UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

ANALYSIS OF REWORK IN CONSTRUCTION PROJECTS IN AHANTA WEST DISTRICT AND TAKORADI METROPOLITAN ASSEMBLY

PRINCE MAWUENA KPEGBA

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A project presented to the to the Department of CONSTRUCTION AND WOOD TECHNOLOGY EDUCATION, Faculty of TECHNICAL EDUCATION, University of Education, Winneba in partial fulfillment of the requirements for the award of Degree of Master of Technology (Construction Technology Education)

SEPTEMBER, 2018

DECLARATION

STUDENTS' DECLARATION

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

SIGNATURE: …………………………

DATE……………………….............

SUPERVISOR'S DECLARATION

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

NAME: DR. NONGIBA ALKANAM KHENI

SIGNATURE……………………………

DATE…………………………………

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DEDICATION

I dedicate this piece of work to the almighty God for protecting and guiding me throughout the period. Most especially for giving me the wisdom and knowledge to carry out this research work to a successful end. Not forgotten my family members and especially my pastor, who is my source of inspiration and hope.

May God shower his limitless blessing on all. Amen.

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ABSTRACT

Rework at the construction phase is a common occurrence during project execution and can lead to time and cost overruns. The aim of the study was to assess the effects of rework on construction project performance in Ghana. The study adopted a quantitative research design and the target population was consultants to assemblies and permanently employed constructional professionals with assemblies (project stakeholders). A sample size of seventy-two (72) was selected. The findings revealed that changes initiated by the client, changes initiated by the design team due to errors and omissions, poor coordination, and finally, poor integration among the design team were the major contributing factors to rework. Moreover, non-compliance with specifications, setting-out errors, low labour skills, and emphasis on time and cost aggravated the occurrence of rework on site. The study revealed that while there is no significant difference between the causes of rework and various project types, rework can and often does make a significant contribution to any project's cost overrun. The study revealed that cost overruns, time overruns and design team dissatisfaction all impacted on project performance. The findings indicate that design related rework can be minimised by implementing the following strategies: team building, involvement of subcontractors and suppliers, and design for construction. Moreover, involvement of subcontractors during construction, and the implementation of quality control and site quality management systems could also lead to reduction in rework during the construction phase. The research concludes by recommending that design and construction firms should develop organisational measurement systems for recording rework occurrence and its associated costs. It is by determining the frequency and costs of rework that effective strategies for its containment and reduction can be identified.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The construction industry plays a major role in national development. However, it faces significant problems of high cost of project delivery, bad financial performance and inability to deliver value to customers on time. As a result, the industry is often criticized extensively for poor performance, inefficient productivity and low demand. Cost and time overruns as well as poor quality of construction work have become the biggest canker of the construction industry. A major factor contributing to this setback is rework. Rework refers to unnecessary effort of redoing an activity that was inaccurately done the first time (Love, 2002a). Rework is a chronic problem in construction and engineering projects. Various definitions if rework have been propagated, which has resulted in significant discrepancies in reported cost. It includes design and construction errors, omissions, and changes that may arise.

Robinson – Fayek et al. (2003) refers to rework as the "total" direct cost of re-doing work in the field regardless of initiating cause" in essence, rework and wastage have become recognized as non-value adding endemic symptoms that seriously affect the performance and productivity aspects of construction projects (Alwi, Hamps & Mohammed, 2002; Josephson, Larson & Li, 2002). Palaneeswaran (2006) stated that the construction industry is mainly project – based and various perplexities are inherent in the construction projects such as dealing with diverse interests of multiple stakeholders and resultant changes. Due to these characteristic complexities of construction, amendments may be deemed inevitable in some instances; however, uncontrolled occurrences of rework and wastage should actually be more effectively controlled. When construction products do not meet the requirements or expectations, work often has to be redone. Rework occurs in various phases of the construction process or in various division of a company.

Rework is a major contributor to time wastage and schedule overruns which eventually impact on cost, resources and quality (love and Edwards, 2004a). Cooper (1993) stated that rework emerges as overtime, the additional hiring of resources such as labour and plant workers, schedule slippage and reductions in project scope and quality. The adverse consequences of rework include reduced profit, loss of market shave, damaged reputation, increased turnover of management and workforce, lower productivity, higher, costs and finally, costly litigation between participants over responsibility for overruns and delays (Ackermann, Eden & Williams, 1997; cooper, 1980, Eden, Williams & Howick, 2000). According to Davis, Lebetter and Burati (1989), the additional cost to construct caused by rework can be as high as 12.4 % of the total project cost. Similarly, Love (2002a) suggested that rework typically increased total project cost by 12.6%. the actual costs could be substantially higher, however, because these findings did not account for schedule delays, litigation costs and other intangible cost of poor quality. The indirect cost of rework, according to Love (2002b), could be as much as six times the cost of rectification. Knowing and understanding rework causes can provide the basis to stimulate learning with in the project environment especially when litigation proceedings have been enacted. It is against this backdrop that this research intends to examine the effect or rework on project performance, thereby contributing to the enhancement of the attainment of value for money.

