future research would be done based on these limitations

1.9 ORGANIZATION OF STUDY

The study comprised five (5) independent but related chapters. Chapter one entailed the general introduction and background to the study. The problem has been analysed and need for research has been justified. The research aim, objectives and scope has been presented, and the research questions spelt out. Chapter two discussed the review of relevant literature with regard to the study. The chapter provided literature based on information provided by other renowned researchers, identify the gaps in the literature that the research seeks to address and also draw conclusion on what was found in relation to the area of study. Chapter three embodied the methodology of the research: how you

would go about the research, the approach that would be adopted, the tools for analysis, and how the sample size was obtained. Chapter four provided an in- depth analysis of all the data collected for the study in relation to the research objectives and questions mentioned in chapter one. Chapter five presented the summary of the research findings, recommendations, conclusion and suggestions for further research on the topic.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

The previous chapter entailed the general introduction of the study. This chapter presents a comprehensive review of pertinent literature related to reworks in the construction. The chapter starts with an overview of the construction industry. Conceptual review of reworks is undertaken while empirical review of causes of reworks, effects of reworks and strategies to reduce reworks is reviewed. Finally, a theoretical review was undertaken.

2.2 CONSTRUCTION INDUSTRY

The construction industry is a very significant industry. According to Tonnquist (2010), a project is a temporary endeavour with clearly defined goals and specific target. Projects have a clearly spelt out starting and finishing points and are restricted by budgets.

Projects are normally apportioned into phases and stages as well as defined milestones to mark the beginning and ending of phases. These phases are useful in making it more convenient to get a better structured work and also to have focus on the most important tasks (Koskela and Howell, 2008). A research carried out by Project Management Institute (PMI) (2008) posited that project risk management is one of the areas out of the nine areas that is crucial for the success of a project. Each and every project has its inherent risks as soon as it starts and the role of the project manager is important in determining the success or failure of the project (Ashleigh, 2012). A study by Jha (2013) established that the major task of a project manager is seen in the pre contract and pre construction stage where a lot of planning takes place. At these stages, the project manager is involved in responsibilities such as: preparing the preliminary schedule for

construction works, drawing a schedule to develiered in time according to client's specifications, delineation of project requirements, allocating of new resources, review planning as well as setting goals (Lianying *et al.,* 2012). Contrasting views were however presented by Hopp and Spearman (2011) as well as Burdge and Robertson (2009) who posited that the major role of project managers is in admistering projects. In this instance, project manager has the responsibility of managing project client, communicating issues, co-ordination of activities and managing of information flows. Egan (2012) proposed that the major role of a project manager is to make acquisitions that are needed for the construction project which includes consistently refining scope of project, identifying items that due for delivery and that have an effect on the procurement, scheduling and purchase of materials (PMI, 2008).

2.2.1 Risk management in the construction industry

A study by Laryea and Hughes (2009) showed that management of risk in the construction industry has varying focus in firms and organizations. At the top management level, risk management involves finances. The focus is on how certain business deliveries and risk management caters on ensuring the best business portfolio is had and has varying products in the various markets. Risks encountered at this stage involve the presence of a strong economy having sound outflow of cash and investments that yield results (Laryea and Hughes, 2008).

The management of construction firms have the responsibility of ensuring that project risk management is applied in organizations and then finding systems for controlling them. Bigger construction firms possess their own recommendations regarding insurance for projects and they also have units dedicated to handling insurance issues.

In order to safeguard the economy when large insurance situations happen, bigger organizations undertake re-insurance. Small companies are however fully dependent on outside insurance agencies. Premiums mainly depend on the ability of the company to manage business well in spite of the involvement of external insurance agencies or internal insurance firms. When firms have their own insurance in the organization, it is important to determine the rate of using this internal insurance. When less insurance is utilized, it cases more profits to be retained in the organization. When the construction firm has a good performance and experiences limited losses, this also reduces external premiums and is ultimately beneficial at the end.

Identifying risks is not done once but continually and is undertaken s a regular occurrence throughout the project. Identification of risks are responsible for addressing external and internal risks. Project team has control on internal risks including cost estimates. Project team does not have control on external risks like government actions. Risks entail the likelihood of having losses or harm. Risk identification is concerned with both negative outcomes and positive outcomes (Laryea and Hughes, 2009).

The purpose of risk identification is to assess the things that can go wrong. It looks at the current and proposed staff, design, process, supplier and monitoring tests, analysis of trends that are negative. Risk identification examines every element of program to aid in identifying major causes, work on their documentation and successfully manage them. Identification if risks should proceed as early as possible and be continued throughout the program.

Risks are associated with various aspects of programs like constraints, operation needs and attributes. It also includes Key Performance Parameters (KPMs), WBS, technology, threats. It is essential to note that identifying risks is not just the project manager's responsibility but that of everyone (Laryea and Hughes, 2009).

Program examination is attained by way of breaking it down into significant areas and elements. The decomposition must be focused on technical baselines, requirements, processes, acquisition phases and functional areas. WBS should also be createdfor decompositions that are product oriented (Laryea and Hughes, 2009).

2.3 CONCEPTUAL REVIEW

2.3.1 Reworks

As the word implies, rework means that a specific task must be performed not just once with the aim of accomplishing, which is geared toward the consumption of extra resources such as labour, materials and additional use of facilities which could have been reduced if the task was executed once (Josephson *et al.*, 2002). Cost and schedule overruns within construction project (Hwang *et al.*, 2009), rework poses a potential risk towards work quality and safety of employees (Love, 2002). Precious literature has measured the effect of rework on project paying keen attention to cost and again classified the causes of rework (Fayek *et al.*, 2004).

Rework has been interpreted by the construction management literature in numerous dimensions such verbal description, its scope, and performance or measurement. Rework has defined by Love suggest that, it is the needless energy geared toward rebuilding a process that was executed inappropriately at first attempt (Love, 2002). According to CII, field rework constitutes an activity that has to be performed at least not just once or a task eradicate work that were initially fixed as a constituent of the project (Rogge *et al.*, 2001). Fayek piloted research on COAA which seems to indicate a restraint with reference to field rework: rework as a result of the scope altered and other alterations by the client would not be considered as field rework (Fayek et al., 2003).

According Feng et al., (2008) rework can be categorised into two (2), thus positive and negative. The addition of value when designs are repeated which brings about better understanding of the requirements of a customer is as a result of positive rework. Primarily, the failure of a building element to give the client value for money or when the contract documents are inconsistent with works completed would lead to the need rework. The causes of rework have been identified on the basis of construction, design, the ability to operate, fabrication, and transportation from nine well-developed industrial construction projects using deviation categories (Burati et al., 1992). Love et al. (1997) proposed a rework classification system based on three principle groups; people, design, and construction. According to Love and Li (2000) rework can be categorised into three namely client initiated changes, non-variations, and defects.

2.4 EMPIRICAL REVIEW

2.4.1 Causes of Reworks in in building construction projects

According to Love and Edwards (2004a) client- related, design-related, and contractor-related factors are the core causes of rework without excluding management of the site and factors of the subcontractor. A general overview of rework is discussed below:

2.4.1.1 Client related factors

Palaneeswaran (2006) stated some client-related factors as fledgling, inadequate understanding of the design and construction process; inadequate finance for site exploration, unwillingness of employer to get involve in the project, insufficient information given about the project in the beginning, poor channels of communication among the design team, poor documentation of contract document (Elchaig *et al.,* 2005). According to Dalty and Crawshaw (1973) defects in communication between the client and the rest of the team can constitute error and omission in contract documentation.

Walker (1994) emphasised that the client and the project team should frequently communicate amicably to ensure the right and correct execution of the project.

2.4.1.2 Design related factors

Non-existence of integral coordination resulting from the design primes on the deficiency and aggravates the grounds for rework. According to Josephson and Hammarlund (1999) any rework activity in relation to design within the construction industry is mainly as a result of communication problem. Likewise, Austin et al., (1994) stated that the quantity of rework that occurs on a project site is getting worsened due to insufficient involvement of information technology in managerial activities and communication information. A research work cited by Love and Li (2000) measured the main causes of rework on constructing a residential facility and an industrial warehouse. The research established that poor communication among the professionals on the project obstructs the channel of communication among them. Engineers make use of CAD technology while the Architects uses a manual system design to carry out their designs, causing some drawings to be dimensional shortened or omitted (Love and Li, 2000). Love *et al.* (2010) are of the view that unprofessionalism arises from some design professionals.

2.4.1.3 Contract related factors

The growing volume and costs of rework is attributed to the fact that there is failure on the part of supervisors to plan, poor communication between supervisors and workers, and poor coordination of activities by supervisors (Love and Li, 2000). The smooth execution of projects by site management and subcontractors is based on the main contractor's effectiveness (Love and Li, 1999; Walker, 1994). According to Josephson and Hammarlund (1999) there would be a 10% increase in cost of projects without any

good mechanism put in place as a result of rework. Some of the causes of rework are discussed below:

• Errors resulting from setting-out: This type of error occurs when the working drawings are read wrongly (Josephson and Hammarlund, 1999).

• Errors resulting from poor personnel planning: This type of error occurs as a result of large volumes of work assigned to a worker and unnecessary demand for fast completion of work. In addition, the reallocation of a worker could lead to disturbance in personnel planning (Love *et al.,* 1999a).

• Errors resulting from the lack of protection of works: For instance, the mounting of a scaffold on a floor that is tiled without any adequate protection. In addition, the absence of protection to certain parts of the building in the execution of works related to alteration (Barber, 2000).

According to Josephson *et al.* (2002), Love and Smith (2003), and Love *et al.* (1999a) some of the factors that cause rework to a sub-contractor are as follows: poor supervision, recklessness leading to the destruction of other work sections, inadequate training of artisans and labour, bad selection of materials.

2.4.1.4 Errors

The Researchers concluded that rework aggravates mistakes or error committed during the process of designing, errors then become visible during the process of procurement. The Researchers are of the view that if an error goes without detecting it for a long-time increases the chances rework happening and severally influencing time and cost overruns. The Construction Industry Institute (CII) carried out a research on nine advance industrial construction projects and established that rework arising from design errors sum up to about 79% of the total cost of rework. The degree of rework mandated depends

on the duration the error went disregarded or unnoticed. For example, errors or spatial conflict forming part of the design contained within design identifications may not be seen until the physical construction of the project began (Endut *et al.*, 2005). The researchers however suggested that, errors maybe because of the complex varieties of interactions and hence an attempt separate a singular causative variable is an unseemly strategy to undertake. Error reduction and restraint approaches can be implemented in projects when knowledge is gained about the nature and dynamics of the errors.

2.4.1.5 Changes

Scholarly works indicated that change is a directed action that transmogrifies existing structures in place. There can be an impact on the beauty and design of the structure, the scope together with the type of work. According to CII, productivity and project performance can be affected negatively due to rework. Majority of rework activities have been as result of changes in design.

2.4.1.6 Omissions

As a result of subjecting the brain to stress, there is the tendency to commit errors Reason (2002). According to Reason (2002) the impact of pathogens lead to linkages that cannot be worked on and together with design and construction inaccuracies which end up in bringing about rework.

2.4.1.7 Contractor-related factors

The large volumes and costs of rework activities are largely attributed the failure of supervisors to organise work, and communicate effectively with worker (Business Roundtable, 1982). According to Love and Li (2000) there is a 10% increase in the cost of projects without quality measures in place as a result of rework. Some of the causes of rework identified are as follows:

• Errors arising from setting-out due to wrong reading of dimensions on the drawings to be used in the construction process (Josephson and Hammerlund, 1999).

• Errors generating from bad execution of works which probably may be as a result of too much work and needless instruction to finish task early. In addition, the reallocation of a worker could result into bad planning by a worker leading to the generation of errors (Love *et al.*, 1999a; Endut *et al.*, 2005).

• The lack of protection to works could result into the generation of errors. For instance the failure to secure a scaffold used on a tiled floor. The failure to provide protection to some elements of the structure when changes are to be effected (Barber *et al*., 2000).

2.4.1.8 Poor Leadership and Communication

According to Hwang et al. (2009) bad leadership and communication, and ineffective decision-making leads to rework. According to Love et al. (2009) strategic decisions taken by top management are some of the bad leadership styles that bring about rework. According to Fayek et al. (2003) some of the major factors that cause this problem are: improper control of project team, failure to provide safety and quality assurance policy, poor communication and lack of operation persons' buy-in. The lack of planning by supervisors, poor communication between supervisors and workers are connected with rising volumes and costs of rework. According to Walker (1994) there should be effective communication among building owners and the professionals in the design and construction team in order to have projects completed within time. According to Love et al. (1999a) ineffective communication increases rework.

2.4.2 Effects of Reworks in the Construction Industry

Discussing the effect of rework on the performance of a project is tabled, quality, schedule and cost are the main elements use for the description. The utmost undeviating

and perspicuous metric for showing the rework's impact is the cost directly relating to the reworks. This is the commonly quantifiable approach. Researchers researching on rework constraints within the construction industry has been exploring the direct cost of rework as a percentage of the actual contract value (Love and Sohal, 2003). Love and Li (2000) piloted a case study on the cost of reworks on residential facilities and conducted case studies of rework costs for a residential project and commercialized building and came to the conclusion that rework directly cost between 3.15% and 2.40% of the total cost or value of the project. They again, found out that reworks within the heavy and civil engineering construction is considerably higher, up by an average of 12.4% of the total estimated value of the contract.

Previous literature works gathered by CII shows not so much different result for the cost of rework. Smith and Haggard (2005) revealed the general range of field rework discovered from the study was 0.5% - 19%. This therefore suggest that the average was up by 3.13%. The research gathered quiet enough data from construction projects totalling 22, this included diverse types of project with specific functionality, including some associated conditions with either greenfield projects or modification and maintenance projects. The records clearly demonstrate the fact the extra cost due to rework has negative effect on the performance of the project. Adding to effect on the cost performance of the project, an extension of duration would also be required which would result in delay affecting the project time schedule.

The construction sector has an iniquitous reputation of being fragmented, absence of coordination good communication lines among parties, this may generate creating adversarial relationship contractually and absence of client's focus (Love et al., 2005). Furthermore, the non-existence of systems to monitor and control rework within the project (Hwang et al., 2009). The amalgamation of problems suggest that rework is now

an insidious problem and subsequently, rework cost has been established to be significant. (Love et al., 2005). Love et al. (2002) purported that the internal and external environment keep on changing and moderately not stable with reference to the construction projects. The activities executed in construction project are often shared between professional and trade disciple. The professionals include, architect, structural engineer, project manager and the trade discipline include contractors, carpenters, plumbers. These disciplines work independence of each other.

Oyewobi and Ogunsemi (2010) asserted that the beginning of the challenges faced by the clients and the construction industry rest within the shared responsibilities between the designers (design) and contractors (construction aspect).

The organizational structure of the construction industry has been criticised by many researchers because the design process is entirely detached from the construction process. Adejimi (2005) is of the view that, there is no integral linkage in the construction disciplines only at the terminal ends of each discipline and there is not mutual benefit within the entire process. Adejimi (2005) additionally stated that, the various players of the construction industry need to enhance the process by working hand-in-hand in other to accomplish construction rework. Rework manifestation can be associated with alterations at the design and construction stage. Love (2002b) buttress the point that, the extend of alteration can be and to a certain extend should be affirmed in the construction industry, as clients may not be able to visualise what they actual demand. Bramble and Callahan (2000) purported that, clients of a construction work have the liberty to make alteration to the scope of work without nullifying the contract. Rework in any case can be attributed to the lack of plan or insufficient time spent on the planning process before work starts (Love, 2002a). Oyewobi and Ogunsemi (2010) emphasis that a construction project ought to be well planned in order to complete the project successfully. At the

onset stage of the construction, all parties must collaborate and work together to overcome the chance of rework. Improper planning has the tendency to destruct a well-conceived project. The genesis of a construction project execution starts when the architect and engineer envisage a design. Poor execution of the design will result in rework, time and cost overruns at the design and construction phase (Oyewobi and Ogunsemi, 2010). Resource allocation and planning contract document are greatly beneficiary to avoid rework (Love et al., 2000).

2.4.3 Strategies to reduce Reworks in the Construction Industry

Measures can be put in place to alleviate rework by creating awareness of the main factors that can bring about rework and putting in place strategy to quantify rework. Some of the strategies that can be put in place to aid curb reworks are as follows;

• A well-trained supervisor should always be on the site to help prevent the occurrence of mistakes made by workers who are not well-trained.

• There should be the employment of more skilled labour than unskilled labour. Nonetheless, unskilled labourers employed should be given adequate training to aid prevent or alleviate the occurrence of errors.

• There should be thorough checks on materials supplied to aid identify bad materials. There should be written information regularly on the site and throughout the duration of the project to identify work performed and rework. Supervisors should be given training regular training such as communication, leadership, work planning and motivation to aid increase the skills of the supervisor..

2.4.2 Effects of Reworks in in building construction projects

Rework affects productivity through its impact on the morale level, absenteeism, weak supervision, fatigue, conflict and communication. Ajayi and Oyeyipo (2015) posited that

aside the effect of rework on cost and schedule; rework also has negative influence on intra and inter-organisational relations and the psychological wellbeing of individuals.

Weak supervision is one of the factors that can affect productivity. Love and Sohal (2003) suggested that rework leads to diversion of resources which in turn dilutes supervision in other parts of a project. Love and Sohal (2003) outlined the effects of such dilution as; the need for extra supervision, as some extra time from subcontractors to redo work and this may cause stacking; and compromise of safety.

Organisational conflicts that may result from rework, are intergroup conflict, interpersonal conflict, intra-group conflict, and inter- organisational conflict; questions regarding the causes of rework may cause conflict between client and contractor. (Hwang *et al.*, 2009) therefore, suggested that inter-organisational conflict is an indirect consequence of rework; should rework happened then conflict may arise between the client and the contractor. According to (Hwang *et al.*, 2009), rework has both direct and indirect effects on the performance of construction projects. For poorly managed projects, the overall impacts of rework may be equal to or even exceed the estimated profit margin (or markup). Also, there are cases in which the ripple effects of rework will be carried forward on different aspects such as reputation, stress, motivation and relationships. Oyewobi and Ogunsemi (2010) revealed that additional time to re-do task, additional costs for re-doing work, additional materials for rework and subsequent wastage handling, and additional labour for rework and related extensions of supervising manpower; were the direct effect of the impact of rework on project management transactions.