1.2 Problem Statement

Rework has become an acceptable and regular feature of Ghanaian construction projects. Most buildings constructed in Ahanta West District and Takoradi Metropolitan Assembly, have a lot of challenges after completed. These challenges include building roofs destroyed by rainstorm or rainfall, roof leakage, cracks in walls and decay of timber components. Construction deficiencies which call for rework are caused by a variety of issues such as direct and indirect causes, such as poor-quality management practice, poor contract administration and document practice, lack of effective communication between client and project team, incompetent site management team and contractors on site lack of skills, poor coordination emphasis on time and cost and overall work organization have not been fully examined in terms of their frequency and project phases. Furthermore, the effect of rework on cost and overall project performance has been overlooked. Research undertaken by Cox et, al. (1999) reveals that the cost of design-related change orders could range from 5 to 8% of the constructive value, even when projects are managed effectively, as most of the changes are initiated by clients Hwang et, al. (2014) reported in their study that, changes initiated by clients were a primary cause of rework. In addition, Kakitahi et al (2014) stated that having quality framework in place will improve project governance and reduce rework as reported by Burati et al. (1992).

It is very important to find the major causes of reworks in the construction projects in the Ahanta West District and Takoradi Metropolitan Assembly so as to determine an optimal approach to reducing the negative impact it has on projects.

It is however not clear on the understanding of the stakeholders what the causes of reworks are and what needs to be done in preventing or minimizing the occurrence. This study seeks to offer knowledge which will help stakeholders gain much insight on the underlying causes of reworks and also offer recommendations that would help reduce the occurrence of rework.

1.3 Aims and Objectives of the Research

The aim of the study is to examine rework and its effects on construction project delivery in the Ahanta West and Takoradi Metropolitan Assembly. The specific objectives of the study are as follows:

- to determine the causes of rework in construction project in Ahanta West District and Takoradi Metropolitan Assembly;
- to identify the key effects of rework on project performance in Ahanta West District and Takoradi Metropolitan Assembly;
- to identify effective ways of addressing the effects of rework in Ahanta West District and Takoradi Metropolitan Assembly; and,

1.4 Research Questions

- What are the causes of rework in construction project in Ahanta West District and Takoradi Metropolitan Assembly?

- What are the key effects of rework on project performance in Ahanta West District and Takoradi Metropolitan Assembly?
- What are the effective ways of addressing the effects of rework in Ahanta West District and Takoradi Metropolitan Assembly?

1.5 Significance of the Study

The findings of the study will enable project participants to be aware of the influence rework has on the performance of construction projects and therefore enable them to take actions towards mitigating the undesirable effects rework has on construction project performance in district assemblies in the study area and other similar assemblies in Ghana. Also, the study will contribute to value for value and thus be of immense benefits to clients of the construction industry. The study will add to knowledge in the area of construction management research and therefore serve as reference literature for construction professionals.

1.6 The scope of the Study

The study was limited to data gathered from the construction industry in Ghana area in Ahanta West District and Sekondi–Takoradi Metropolitan Assembly. Information was gather from the following stake holders in both construction and consultancy firms: site managers, architects, quantity surveyors and engineers.

1.7 The Limitation and Delimitations of the Study

A major setback of this research is that owing to time and financial constraints the number of respondents interviewed in the survey were not an adequate representation of the population (Stakeholder in the construction industry). And the time to administer questionnaires. The researcher has noticed the effects of reworks in Western Region and in all the District but would like to take the study in only Ahanta West and Sekondi Takoradi Metropolitan Assembly. The study will comprise the site managers, architects, quantity surveyors, project managers and engineers.

1.8 Organisation of the Study

The introductory chapter comprises the background information, the problem statement, Research Questions, aims and objectives, the scope of the Study, The Limitation and Delimitations of the Study and the organisation of the Study. The introductory chapter outlines the framework of the study. The historical background emphasised the fact that rework is wasteful and provided insight regarding the impact of rework in construction projects. Subsequently, the problem statement and hypotheses were formulated based on the background information. The aim of the study is to determine the underlying causes of rework during construction and the impact of rework on overall project performance. The limitations of the study have been stated and the key concepts defined, including errors, non-value-adding activity, omissions and rework. The Organisation of the Study presented an overview of each chapter of the study.