Reworks have grave effect on individuals, an organisation and a project's performance indirectly (Hwang *et al.*, 2009). At the organisation level, the indirect impacts of rework

according to (Hwang *et al.,* 2009) are loss of future work, reduced profit, inter-organisational conflict, diminished professional image and poor morale. Also, according to Love (2001), the indirect effect of rework at the individual level are; de-motivation, stress, absenteeism, fatigue and poor morale. In fact, prolonged work hours being subjected by an individual due to errors, omissions, changes, fatigue and stress may emerge; thereby increasing the likelihood of even further rework occurring. Indirect rework effects at the project level include; work inactivity such as waiting time, idle time, travelling time and dissatisfaction of end-users.

When the effects on project performance is discussed, quality, schedule, and cost are the three elements commonly used to describe it (Ajayi and Oyeyipo, 2015). The most direct and perspicuous metric for displaying the impact of rework is the direct cost of the rework, which is also the most easily measured operational approach. Researchers who have studied the rework issue in construction have almost always investigated the direct cost of rework as a percentage of the actual value of the contract (Love and Sohal, 2003). Love and Li (2000) conducted case studies of rework costs for a residential project and an industrial building project and found that the direct cost of rework was about 3.15 % and 2.40 % of the value of the entire contract, respectively. They also identified that the cost of rework in civil and heavy industrial engineering projects could be significantly higher, averaging up to 12.4 % of the value of the contract.

Previous CII research obtained very similar data for the cost of rework. Smith and Haggard (2005) showed that the overall range of field rework reported in surveys was from 0.5 % to 19 %, with an average rate of 3.13 %. The surveys collected significant amounts of data from 22 projects, which involved a variety of functional types of projects and included conditions associated with either greenfield projects or modification and maintenance projects. These figures categorically illustrate the fact that additional costs

due to rework have a considerable adverse impact on project performance. In addition to the impact of cost on project performance, the additional time required to redo the work would also result in a time shift or delay and would probably affect the project schedule.

The construction industry has the iniquitous reputation of being fragmented, lacking coordination and communication between parties, creating adversarial contractual relationships and lacking customer focus (Love *et al.*, 2005). Besides, there is generally an absence of systems within projects to monitor and control rework (Hwang *et al.*, 2009). This combination of problems has meant that rework has become an insidious problem and consequently, the costs of rework have been found to be considerable (Love *et al.*, 2005). Love *et al*. (2002) stated that both the internal and external environments of construction projects are dynamic and relatively unstable. Tasks performed in construction projects are typically divided between professional disciples (architect, structural engineer, project manager) and trade disciplines (the contractors' and sub-contractors' carpenters, bricklayers, plumbers), which frequently operate independently of one another.

Oyewobi and Ogunsemi (2010) reported that the genesis of the problems experienced by the construction industry and clients lie in the division of the responsibilities between the design and the construction aspect. A direct criticism of the organisational structure of the construction industry by many researchers is that the construction industry is different in the sense that the design process is separated from construction process. Adejimi (2005) argued that construction is not well-connected or integrated until at the terminal end of each other rather than overlapping and mutually benefiting throughout the process. Adejimi (2005) further opined that if the design process is to be enhanced, the participants within the industry, including the architects, planners, engineers, contractors and the initiator of the process, need to come together in well-coordinated effort,

especially if rework-free construction is to be attained. The occurrence of rework can be attributed to changes during the design and construction stage. Love (2002b) affirmed that a degree of change can be, and to a certain extent should be, expected in construction, as it is difficult for clients to visualise the end product that they procure. According to Bramble and Callahan (2000), most construction contracts give the owner the right to make changes within the general scope of the contract without breaching or invalidating the contract. Rework, nevertheless, often occurs and can usually be attributed to poor planning or devoting of insufficient time to the planning and design before commencing construction (Love, 2002a). Oyewobi and Ogunsemi (2010) stressed that a project must be well-conceived, must start right in order to end well. At the outset of the planning stages, the building owner, the initiator of the contract and the designer must come together and plan the work properly to prevent occurrence of rework. Inadequate planning can affect a well-conceived construction project, leaving all the participants-designers, clients and contractors-dissatisfied at the conclusion of the project. Thus, as construction involves the execution of a design envisioned by the architects and engineers, ineffective execution of this design process will unavoidably lead into rework and resultant time and cost overruns in both phase-design and construction (Oyewobi and Ogunsemi, 2010). The allocation of resources and planning of the documentation process are significantly important facets that need to be addressed if rework is to be reduced (Love *et al.*, 2000).

Litigation remains a challenge in the construction industry (Hoe, 2013) with the potential to leading to project failures and delays. Litigations come about through conflicts and usually entail scrutinizing the facts (Aibinu and Jagboro, 2002). Dispute and arbitration are consequences of delay in the construction industry (Platz, 2009). Some unbearable friction happens among the parties to the contract whenever delays set in. Such incidence,

usually mean subjecting the facts to scrutiny, causal factors and how the terms of the contract are interpreted, which have been taken up by (Platz, 2009).

Delay of projects seems to be a continuing setback and the inability to manage the various agencies and subdivisions in the purchasing of goods and services go on to cost hundreds of millions (Aibinu and Jagboro, 2002). In the research conducted by Manavazhia and Adhikarib (2002), whenever equipment and the needed materials do not get to the site on time, it results in delay which further incurs additional cost by the parties involved in the project in countries that are now developing (Aibinu and Jagboro, 2002).

2.4.3 Strategies to reduce Reworks in building construction projects

Measures can be put in place to alleviate rework by creating awareness of the main factors that can bring about rework and putting in place strategy to quantify rework. Some of the strategies that can be put in place to aid curb reworks are as follows;

• A well-trained supervisor should always be on the site to help prevent the occurrence of mistakes made by workers who are not well-trained.

• There should be the employment of more skilled labour than unskilled labour. Nonetheless, unskilled labourers employed should be given adequate training to aid prevent or alleviate the occurrence of errors.

• There should be thorough checks on materials supplied to aid identify bad materials. There should be written information regularly on the site and throughout the duration of the project to identify work performed and rework. Supervisors should be given training regular training such as communication, leadership, work planning and motivation to aid increase the skills of the supervisor.

It’s very critical for the construction firms to uphold high ethical standards in that they should only engage in contacts they have the skill to execute, they should also engage

the right subcontractors for the proper work to be done, well established strategies must be enforced and deliver the overall timetable to the owner, and the contractors should be financially sound (Hoe, 2013).

Contractors should adopt proper cash flow management (Kehew *et al.,* 2005). This will help ensure they don't face financial difficulties thereby leading to quick delivery of the projects (Hillebrandt, 2000). Furthermore, local contractors should develop partnerships and alliances to ensure they are financially enabled to help them successfully develop projects on time (Ngowi, 2006).

While choosing the contractors, custodians of the project need to ensure that the contractors are not chosen based only on the lowest bidder (Hillebrandt, 2000). The chosen contractor must be experienced in the field of work, must be well vexed with technical abilities, financially sound, and adequate labor to complete the project; the clients must not obstruct the flow of work and must stick to the proposed schedule of the project (Hoe, 2013). This can result in excessive delays to the project; contractors should be paid on time in order to facilitate the completion of the task at hand. As a result, the right agreements should be reached with the financial organizations for timely access of funds for the project, and clients should endeavor to resolve their differences on time (Aryeetey and Baah-Boateng, 2007).

Government should reduce the tax on building materials to make them affordable (Onyina-Adjei, 2007). This will help local construction firms to be able to afford these materials thereby leading to less delay of the projects (Onyina-Adjei, 2007). Enough funds should be also made available based on reliable estimate by the Quantity Surveyor at the inception of the project (Onyina-Adjei, 2007). This will improve the liquidity of the contractors thereby preventing delays (Assaf, 2006).

2.4.4 Past studies undertaken

The State of the South African Construction Industry's report compiled in June 2011 revealed that the gross fixed capital formation in non-residential buildings in South Africa in 2010 amounted to R41 928m which constitutes 2.3% of gross domestic product (GDP). Based upon prior research undertaken and among general contractors in South Africa which determined that rework constituted on average, 13% of the value of completed construction, the cost of rework in non-residential buildings could have been 5 m. Rework in construction projects is attributable to lack of skills, quality management issues, lack of communication and coordination during design and construction, and emphasis on time and cost. In their status report, the Construction Industry Development Board (CIDB, 2004) revealed that design professions do not have enough knowledge of construction processes, and consequently, are not able to stay abreast of the changes in construction technologies. Furthermore, consultants do not provide sufficient design and construction process details, resulting in unnecessary design rework by contractors and construction delays. The CIDB (2004) also raised the issue of discounting of fees as a commonplace practice in the industry, in the order of 15 to 25%, with extremes of up to 50%. This discounting of fees places pressure on the quality of the work produced by consultants, who tailor their service to suit the price. Various studies conducted by Smallwood and among architectural practices and general contractors consistently identified construction and procurement-related barriers as the dominant barriers to the achievement of quality, often together with design-related factors as additional barriers.

 Design-related factors identified by the authors include inadequate details, inadequate specifications and poor design coordination.

 Procurement-related factors include emphasis on time and budget, shortened project periods, lack of prequalification, competitive tendering and awarding of contracts primarily on price.

2.5 THEORETICAL REVIEW

2.5.1 Theory on Cause-and-Effect of Rework

Love *et al*. (1997) established a rework classification system based on the study of two construction projects: a residential development and an industrial development. As illustrated in Figure 2.1, the causes of rework are sorted into three principle groups: people, design, and construction. A number of common causes are included in each group, which enhances a user's understanding of the system.

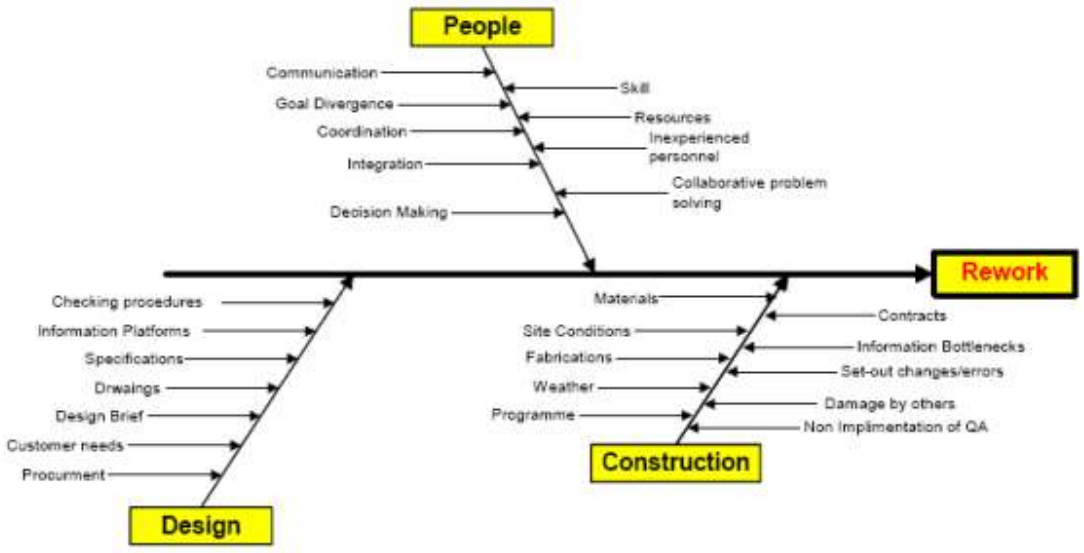

Figure 2.1 Generic Cause-and-Effect Rework Diagram

Source: Love *et al.* (1997)

2.5.2 Fishbone Theory on Rework Cause Classification

Fayek determined five major causes of rework: human resources capability, leadership and communications, engineering and reviews, construction planning and scheduling,

and materials and equipment supply (Fayek *et al.*, 2003). Each category has four sub-causes (Figure 2.2). Their classification shows that human performance plays a significant role in the causes of rework.

Figure 2.2 COAA's Fishbone Rework Cause Classification

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter is the methodology of the research. It touches on the research strategy adopted as well as approach and design. The population and sample size are touched on including the sampling techniques used.

3.2 RESEARCH STRATEGY

According to Creswell (2009), strategies of inquiry include qualitative, quantitative or mixed methods. While quantitative method explains a phenomenon using numerical data and mathematical analysis, qualitative method is based mostly on descriptive analysis of data which does not necessarily rely on mathematical models. Due to identified gaps in both quantitative and qualitative methods, the two methods are often combined to complement each other. The research strategy obtained from combining these two strategies is called mixed strategy.

This research adopted the quantitative strategy for the following reasons:

The study identified various variables under the two objectives. After which the various variables were quantified numerically from responses by respondents using a Likert Scale of 1 to 5, where 1 represents not very important, 2 is not important,3 is average,4 being important and 5 is very important.

3.3 RESEARCH APPROACH

The deductive approach was adopted. With regards to the research approach, a particular study could be inductive or deductive. The inductive reasoning starts from a narrow area

or theory and then moves to a broader perspective by collecting data to verify the theory. However, the deductive approach solves a problem by focusing on a broader perspective and moves to a narrower perspective/formation of theory (Gray, 2004).

3.4 RESEARCH METHODOLOGY

Creswell (2009) and Gray (2004) identified the following research methods, experimental research, survey action and ethnographic research.

This research work is not experimental since the study was not carried out in a controlled environment. It is not also action research because action researches are carried out in organizations or institutions of which the researcher is part of with the aim of making improvement in the organization.

Ethnographic study which is the study of cultures or communities about their lifestyle is out of the scope of this study. The research methodology is a survey due to the noted similarities of the study to survey. The study involved sampling respondents from a greater number of people and then asking respondents questions through the use of a questionnaire to obtain mostly quantitative data – these are the typical characteristics of a survey.

3.5 POPULATION

The population for this study includes all participants in construction projects namely; Quantity Surveyors, Architects, Project Managers, Contractors and Consultants. From the website of the Ministry of Works and Housing, the population of 120 was obtained as the list of consultants and D1K1 contractors in Kumasi in good standing.

3.6 SAMPLE SIZE AND SAMPLING TECHNIQUE

Sampling technique could be probability sampling such as random sampling, stratified and systematic sampling. It could also be non-probability sampling technique such as purposive and snowball (Creswell, 2009). Both probability and non-probability sampling techniques were used. Simple random sampling and purposive sampling were adopted.

Kish formula was used to determine the sample size (Kish, 1965).

n= n^1 (1 + $n^1/_N$) …… (1)

Where, n = the sample size, N = the total population size

$n^1 = S^2/_{V^2}$ …… (2)

V= the standard error of sampling distribution assumed to be 0.05

S= the maximum standard deviation of the population size (Total error of 0.05 @ 95% confidence level)

S^2 = P (1–P) ……..... (3)

Where, P = the proportion of the population elements that belong to the defined class assumed to be 0.85

From eqn (3), S^2 = P (1–P) = 0.85 (1– 0.85) = 0.1275

From eqn (2), $n^1 = S^2/_{V^2} = 0.0979/_{0.05^2}$ = 51

From eqn (1), n= n^1 (1 + $n^1/_N$) = 51 (1 + $51/_{120}$) = 79 questionnaires (approximated to 80)

3.8 DATA COLLECTION METHODS

Due to the stated advantages of allowing minimum contact with the project participants and ensuring a quicker collection of data, a questionnaire survey was preferred to interview for cross-sectional data collection.

3.8.1 Design of Questionnaire

The research questionnaires were designed to capture the demographic data of respondents such as respondents' profession, and years of experience. Respondents were asked to rank using a Likert Scale of 1 to 5.

3.8.2 Piloting of Questionnaire

The questionnaires were pre–tested before final administration. This was done by piloting it on a few construction professionals. While this was done, notice will be taken of the time used to complete the questionnaire and the questions that were not clear to the piloted participants. After which questions that needed rephrasing, for clarity and to enable quicker response without compromising the research aim.

3.8.3 Data Collection

Data will be collected through the administration of questionnaire to a sample of eighty (80) respondents. Consistent follow ups will be undertaken to retrieve the questionnaires.

3.9 DATA ANALYSIS

Data analysis was done using Statistical Package for Social Science (SPSS). For demographic data, frequency distribution including percentages were used to describe the data. The tools for analyzing the data collected consisted of descriptive statistics and mean score ranking for ranking the various phenomena identified. One sample t-test was used for testing relative significance of variables. Cronbach Alpha was be used for testing internal reliability.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION

4.1 INTRODUCTION

This chapter is the data analysis and discussions of the results obtained using Statistical Package for Social Sciences (SPSS). The statistical tool employed for the analyses was descriptive statistics and mean score ranking. One sample t-test and Cronbach Alpha tests were also conducted. The chapter also presents the results of the analysis and discussions in the form of texts, figures, tables and the like. Fifty-eight (58) questionnaires were retrieved from seventy-nine (79) distributed representing seventy-three percent (73%) response rate.

4.2 DEMOGRAPHY OF RESPONDENTS

The purpose was to provide an understanding of the background of the targeted respondents. The profile of the respondents is to generate confidence in the reliability of data collected.

4.2.1 Gender of respondents

In this section, respondents for the study were asked to indicate their gender. Figure 4.1 below documents their responses. 68 percent of the respondents were males. The remaining 32 percent of respondents were females. The study has a fusion of male and female respondents which is good for the study. It can also be inferred that majority of respondents for the study are males.

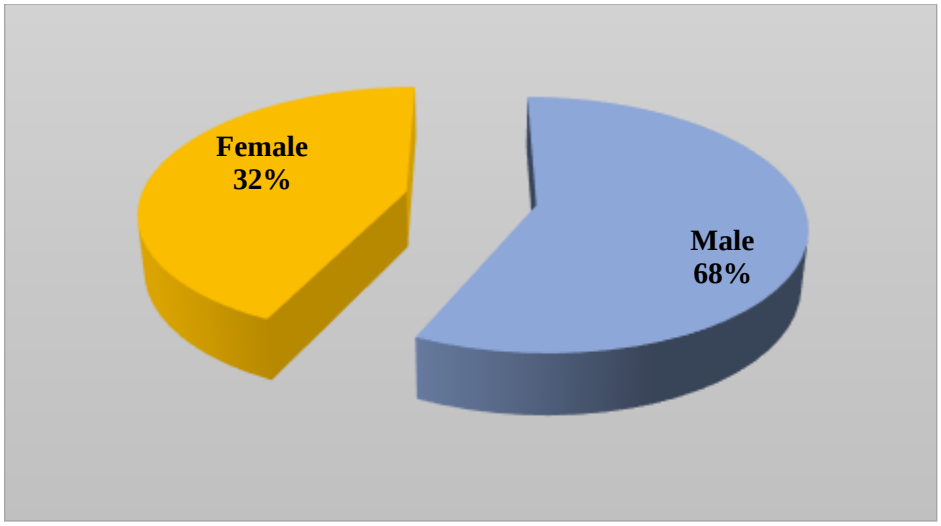

Figure 4.1 Gender of respondents

Source: Author's field study (2019)

4.2.2 Category of respondents

This part of the study sought to know from the respondents their ages. From Figure 4.2 below, 65 percent of the respondents are working with contractor firm while the remaining 35 percent of the respondents are working with consultancy firm. It can be seen that the study is made up of fusion of contractors and consultants which is good for the study.