The second chapter will review related literature on the research topic.The literature review emphasises the previous works of numerous authors related to the study, discussing some of the literature related to the root causes and impact of rework in construction projects. The methods adopted to address the research questions and to achieve the objectives of the study will be presented in chapter three. The chapter highlights the methodology utilized to drive through the study to establish the aims and objectives. It also discusses the sample size, data collection instruments and how these were administered. Chapter four will cover the presentation, analysis and discussion of results. The chapter will enable the research to come with the findings in relations to the objectives of the study. The last chapter is chapter five and reports on the summary of findings, the conclusion of the study and the general recommendations of the study as well as recommendations for further research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews the literature pertaining to rework, covering, the previous studies on rework pertaining to the Ghana construction industry, the nature of rework and rework as a waste of time and cost. This section will also discuss the pervasiveness of rework and factors influencing rework occurrence and their causes, the cost of rework and impact on construction projects.

2.2 The Ghanaian Construction Industry

The construction industry is one of the backbones of the nation's economy contributing about 8.5% to the overall Gross Domestic Product (GDP) and employing 2.3% of the active population (Akomah et al., 2010). However, it is one industry that is inundated with poor performance. This is because many who head even the large Ghanaian owned construction firms have little or no knowledge about the industry (Tawiah, 1999). They have limited knowledge in the application of basic management techniques in solving problems on life projects. The deficiency in knowledge has led to the haphazard use of financial, material and human resources which does not promote organizational growth (Vulink, 2004).

The industry is highly unstable. It has high inflationary rate which devalues the capital of contractors and makes it extremely difficult for contractors to manage their firms (Dansoh, 2005). This makes it impossible for local contractors to complete with foreign firms who have the financial muscles to undertake large and complex projects (Vulink, 2004). There are number of challenges that the contractor in Ghana face. Every one of the challenges has a way of influencing performance. Laryea (2010) identified finance, payment delays, poor designs, quality issues, personnel issues, bribery and corruption and poor contractor classification and low workloads as some of the challenges of Ghanaian contractors. He said funding and access to credit by contractors are the two problems appear to be connected to many other problems that Ghanaian contractors have to contend with in the running of their businesses. He concluded by acknowledging that any improvement in access to finances and credit will not be a universal remedy to the problems faced by firms but will give firms the opportunity to be selective in their pursuit for projects.

2.3 Nature of Rework

A review of literature was conducted which provided an operational definition of rework was required to clearly indicate what is and what is not considered rework in the present study. For the purposes of the research, Rework is a chronic problem is construction and engineering projects. A wide variety of studies examining the nature of rework have been undertaken since the seminal research of Burati in the early 1990s, which examined quality deviations. Rework will include the following: design errors and changes that affect construction activities, constructability errors, additional or missing scope due to designer or constructor errors and on-site fabrication errors that affect construction activities.

According to Love (2002) rework has various definitions and interpretations within the construction management literature: terms for it include “quality deviations” Burati et al. (1992), “nonconformance” Abdul-Rahman (1995), “defects” Josephson and Hammarlund (1999), and “quality failures” Barber et al. (2000).

Love et al. (2000) characterize rework as the unnecessary effort of redoing a process or activity that was incorrectly implemented the first time. Similarly, field rework is defined as activities that have to be done more than once or activities that remove work previously installed as part of a project CII 2001. Based upon CII's definition, Fayek et al.

2003 proposed a definition of rework that adds the constraint that rework caused by scope changes and change orders from owners should not be

classified as rework. In the sense of conformance, there are two main definition of rework (Love 2002b; Fayek et al. 2003). The first definition is that rework is the process by which an item is made to conform to the original requirement by completion or correction (Ashford, 1992). The second definition, given by the Construction Industry Development Agency (1995), holds that rework involves doing something at least one extra time due to nonconformance to requirements.

Feng, Tommelein and Booth (2008) classified rework as either positive or negative. Positive rework adds value, for instance, when designs are reworked and participants in the design process leave with a better understanding of customer requirements. Fundamentally, rework becomes necessary either when an element of building works fails to meet customer requirements, or when the completed work does not conform to the contract documents. In either scenario, the product is altered so as to ensure conformity (Feng et al., 2008). Burati et al. (1992) used deviation categories based on construction, design, operability, fabrication and transportation to identify the causes of rework from nine fast-tracked industrial construction projects. Love, Wyatt and Mohamed (1997) proposed a rework classification system based on three principle groups: people, design and construction. Love et al. (1997) concluded that some causes are interrelated due to the complexity of construction operations. Love and Li (2000) also classified rework in three categories, namely client-initiated changes, non-variation, and defects.