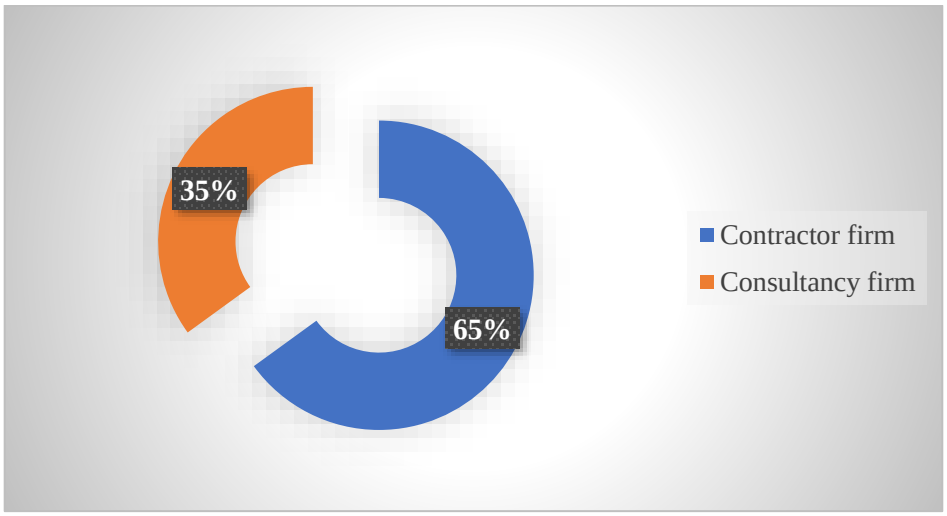

Figure 4.2 Category of respondents

Source: Author's field study (2019)

4.2.3 Highest level of education

Respondents for the study were asked to state their highest educational level. From Figure 4.3 below, 10 percent of the respondents have Diploma. 68 percent of the respondents have first degree while the remaining 22 percent of the respondents have MBA/Masters. All the respondents for the study are well educated and their responses can be trusted. It can also be inferred that majority of respondents for this study have first degree.

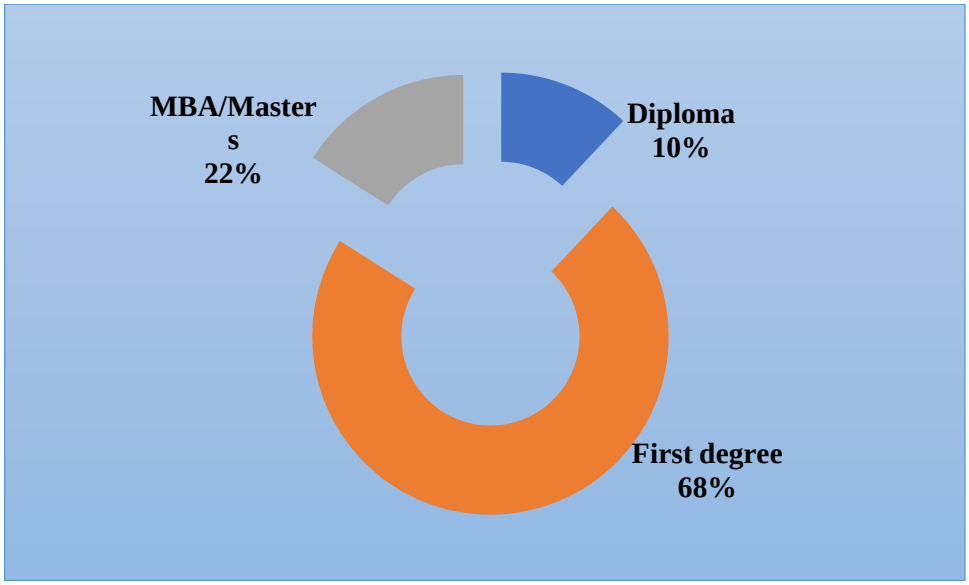

Figure 4.3 Highest level of education

Source: Author's field study (2019)

4.2.4 Years of experience in the insurance industry

The respondents were asked in this section to state their years of experience in the construction industry. From Figure 4.4 below, 37 percent of the respondents have less than 5 years of experience. 24 percent of the respondents have 5-10 years of experience. 30 percent of the respondents have 11-16 years of experience. The remaining 9 percent of respondents have 16 years and above experience. All the respondents for the study have enough and adequate experience in the insurance industry. Confidence can therefore be reposed in their responses.

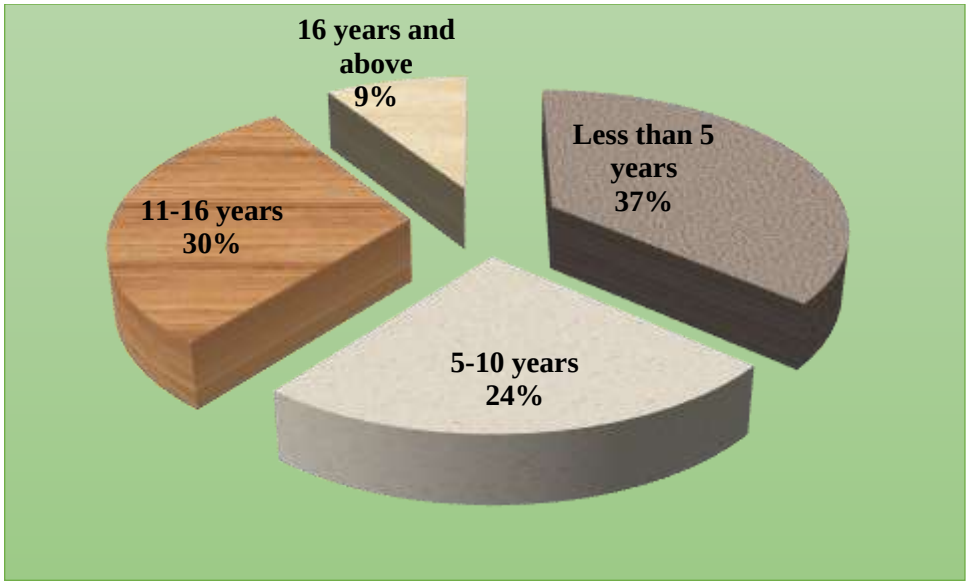

Figure 4.4 Years of experience

Source: Author's field study (2019)

4.3 CAUSES OF REWORKS IN IN BUILDING CONSTRUCTION PROJECTS

Respondents for the study were asked in this section to rank the causes of reworks in building construction projects on a Likert scale of 1 to 5 where 1 – Strongly disagree 2 – Disagree 3 – Neither agree nor disagree 4 – Agree 5 – Strongly agree. From Table 4.1 below, *Non-compliance with specification* was ranked 1st with a mean of 4.51 and standard deviation of 0.662. *Failure to implement Quality management practices* was ranked 2nd with a mean of 4.48 and standard deviation of 1.004. *Poor scheduling of construction resources* was ranked 3rd with a mean of 4.43 and standard deviation of 0.498. *Poor monitoring and control* was ranked 4th with a mean of 4.43 and standard deviation of 0.522. *Ineffective communication* was ranked 5th with a mean of 4.40 and standard deviation of 1.005.

Palaneeswaran (2006) stated some client-related factors as fledgling, inadequate understanding of the design and construction process; inadequate finance for site exploration, unwillingness of employer to get involve in the project, insufficient

information given about the project in the beginning, poor channels of communication among the design team, poor documentation of contract document. According to Dalty and Crawshaw (1973) defects in communication between the client and the rest of the team can constitute error and omission in contract documentation. Walker (1994) emphasised that the client and the project team should frequently communicate amicably to ensure the right and correct execution of the project.

Non-existence of integral coordination resulting from the design primes on the deficiency and aggravates the grounds for rework. According to Josephson and Hammarlund (1999) any rework activity in relation to design within the construction industry is mainly as a result of communication problem. Likewise, Austin et al., (1994) stated that the quantity of rework that occurs on a project site is getting worsened due to insufficient involvement of information technology in managerial activities and communication information. A research work cited by Love and Li (2000) measured the main causes of rework on constructing a residential facility and an industrial warehouse. The research established that poor communication among the professionals on the project obstructs the channel of communication among them. Engineers make use of CAD technology while the Architects uses a manual system design to carry out their designs, causing some drawings to be dimensional shortened or omitted (Love and Li, 2000). Love et al. (2010) are of the view that unprofessionalism arises from some design professionals.