2.4 Consequences of Rework

Rework has many effects on construction projects. The sections that follow present a discussion of the consequences of rework in the construction industry.

2.4.1 Waste Associated with Rework

Koskela (1994) described the construction process as a combination of value-adding activities and non-value-activities. Value-adding is to change the form, fit or function of a product in order to satisfy the customer (Allen, 2000). For instance, in the purchase of a constructed facility, Seibert, Seppanen, Kunz and Paulson (1996) stated that the buyer or owner values those components that are in place when the owner or end-user occupies the building. The activities essential to place these are therefore clearly value adding. Value-adding activities are only part of the work completed during a construction operation. Maximizing the fraction of all activities that are value-adding increases the overall effectiveness in adding value during a construction operation (Seibert et al., 1996).

Alarcon (1994), Koskela (1992) and Love, Mandel, and Li (1999a) stated that all those activities that produce costs, direct or indirect, and take time, resources or require storage but do not add value or progress to the product can be called non value adding activities or waste. For instance, when rework ensues, numerous non value-adding activities with associated costs are likely to arise, activities which include idle plant and labour during the waiting time, demolitions, time taken by the designer to understand the required change and redesign, and cost and time for litigation in case misunderstanding arises between the contractor and the client or client's consultant (Ndihokubwayo, 2008). According to Alarcon (1994), Koskela (1992) and Love, Mandel, Li (1997) waste categories are measured as a function of their costs, including opportunity costs. Furthermore, other types of waste are related to the efficiency of process, equipment or personnel. Ekanayake and Ofori (2000) classified construction waste into three main categories: materials, labour and machinery waste. However, any effort in terms of labour, materials and machinery which is directed towards the construction of a part or element of a building and which has to be done again due to non-conformity to the design constitutes a waste, which is also seen as rework.

Alarcon (1995) argued that construction activities are characterized by high contents of non-value-activities leading to low productivity. For this reason, process improvement, through identifying and eliminating rework, has a significant impact on productivity. Love and Irani (2002) stated that non-productive time is waste as waste consists of inactivity and ineffective work. The author stressed that inactivity includes waiting time, idling time, and travelling time. In the same vein, ineffective work includes rectifying mistakes and errors, working slowly and inventing work. In project-based transactions, any occurrence of rework is mainly considered as an unnecessary non-value adding item (Love, Mandal & Li, 1999a) that should be avoided if not completely eliminated. Fayek, Dissanayake and Compero (2003) intimated that rework costs are determined from the point where rework is initially identified to that final time when rework is completed and the activity has returned to its original state. The duration of the cost tracking includes the length of the standby time once rework is identified, the time required to carry out the rework, and the time required to gear up to carry on with the original scope of the activity. Saukkoriipi (2005) concluded that will most construction industry stakeholders are arguably interest in the reduction of overall production costs, they are not always of the extent of non-value adding activities on construction projects.

2.4.2 Pervasiveness of Rework in Construction Projects

Rework is a pervasive problem within the construction industry, but many firms are reluctant to openly acknowledge it is an issue because it can potentially damage their reputation. The construction industry has the iniquitous reputation of being fragmented, lacking coordination and communication between parties, creating adversarial contractual relationship and lacking customer focus (Love, Edward & Smith 2005). Besides, there is generally an absence of systems within projects to monitor and control rework (Hwang, Thomas, Haas & Caldas, 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, Holt, Shen, Li and Irani (2002) stated that both the internal and external environment of construction projects are dynamic and relatively unstable. Tasks performed in construction projects are typically divided between professional architect, structural engineer, project manager and trade disciplines (the contractors' and sub-contractors' carpenters, bricklayer, plumbers), which frequently operate independently of one another.

Oyewobi and Ogunsemi (2010) reported that the genesis of the problem experienced by the construction industry and clients lie in the division of the responsibilities between the design and construction aspect. A direct criticism of the organizational 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, planner, 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 visualize 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). Oyewpbi 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 constructors-dissatisfied at the conclusion of the project. Thus, as construction involves the execution of this design process will unavoidably lead into rework and resultant time and cost overruns in both phase-design and construction (Oyewobi & Ogunsemi, 2010). The allocation of resource and planning of the documentation process are significantly important facets that need to be addressed if rework is to be reduced (Love, Mandal, Smith & Li, 2000).

Oyewobi and Ogunsemi (2010) stated that one major factor responsible for having buildings that will require rework is lack of adequate information, build-ability of many designs and the separation the contracts interfaces, that is, separation of the design and construction interface, coupled with the fact the construction processes are still sequential in nature. Indeed, the multitude of interfaces that exist between functional disciplines has unwitting created a potential barrier of the effective and efficient flow of project information. Thus, the flow of physical resources and information from one discipline in a supply chain may become dysfunctional as rework emerges (Love, Edward & Smith, 2005).

2.5 Factors Influencing the Occurrence of Rework

Rework is excepted to occur in all construction projects. Factors influencing its occurrence include the, the procurement method and the complexity of the project.

2.5.1 Procurement Factors

Those involved in the procurement of building invariably do not realize the extent of rework that actually occurs (Love, Mandel & Li, 1999a) conceded that there is an escalating need to improve the quality of operations throughout the procurement process in order to reduce the occurrence of rework. The type of procurement method may then influence the extent of rework that might occur in a project. For instance, non-traditional methods are subject to higher rework level than traditional methods, especially when errors, omissions, or changes occur (Love, 2002a). Traditional methods can provide clients with cost certainty, whereas non-traditional methods are often used when the pressure of early completion is imposed on the project (Holt, Proverbs & Love, 2000). Maizon (1996) concluded that one of the principal reasons for the construction industry's poor performance is the in appropriateness of the procurement systems selected for construction projects.

2.5.1.1 Traditional Method of Procurement

Morledge (2002) stated that under traditional methods (design-bid-build), such as traditional lump sum and traditional with provisional quantities, the cost can be determined with reasonable certainty before construction starts. In addition, Ibeyemi, Adenuga and odusami (2008) maintain that the traditional approach provides a better pedestal for ensuring quality control. Moreover, under traditional methods, design and documentation are supposed to be complete, or at least largely complete, before construction commences onsite, so in theory there should be less rework attributable to design-related sources (Love, 2002a). However, traditional methods of procurement have been heavily criticized for their sequential approach to project delivery, as they have contributed to the so-called "procurement gap" whereby design and construction processes are separated from one another (Love, Gunasegaram and Li, 1998a). As a result, Love et al. (1998) suggest that behavioral, cultural and organizational differences exist between project individuals. In addition, the procurement gap that exists between design and construction inhabits communication, coordination, and integration among project team members which can subsequently cause rework and adversely affect project performance (lahdenpera, 1995; Evbuomwan and Anumba, 1996). As a result, traditional procurement is not entirely suitable for

2.5.1.2 Non-traditional Methods of Procurement

Hanna, Russell, Gotzin and Nordheim (1999) asserted that to satisfy the requirement of time, a plethora of non-traditional procurement methods have surfaced in the marketplace resulting in the compression of design and construction schedules and construction commencing before the final design is complete. As design and construction time compressed, the degree of overlap, or concurrency, between activities increases which in turn increases project complexity as activities are sub-divided into trade packages (Love, 2002a). For instance, under design and build procurement method, a single contractor assumes the risk and responsibility for designing and building the project (Morledge, 2002).

Design and build method (D&B) in imputed with a time –saving mechanism which makes many activities overlap thereby minimizing delay in completion time and reducing frequent adjustments in design (Ibeyemi, Adenuga, & Odusami, 2008). One key advantage of using D&B is the opportunity to integrate the design and construction components; Saxon (2000) and Banik (2001) argued that integration of design and construction offers better performance in time and cost resulting in fewer defects. With construction management procurement method, the client employs the design team and a construction manager is paid a certain fee to programme and coordinate the design and construction activities and to improve the build-ability of the design (Morledge, 2002). The management contracting, also known as a "fast-track" strategy is suitable where all design necessary for those packages must be complete. As design is completed, subsequent packages of work are tendered and let (Morledge, 2002).

The package deal, or turnkey procurement method, is where the client has little involvement in the design development or building procurement process, a complete hands-off approach (Morledge, 2002) which is less prone to rework. Hoed maker, Blackburn, and Van Wassenhove (1999) indicated that there is a limit to the number of tasks that can be carried out in a concurrent manner. Beyond this specified limit, the probability of rework occurring, as well as time and cost overruns being experienced, increases significantly, primarily due to the complexities associated with communication and coordination of a large number of tasks undertaken concurrently (Love, Mandel, Smith & Li, 2000). Non-traditional methods such as construction management and design and build have been advocated a method for overcoming some of the problems inherent in traditional methods (NEDO, 1988; Turner, 1990; Master man, 1994). Yet in a study conducted by Love (2002a) to establish the influence of project type and procurement method on rework costs in building construction projects, it was demonstrated that their use is minimal.