The growing volume and costs of rework is attributed to the fact that there is failure on the part of supervisors to plan, poor communication between supervisors and workers, and poor coordination of activities by supervisors (Business Roundtable, 1982). The smooth execution of projects by site management and subcontractors is based on the main contractor's effectiveness.

Table 4.1 Causes of reworks in the construction industry

CAUSES	Mean	Std. Dev	Rank
Non-compliance with specification	4.51	0.662	1st
Failure to implement Quality management practices	4.48	1.004	2nd
Poor scheduling of construction resources	4.43	0.498	3rd
Poor monitoring and control	4.43	0.522	4th
Ineffective communication	4.40	1.005	5th
Drawings and specification errors or omissions	4.37	0.876	6th
Scopes and design changes	4.36	1.005	7th
Inadequate pre-project planning	4.34	0.765	8th
Deficiencies in personnel training	4.33	1.008	9th
Poor decision making process	4.29	0.865	10th
Lack of motivation	4.26	1.112	11th
Deficiencies in documentation control	4.25	0.632	12th
Defect of prefabrication	4.23	0.722	13th
Lack of attention to detail	4.19	1.071	14th
Poor development and application of realistic work procedures	4.18	0.843	15th
Equipment and tools not sufficiently advanced	4.11	1.005	16th
Deficiencies in forecasting field conditions	4.06	0.675	17th
Lack of Audit and control	4.02	0.883	18th
Inadequate knowledge of action required to complete task successfully	3.98	0.712	19th
Lack of domain-specific skill	3.94	0.765	20th
Acts of God/Force Majeure	3.89	0.882	21st
Untimely deliveries or misplacement	3.87	1.087	22nd
Political situation/siege	3.76	0.764	23rd
Adulterated materials	3.75	0.553	24th
Conflict of interest	3.59	0.854	25th
Violation of rules or policy, or failure to adhere to work instructions or procedure	3.50	0.772	26th

Source: Author's fieldwork (2019)

4.4 EFFECTS OF REWORKS IN BUILDING CONSTRUCTION PROJECTS

Respondents for the study were asked in this section to rank effects of reworks in building construction projects on a Likert scale of 1 to 5 where 1= Not important; 2= Less important; 3=Moderately important; 4= Important; 5= Very important. From Table 4.3 below, *Wastage of resources* was ranked 1st with a mean of 4.46 and standard deviation

of 0.622. *Monetary loss due to the delay of work* was ranked 2nd with a mean of 4.40 and standard deviation of 0.561. *Results in human health hazard or equipment failure* was ranked 3rd with a mean of 4.35 and standard deviation of 0.644. *Cost overrun* was ranked 4th with a mean of 4.33 and standard deviation of 0.533. *Late site hand over* was ranked 5th with a mean of 4.20 and standard deviation of 0.556.

Rework affects productivity through its impact on the morale level, absenteeism, dilution of supervision, fatigue, conflict and communication. Ajayi and Oyeyipo (2015) posited that aside the effect of rework on cost and schedule; rework also has negative influence on intra and inter-organisational relations and the psychological wellbeing of individuals.

Dilution of supervision is one of the factors that can affect productivity. Love and Sohal (2003) suggested that rework leads to diversion of resources which in turn dilutes supervision in other parts of a project. Love and Sohal (2003) outlined the effects of such dilution as; the need for extra supervision, as some extra time from subcontractors to redo work and this may cause stacking; and compromise of safety.

Organisational conflicts that may result from rework, are intergroup conflict, interpersonal conflict, intra-group conflict, and inter- organisational conflict; questions regarding the causes of rework may cause conflict between client and contractor. (Hwang *et al.,* 2009) therefore, suggested that inter-organisational conflict is an indirect consequence of rework; should rework happened then conflict may arise between the client and the contractor. According to (Hwang *et al.,* 2009), rework has both direct and indirect effects on the performance of construction projects. For poorly managed projects, the overall impacts of rework may be equal to or even exceed the estimated profit margin (or markup). Also, there are cases in which the ripple effects of rework will be carried forward on different aspects such as reputation, stress, motivation and

relationships. Oyewobi and Ogunsemi (2010) revealed that additional time to re-do task, additional costs for re-doing work, additional materials for rework and subsequent wastage handling, and additional labour for rework and related extensions of supervising manpower; were the direct effect of the impact of rework on project management transactions.

Reworks have grave effect on individuals, an organisation and a project's performance indirectly (Hwang *et al.,* 2009). At the organisation level, the indirect impacts of rework according to (Hwang *et al.,* 2009) are loss of future work, reduced profit, inter-organisational conflict, diminished professional image and poor morale. Also, according to Love (2001), the indirect effect of rework at the individual level are; de-motivation, stress, absenteeism, fatigue and poor morale. In fact, prolonged work hours being subjected by an individual due to errors, omissions, changes, fatigue and stress may emerge; thereby increasing the likelihood of even further rework occurring. Indirect rework effects at the project level include; work inactivity such as waiting time, idle time, travelling time and dissatisfaction of end-users.

The findings of this study agree with past literature.

Table 4.2 Effects of reworks in building construction projects

EFFECTS	Mean	Std. Dev	Rank
Wastage of resources	4.46	0.622	1st
Monetary loss due to the delay of work	4.40	0.561	2nd
Results in human health hazard or equipment failure	4.35	0.644	3rd
Cost overrun	4.33	0.533	4th
Late site hand over	4.20	0.556	5th
Litigation	4.14	0.841	6th
Loss to the economy	4.09	0.722	7th
Decrease in economic activities	4.01	1.030	8th
Leads to time shift of subsequent jobs	3.92	1.019	9th
Arbitration	3.90	0.549	10th

Source: Author's fieldwork (2019)

4.4.1 One Sample T-test on effects

All the factors had t-values (the strength of the test) that were positive indicating that their means were above the hypothesized mean of 3.5 Almost all of the factors had a p-value (significance of the test) less than 0.05 and this implies that the means of these variables are not significantly different from the hypothesized mean of 3.5.

However, the factors *Late site hand over* and *Decrease in economic activities* had p-values of *.718* and 0.613 which are greater than 0.05 indicating that their means are significantly different from 3.5. Furthermore, the 95% confidence level interval estimates the difference between the population mean weight and the test value (i.e. 3.5). For example, the factor *Wastage of resources* is estimated to have a mean weight difference of *.56536*. It therefore has *.2620* and *.8687*, lower and upper values respectively. *Arbitration* also has a mean difference of 0.0000 and hence has .3568 and .3568 as the lower and upper confidence interval values respectively.

Table 4.3 One-Sample Test of effects

	Test Value = 3.5					
					95% Confidence Interval of the Difference	
	t	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Wastage of resources	2.339	57	.000	.56536	.2620	.8687
Monetary loss due to the delay of work	1.950	57	.109	.15360	.5383	.0100
Results in human health hazard or equipment failure	2.092	57	.000	.68301	.4180	1.0482
Cost overrun	5.097	57	.114	.06536	.4166	.0637
Late site hand over	0.417	57	.718	.07713	.4076	.2312
Litigation	2.453	57	.100	.15360	.0575	.4870
Loss to the economy	3.951	57	.000	.61111	.3946	.8276
Decrease in economic activities	1.445	57	.613	.20588	.5444	.1326
Leads to time shift of subsequent jobs	2.665	37	.006	.14815	.0651	.3314
Arbitration	7.000	37	1.000	.00000	.3568	.3568

4.5 STRATEGIES TO REDUCE REWORKS IN THE CONSTRUCTION INDUSTRY

Respondents for the study were asked in this section to rank strategies to reduce reworks in building construction projects on a Likert scale of 1 to 5 where 1= Not significant; 2= Less significant; 3=Moderately significant; 4= Significant; 5= Very significant. From Table 4.4 below, *Effective planning and scheduling* was ranked 1st with a mean of 4.51 and standard deviation of 0.694. *Teamwork effectiveness* was ranked 2nd with a mean of 4.43 and standard deviation of 0.765. *Strong qualified supervision* was ranked 3rd with a mean of 4.37 and standard deviation of 0.896. *Qualified Contractor* was ranked 4th with a mean of 4.32 and standard deviation of 0.596. *Effective Communication* was ranked 5th with a mean of 4.28 and standard deviation of 0.768.

Rework can be reduced by developing adequate awareness about the root causes and what constitutes rework and implementing systematic approach to measure rework. As the word implies, rework means that an action must be executed more than once in order to achieve the specified objectives, which results in the unnecessary consumption of additional resources in the form of labor, materials, and facilities beyond what would have been used if the action had been performed only once (Simpeh, 2012). There should be written information regularly on the site and throughout the duration of the project to identify work performed and rework. Supervisors should be given training regular training such as communication, leadership, work planning and motivation to aid increase the skills of the supervisor.

It's very critical for the construction firms to uphold high ethical standards in that they should only engage in contacts they have the skill to execute, they should also engage the right subcontractors for the proper work to be done, well established strategies must be enforced and deliver the overall timetable to the owner, and the contractors should be financially sound (Hoe, 2013).

Contractors should adopt proper cash flow management (Kehew *et al.*, 2005). This will help ensure they don't face financial difficulties thereby leading to quick delivery of the projects (Hillebrandt, 2000). Furthermore, local contractors should develop partnerships and alliances to ensure they are financially enabled to help them successfully develop projects on time (Ngowi, 2006).

While choosing the contractors, custodians of the project need to ensure that the contractors are not chosen based only on the lowest bidder (Hillebrandt, 2000). The chosen contractor must be experienced in the field of work, must be well vexed with technical abilities, financially sound, and adequate labor to complete the project; the clients must not obstruct the flow of work and must stick to the proposed schedule of the

project (Hoe, 2013). This can result in excessive delays to the project; contractors should be paid on time in order to facilitate the completion of the task at hand. As a result, the right agreements should be reached with the financial organizations for timely access of funds for the project, and clients should endeavor to resolve their differences on time (Aryeetey and Baah-Boateng, 2007).

The findings of this study agree with past literature.

Table 4.4 Strategies to reduce reworks in in building construction projects

STRATEGIES	Mean	Std. Dev	Rank
Effective planning and scheduling	4.27	0.551	1st
Teamwork effectiveness	4.23	0.724	2nd
Strong qualified supervision	4.17	0.833	3rd
Qualified Contractor	4.15	0.576	4th
Effective Communication	4.12	0.722	5th
Project documentation	4.12	0.811	6th
Quality/rework auditing	4.10	0.675	7th
Sufficient and capable human resources	4.01	1.003	8th
Effective Leadership	4.00	1.086	9th
Unification work standards	3.98	0.911	10th
Strict resistance against cheating (fraud fighting)	3.94	1.002	11th
Minimization work stress	3.91	0.987	12th
Employee involvement	3.87	0.765	13th
Commitment to safety (Strict laws)	3.79	0.661	14th
Continuous evaluation before and during the implementation of work	3.66	0.569	15th
Owner involvement	3.62	0.644	16th
Qualified Consultant	3.61	0.533	17th
Strengthen personnel internal ethics	3.55	0.556	18th
Supplier prequalification	3.54	0.841	19th
Field verification	3.48	0.722	20th
Job security	3.39	0.811	21st
Using lean construction improvement	3.20	0.675	22nd

Source: Author's fieldwork (2019)

4.6 RELIABILITY OF THE RESPONSES RECEIVED

This section sought to check the internal consistency of the responses of this study by conducting a reliability analysis. From the Cronbach's Alpha coefficient value from the variables as shown in Table 4.5, the value was 0.847. This is above the cut-off limit of 0.700 thereby implying that all the responses are reliable.

Table 4.5 Reliability Statistics

	Number of Items	Cronbach's Alpha Coefficient
Variables	59	0.847

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter of the study presents summary of the findings gotten from the study, recommendations, conclusion, limitation of the study and suggestions proposed for direction of future studies on the topic.

5.2 ACHIEVEMENT OF RESEARCH OBJECTIVES

5.2.1 Causes of reworks in building construction projects

This was the order of importance:

- Non-compliance with specification;
- Failure to implement Quality management practices;
- Poor scheduling of construction resources;
- Poor monitoring and control;
- Ineffective communication

5.2.2 Effects of reworks in building construction projects

The following were the most important findings:

- Wastage of resources;
- Monetary loss due to the delay of work;
- Results in human health hazard or equipment failure;
- Cost overrun;
- Late site hand over.

5.2.3 Strategies to reduce reworks in building construction projects

The analysis was done using mean score ranking. The following were the most important findings:

- Effective planning and scheduling;
- Teamwork effectiveness;
- Strong qualified supervision;
- Qualified Contractor;
- Effective Communication.

5.3 CONCLUSION

Rework poses a potential risk towards work quality and safety of employees. Rework affects productivity through its impact on the morale level, absenteeism, weak supervision, fatigue, conflict and communication. Rework has both direct and indirect effects on the performance of construction projects. For poorly managed projects, the overall impacts of rework may be equal to or even exceed the estimated profit margin.

5.4 RECOMMENDATIONS

- There should be adequate training given to employees to aid in the reduction of mistakes. The leaders on a construction projects must put in place measures in the beginning to ensure that regular check are performed either every day or week in order to prevent the occurrence of errors.
- There should be mandatory checks performed on materials supplied to ensure that materials in bad condition are identified.
- There would be reduction in rework if there is proper quality management system put in place.

- There should be written information available on the site all the time in order to inspect work done and make known any rework.
- The should be an increase in the planning skills of supervisors, increase in communication skills, motivation and leadership as a result of granting official training to them.

5.5 DIRECTION FOR FURTHER RESEARCH

This study was conducted using quantitative methods. Further studies should be conducted using qualitative methods.

REFERENCES

Abdul-Hamid, T.K. and Madnick, S.E. (1991), Software project dynamics - an integrated approach, Prentice-Hall, Englewood Cliffs, NJ.

Abdul-Rahman, I., Memon, A.H. & Abd-Karim, A.T. (2013). Significant factors causing cost overruns in large construction projects in Malaysia. *Journal of Applied Sciences*, 13(2), pp. 286-293. http:// dx.doi.org/10.3923/jas.2013.286.293

Abeku, D. M., Ogunbode, E. B., Salihu,C., Maxwell, S. S. and Kure, M. A. (2016); Projects Management and the effect of Rework on Construction Works: A Case of selected Projects in Abuja Metropolis, Nigeria. *International Journal of Finance and Management in Practice*, Vol. 4, No. 1, June 2016.

Ajayi, O. and Oyeyipo, O. (2015); Effect of rework on project performance in building project in Nigeria. *International Journal of Engineering Research & Technology (IJERT).* Vol. 4 issue 02, February-2015

Alwi, S., Hampson, K. and Mohamed, S. (2001), Effect of quality supervision on rework in the Indonesian context, *Asia Pacific Building and Construction Management Journal*, Vol.6, pp. 2-6.

Alwi, S., Hampson, K. and Mohamed, S. (2002), Non-value adding activities: A comparative study of Indonesian and Australian construction projects, Proceedings of the 10th annual conference of lean construction, Gramado, Brazil, pp.12.

Austin, E., Atkinson, J., Rogge, D. F., & Haggard, R. (2001). RS 153-1 The Field Rework Index: Early Warning for Field Rework and Cost Growth. Construction Industry Institute.

Azhar, N., Farooqui,R. U., Ahmed S. M. (2008), Cost Overrun Factors In Construction Industry of Pakistan, First International Conference on Construction In Developing Countries (ICCIDC–I) "Advancing and Integrating Construction Education, Research & Practice" August 4-5, 2008, Karachi, Pakistan

Barber,Y.C. (2000). Reducing rework costs in construction projects. Published Bsc thesis, University of Twente, San Pedro Sula, Honduras

Burati, J. L., Farrington, J. J. and Ledbetter, W. B. (1992). Causes of quality deviations in design and construction. *Journal of Construction Engineering and Management*, Vol. 118 (No. 1), 34-49
Business Roundtable (1982) Causes of quality deviations in design and construction.

Chan D.W.M. and Kumaraswamy M.M. (1997), A comparative study of causes of time overruns in Hong Kong construction projects, *International Journal of Project Management*, 15 (1): 55-63.

Chan, A. P. C. and Tam, C. M. (2000); "Factors affecting the quality of building projects in Hong Kong," *International Journal of Quality & Reliability Management*, vol. 17, pp. 423-441.

CII (2008). RD-310 Safety Analysis For Nuclear Power Plants. Ottawa: Canadian Nuclear Safety Commission

Cooper, K. G. (1993), The rework cycle: Benchmarking for the project manager, *Project management Journal*, 24 (1): 17–22.

Dalty, R. and Crawshaw, R. (1993). RS 203-1 Making Zero Rework A Reality. Construction Industry Institute. Austin: CII

Dania, A.A., Kehinde, J.O. & Bala, K. (2007). A study of construction material waste. In: Egbu, C.O. & Tong, M.K.L (Eds). Proceedings of the 3rd Scottish Conference for Postgraduate Researchers of the Built & Natural Environment (PRoBE) 20-22 November, Glasgow, United Kingdom. Glasgow: Glasgow Caledonian University, pp. 121-129

Davis, K., Ledbetter, W.B. and Buratti, J.L. (1989), Measuring design and construction quality costs, *ASCE Journal of Construction Engineering and Management*, 115 (3): 389–400.

Elchaig, T., Boussabinaine A., and Ballal T. (2005) “Critical determinants of construction tendering costs: Quantity surveyors’ standpoint”, International Journal of Project Management.

Elinwa, A.U, Joshua, M. (2001). “Time overrun factors in Nigeria construction industry”, *Journal of Construction. Engineering Mgt*., 127(5): 419-25.

Endut, I. R. Akintoye, A. and Kelly J. (2005), Cost and time overruns of projects in Malaysia, Proceedings of the 2nd Scottish Conference for Postgraduate Researchers of the Built and Natural Environment (PRoBE) 16-17 November, Glasgow Caledonian University.

Fellows, R. R. and Liu, A. (2008). Research Methods for Construction, 3rd Edition. WileyBlackwell Science,

Fayek, A. R., Dissanayake, M., and Campero, O. (2003), Measuring and classifying construction field rework: A pilot study, Research report, Construction Owners Association of Alberta (COAA), The University of Alberta, Edmonton, Canada.

Fayek, A. R., Dissanayake, M., and Campero, O. (2004), Developing a standard methodology for measuring and classifying construction field rework, *Canadian Journal of Civil Engineering*, Vol. 31 No.(6), pp.1077-1089.