2.5.2 Complexity of the Project

NEDO (1988) and Naoum and Mustapha (1994) indicated that facility types are linked to the concept of complexity and thus have influence on project performance. Baccarini (1996) declared that project complexity consists of many varied interrelated parts. Ireland (2007) stated that complexity involves an item having two or more components or two or more variables. Love, Li and Mandal (1999b) stated that in construction projects, activities are typically divided into functional areas performed by different disciplines such as architects, engineers, and contractors and that therefore operate independently. Customarily, each discipline makes decisions without considering the impact on others. Love and Irani (2002) maintained that these functional disciplines often develop their own objectives, goals and value systems. So, each discipline has become dedicated to the optimization of its own function with little regard to its effects on the performance of the project as whole with which they are involved.

2.6 Causes of Rework

Causes of rework differ from one country to another and from one project type to another therefore, the costs of rework between countries hould not be relied upon, but simply suggestive, as levels and interpretations of quality will differ between countries. Local practices, incidence and cost of rework (Love, Mandal & Li, 1999). Rework is significant factor that contributes negatively to the construction process and directly lead to client dissatisfaction, reduces profitability and in extreme circumstance, litigations and other negative consequences. The nature of rework is that it is caused by problems in quality management processes (Mochal, 2005). Several research efforts have attempted to identify and classify the causes of rework, and to quantify its overall extent. Bon-Gang, (2009) suggested that rework is often due to the complicated characteristic of the construction processes and that it can also arise from a number of sources such as changes, non-conformances (e.g. quality deviations), and defects. Fayet et al. (2004) identifies five major causes of rework, they are: human resource capability, leadership and communications, engineering and reviews, construction planning and scheduling, and materials and equipment supply. However, Love and Edwards (2004) classify the root causes of rework into design – related factors, client-related factors, and contractor related factors. This study investigated the cause of reworks based of these three factors.

2.6.1 Design-related Factors

A large number of findings have emphasized the fact mot rework originate at the design stage than in the construction stage. Palaneeswaran (2006) identified seven ways the design-related factors result in rework;

(i) Ineffective use of quality management practices,

(ii) Ineffective use of information technologies,

(iii) Lack of manpower to complete the required tasks,

(iv) Insufficient time prepare the contract documentation

(v) Incomplete design at the time of tender,

(vi) Poor conditions between different design team members.

According to Trigunarsyah (2004), problems attributable to design include"

- Detailing – inaccurate or inadequate detail;
- Specification – incorrectly specified or inappropriate materials and components
- Legislation – inadequate knowledge of or disregard for legislation or guidelines;
- Co-ordination – inadequate coordination between client/designer, designer, and designer/ contractors;
- Communication – poor interaction between client/designer, and designer/ contractors;
- Supervision – inadequate supervision by designer, and constructability – lack of design empathy for construction.

2.6.3 Site Management Related Factor

Palaneeswaran et. al. (2005b) identify site management – related factors as deemed to cause rework. They are:

(i) Poor planning and coordination of resource;

(ii) Ineffective use of information technologies;

(iii) Setting – out errors;

(iv) Ineffective use of quality management practices;

(v) Staff turnover or reallocation to other projects, and

(vi) Failure to provide protection to constructed works.

2.6.4 Subcontractor-related Factor

Josephson et al. (2002 found that inadequate managerial and supervisory skills and the carelessness by subcontractors were the primary factors that contribute to rework. Multi-layered subcontracting and low skill level of labourers in subcontracted works are also widely recognized as a contributor to rework. The use of poor quality materials by subcontractors is identified as a cause of rework. Other subcontractor related factors that might cause rework includes damages, defects, poor workmanship, constructability associated concerns, poor site conditions and other environment parameters such as failure to provide protection to construction works, changes in construction method errors due to inappropriate construction methods, and the omissions of some activity or tasks.

2.6.5 Client-related Factors

Mainly, the client factor-based rework causes are from design and construction related sources such as the design changes made at the request of clients and the construction related changes initiated by the client. There include:

(a) After some work have been undertaken on-site, and

(b) When a product/ process had been completed.

The client-related rework factors include:

i. Lack of experience and knowledge of the design and construction process;

ii. Lack of funding allocated for site investigation,

iii. Lack of client involvement in the project;

iv. Inadequate briefing;

v. Poor communication with the design consultants, and

vi. Inadequacies in contract documentation.

2.7 Cost of Rework

According to businessdictionary.com, rework cost is the standard or actual cost of correcting defective work. This is a preventable cost that increases overall operating costs.