Hwang, B.-G., Thomas, S. R., Haas, C. T. and Caldas, C. H. (2009). Measuring the Impact of Rework on Construction Cost Performance. *Journal of Construction Engineering and Management*, 187

Josephson, P. E., Larsson, B. and Li, H. (2002), Illustrative benchmarking rework and rework costs in Swedish construction industry, *ASCE Journal of Management in Engineering*, Vol.18 No.2, pp. 76-83.

Laryea, S. and Hughes, W. (2008). How contractors price risk in bids: Theory and practice. *Construction Management and Economics, 26*(9), 911-924.

Laryea, S. and Hughes, W. (2009). How contractors in Ghana include risk in their bid prices. In: Dainty, A. (Ed) Procs 25th Annual ARCOM Conference, 7-9 September 2009, Nottingham, UK, Association of Researchers in Construction Management, 1295-1304.

Love P. and Sing C. (2013), Determining the probability distribution of rework costs in construction and engineering projects, *Structure and Infrastructure Engineering Journal* , Vol.9, No.11 pp. 1136–1148.

Love P.E.D and Irani Z. (2002), A project management quality cost information system for the construction industry, *Information and Management*, Vol.40, No.(7), pp. 649-661.

Love, P. E. (2002a), Auditing the indirect consequences of rework in construction: A case based approach‖, *Managerial auditing journal*, Vol.17, No.(3), pp. 138-146.

Love, P. E. D., Holt, G., Shen, L., Li, H. and Irani, Z. (1999). "Using Systems Dynamics To Better Understand Change And Rework In Construction Project Management Systems." *Int. J. Proj. Manage*., 20(6), 425–436

Love, P. E. D., Mandal, P. and Li, H. (1999a), determining the causal structure of rework in construction projects, *Construction Management and Economics*, 17 (4): 505–517.

Love, P., & Edwards, D. (2004a), "Determinants of Rework in Building Construction Projects ", *Engineering, Construction and Architectural Management*, 11(4), pp.259 - 274.

Mahamid, I. (2016). Analysis of Rework in Residential Building Projects in Palestine. Jordan *Journal of Civil Engineering*, Volume 10, No. 2.pp 197-208.

Marosszeky, M. (2006). Performance Measurement and Visual Feedback for Process Improvement, A Special Invited Lecture presented in the SMILE-SMC 3rd Dissemination Workshop on 11th February 2006, Centre for Infrastructure and Construction Industry Development of The University of Hong Kong, Hong Kong.

Meshksar, S. (2012); Cost And Time Impacts Of Reworks In Building A Reinforced Concrete Structure. Master Thesis. North Cyprus, Gazimagusa: Eastern Mediterranean University

Oke, A. E. and Ugoje, O. F. (2013) "Assessment of rework cost of selected building projects in Nigeria", *International Journal of Quality & Reliability Management*, Vol. 30 Issue: 7, pp.799-810, doi: 10.1108/IJQRM-Jul-2011-0103

Okpala, D.C. and Aniekwu, A.N. (1988), Cause of high cost of construction in Nigeria. *Journal of Construction Engineering and Management*, ASCE , 114 (2) 223-34.

Oyewobi, L. O., Ibironke, O. T, Ganiyu, B. O. and Ola-Awo, A. W. (2011a): Evaluating rework cost- A study of selected building projects in Niger State, Nigeria. *Journal of Geography and Regional Planning* Vol. 4(3), pp. 147-151, March 2011

Palaneeswaran, E. (2006)." Reducing Rework to enhance Project Performance Levels", Proceedings of the one day Seminar on "Recent Developments in Project Management in Hong Kong.

Rogge, D. F., Cogliser, C., Alaman, H. and McCormack, S. (2001). RR 153-11 An Investigation of Field Rework in Industrial Construction. Construction Industry Institute. Austin: CII

Simpeh, E. K. (2012), An Analysis of the causes and impact of rework in construction projects‖, A dissertation presented to the Higher Degrees Committee of the Cape, Peninsula University of Technology in fulfillment of the requirements for the degree of Master of Technology: Construction Management, Bellville

Sinha, M. and Wayal, A. S.(2007), Dispute Causation In Construction Projects, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Available at: http://www.iosrjournals.org/iosr-jmce/papers/sicete(civil)-volume1/13.pdf, (accessed 30 March 2019)

Walker, T. C. (1994). Total Quality Management as Competitive Advantage: A Review

and Empirical Study. *Strategic Management Journal* , Vol. 16 (1), 15-37

Wasfy, M. A. (2010), Severity and impact of rework, A case study of a residential commercial tower project in the eastern province-KSA‖, Master Thesis. Dhahran, Saudi Arabia: King Fahd university of petroleum and minerals

APPENDIX

PROJECT QUESTIONNAIRE

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

EXPLORING STRATEGIES FOR REDUCING REWORKS IN THE CONSTRUCTION INDUSTRY OF GHANA

Dear Sir/Madam,

This questionnaire is being conducted in partial fulfilment of the award postgraduate degree (MSc). Moreover, this research seeks to explore strategies to reduce reworks in the construction industry.

The core objectives of this research are:

1. To evaluate the causes of reworks in the construction industry;
2. To assess the effects of reworks in the construction industry; and
3. To explore strategies to reduce reworks in the construction industry.

Please we would be grateful if you could answer this questionnaire to aid this study. **All information collected will be confidential and would only be used for academic purposes** Thank you for your time and contribution to this study in advance.

Yours faithfully,

Johnson Oteng Ampofo

Supervisor:

Mr. Joe Kingsley Hackman

KNUST

PART A: DEMOGRAPHIC BACKGROUND OF RESPONDENTS

Please, kindly respond to the questions by ticking (√) the appropriate box for each item.

1. Kindly indicate your gender

[ ] Male

[ ] Female

2. Please indicate which category you belong

[ ] D1K1 Construction company

[ ] Consultancy company

3. Please indicate your years of working experience in the construction industry

[ ] 5 years and below

[ ] 6 – 10 years

[ ] 11 – 15 years

[ ] 16 – 20 years

[ ] 21 and above years

4. Please indicate your highest level of education

[ ] HND

[ ] First degree

[ ] Masters

[ ] PhD

PART B: CAUSES OF REWORKS IN THE CONSTRUCTION INDUSTRY

The following are causes of reworks in the construction industry. Kindly rank them using the following Likert scale **[1=Not severe; 2=Less severe; 3=Moderately severe; 4= Severe; 5=Very severe]**. Please tick (√) in the space provided.

No	CAUSES	1	2	3	4	5
1	Drawings and specification errors or omissions					
2	Deficiencies in documentation control					
3	Scopes and design changes					
4	Lack of attention to detail					
5	Ineffective communication					
6	Poor decision making process					
7	Poor monitoring and control					
8	Deficiencies in forecasting field conditions					
9	Poor scheduling of construction resources					
10	Poor development and application of realistic work procedures					
11	Untimely deliveries or misplacement					
12	Defect of prefabrication					
13	Equipment and tools not sufficiently advanced					
14	Inadequate knowledge of action required to complete task successfully					
15	Lack of domain-specific skill					
16	Deficiencies in personnel training					
17	Violation of rules or policy, or failure to adhere to work instructions or procedure					
18	Lack of motivation					
19	Failure to implement Quality management practices					
20	Lack of Audit and control					
21	Non-compliance with specification					
22	Inadequate pre-project planning					
23	Adulterated materials					
24	Acts of God/Force Majeur					
25	Political situation/siege					
26	Conflict of interest					
	Any other please state and rank					

PART C: EFFECTS OF REWORKS IN THE CONSTRUCTION INDUSTRY

The following are effects of reworks in the construction industry. Kindly rank them using the following Likert scale **[1=Not severe; 2=Less severe; 3=Moderately severe; 4= Severe; 5=Very severe]**. Please tick (√) in the space provided.

No	EFFECTS	1	2	3	4	5
1	Results in human health hazard or equipment failure					
2	Monetary loss due to the delay of work					
3	Leads to time shift of subsequent jobs					
4	Late site hand over					
5	Cost overrun					
6	Litigation					
7	Loss to the economy					
8	Decrease in economic activities					
9	Arbitration					
10	Wastage of resources					
	Any other please state and rank					

PART D: STRATEGIES TO REDUCE REWORKS IN THE CONSTRUCTION INDUSTRY

The following are strategies to reduce reworks in the construction industry. Kindly rank them using the following Likert scale **[1=Not significant; 2=Less significant; 3=Moderately significant; 4= Significant; 5=Very significant]**. Please tick (√) in the space provided.

No	STRATEGIES	1	2	3	4	5
1	Effective Leadership					
2	Sufficient and capable human resources					
3	Employee involvement					
4	Effective Communication					
5	Teamwork effectiveness					
6	Project documentation					
7	Strict resistance against cheating (fraud fighting)					
8	Quality/rework auditing					
9	Strong qualified supervision					
10	Continuous evaluation before and during the implementation of work					
11	Commitment to safety (Strict laws)					
12	Unification work standards					
13	Strengthen personnel internal ethics					
14	Job security					
15	Qualified Consultant					
16	Qualified Contractor					
17	Owner involvement					
18	Field verification					
19	Minimization work stress					
20	Supplier prequalification					
21	Effective planning and scheduling					
22	Using lean construction improvement					
	Any other please state and rank					