2.7.1 Overview of Cost of Rework

Love (2002b) stressed that there is a lack of uniformity in the way in which rework cost data have been collected because of the various interpretations as to what constitutes rework. Arguably, the measurement of rework costs in itself does not result in improvement; it merely provides the starting point for establishing new knowledge (Love & Holt, 2000). Love (2002b) suggested that design and construction organization must implement a quality management system, supported by a quality cost system, in order to reduce the costs of rework. Only when organizations begin to measure their rework costs carefully will they fully appreciate the economic benefits of achieving high quality by eliminating the root causes of rework. Likewise, the BRE (982) stated that 15% savings on total construction costs could be achieve through the elimination of rework, and by spending more time and money or prevention. To improve the performance of construction organisations and reduce costs, Davis et al. (1989), Abdul-Rahman (1993) and low and Yeo (1998) have stressed the need to measure quality costs.

Love and Li (2000) agreed that prevention and appraisal costs are unavoidable costs that much be incurred by construction companies and consultant and consultant firms if their products and services are to be delivered right the first time. Figure 2.2 illustrates the quality cost components that must be incurred by construction organizations to improve their performance in order to reduce rework. The quality cost components are two-fold, namely cost of control and cost of failure control. The cost of control comprises prevention and appraisal cost. Love and Irani (2002) stated that prevention costs involve amounts invested to prevent or reduce errors and defects, whilst appraisal costs include the detection of errors or defects by measuring conformity to the required level of quality. Cost of failure control includes internal and external failure costs. Internal failure costs will be incurred as a result of scraping or reworking defective product or compensation for delays in delivery; on the other hand, external failure costs involves cost of repairs, returns, dealing with complaints and compensation after a product has been delivered to the client (Love and Irani, 2002).

Barber, Graves, Hall, Sheath and Tomkins (2000) acknowledged that rework costs could be as high as 23% of the contract value, with a number of factors contributing to rework cost. According to Love (2002b), these include the extent of quality management practices implemented, the type of project, the form of procurement method used, and project complexity. Love and Edwards (2004a) noted that the Construction Industry Development Authority in Australia found that the average cost of rework in projects without a formal quality management system is 6.5% of contract value and the high value for a project under lump sum procurement was 15%. Conversely, the average cost of rework for projects with a quality system was found to be 0.72%. The cost of rework is poorly managed projects can be as high as 25% of contract value and 10% of the total projects costs (Barber et al. 2000; Love and Li, 2000). For example, the Construction Task Force in the UK reported that up to 30% of construction work is related to rework (Egan, 1998); similarly, the USA based Construction Industry Institute has estimated that the annual loss due to rework could be as high as 15 billion US dollars for industrial construction projects (CII, 2001b). Josephson and Hammarlund (1999) reported that the cost of rework on residential, industrial, and commercial building projects ranged from 2% to 6% of their contract value. Love and Li (2000) found the cost of rework to be 3.15% and 2.40% of the contract value for a residential and an industrial building respectively. In addition, Love and Li (2002) found that when a contractor implemented a quality assurance system in conjunction with an effective continuous improvement strategy, rework costs were less than 1% of the contract value. According to Cusack (1992), projects without a quality system in place typically experience a 10% cost increase because of rework.

Comparatively, the costs of quality deviations in civil and heavy industrial engineering projects have been found to be significantly higher. For example, Burati et al, (1992) studies nine major engineering projects to determine the cost associated with correcting deviations to meet specified requirements. The results of the study indicated that, for all nine projects, quality deviations accounted for an average of 12.4% of the contract value. A significantly lower figure was reported by Abdul-Rahman (1995) who found non-conformance costs (excluding material wastage and head office overheads) in a highway projects to be 5% of the contract value. Love and Edwards (2005), from a national questionnaire survey in Australia, stated that the total cost of rework is a function of both direct and indirect rework costs. While there has been a plethora of research seeking to determine the direct (tangible) costs of rework, the indirect (Intangible) costs remain unexplored in construction. This is because it is difficult, if not impossible; to quantify such costs is purely monetary term (Love 2002b). typically, research efforts have focused on determining direct rework costs at the expense of indirect costs which consequently remain relatively unknown (Josephson, 2000).

To explore cost control and failure of rework, Figure 2.2 shows the quality cost component diagram adopted from Feigenbaum, (1991) which aim at developing a standard methodology for measuring and classifying cost control of rework costs and its preventive costs, appraisal costs, and the internal and external cost failures.

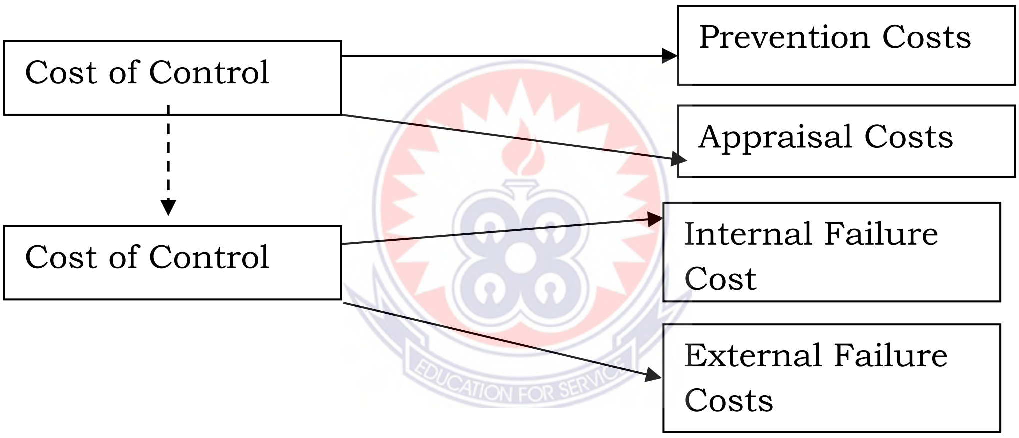

Figure 2.2: Quality cost component: Cost of control and failure

Adapted from: Feigenbaum, 1991.

2.7.2 Direct Cost

Love (2002a) stressed that direct costs are readily cost are readily measureable, often quoted in evaluating quality of workmanship and representing a significant proportion of total project costs. Tommelein, Ballard, Rundall, and Feng (2007) stated that direct rework cost includes man hour, schedule, equipment, materials and space. The Construction Industry Development Agency in Australia (CIDA, 1995) has estimated the direct cost of rework in construction to be greater than 10% of project cost. Thus, if a 10% rework value applied to the annual turnover of the Australian construction industry, which in 1996 was estimated to be $4.3 billion per annum. Numerous studies have attempted to quantify the direct costs of rework in building and engineering projects (Burati et al., 1992). These direct costs (of rework) have been found to be as high as 25% of contract value (Barber et al., 2000).

2.6.3 Indirect Cost

Indirect costs are not directly measurable and include loss of schedule and productivity, litigation and claims, and low operational efficiency (Love 2002a). Similarly, Tommelein, Ballard, Rundall, and Feng (2007) stated that indirect costs have to do with performance factors, changeover, coordination and network impacts. Love (2002b) opined that there is little known about the indirect consequences of rework in construction projects, especially the financial costs. Besides, there has been limited research that has sought to determine the indirect costs of rework in construction projects. In a study conducted by Love (2002b) to audit the indirect consequences of rework in construction, he found that the most significant indirect cost for the drafting firm was related to the extension of its original contract period for the project, as this affected the organization's capacity to take on new contracts. Furthermore, when information was made available, additional resources had to be employed and overtime paid, as deadline needed to be met.

2.8 Impact of Rework on Project Performance

Rework has different impact on project performance depending on the time it occurs in a construction process. Since rework is the act of performing a task more than once, it can occur at different stages throughout the project life cycle. Fayek et al. (2004) declares that rework clearly has huge impact on project performance whether or not projects can be completed within time and cost constraints. Rework also has a large general impact on the industry as a whole; the impact of rework can be direct or indirect. The following impact on project delivery resulting from rework can be identified they are time overruns inflation, cost overruns, client dissatisfaction, contractor financial difficulties, contractor dissatisfaction, demotivation, design team dissatisfaction, poor contract management, and litigation. These are likely consequences of rework: end user dissatisfaction, inter-organisational conflict, stress, fatigue, work inactivity, demotivation, and professional image.

2.8.1 Cost Overruns

Cost overrun is a very common phenomenon and majority of projects in the construction industry is faced with this problem. It is the change in contract amount divided by the original contract award amount. Cost overrun=Final actual cost – Original budget cost. From above cost overrun is defined as the excess of actual cost over budget, cost overrun is called cost escalation, cost increase or budget overrun. Jahren and Ashe (1990 found that a cost overrun rate of 1 to 11% is more likely to occur on biggest projects compared to overrun on smaller projects but mentioned that managers on big projects typically make special efforts to keep cost-overrun rates low. Jahren and Ashe also determined that the risk of high cost overrun rates is grater when the winning bid amount is less than the engineer's estimate and further identified some cost-overrun factors such as the contract document quality, nature of interpersonal relations on the projects and contractor policies. Hinze et al (1992) analyzed cost overrun associated with Washington State highway projects and found that the cost overruns expressed as a percentage of the contract amount tended to increase with project size. In an economic and efficiency audit study for the state of Delaware, Wagner (1998) found that state's department of transportation experienced cost overrun averaging 13.9% between 1994 and 1996, largely due to changes in the work scope and incorrect estimates of work quantities in the original bid specifications. The most important time and cost overrun factors according to contractors were preparation and approval of shop drawings, time and cost overrun in contractor's progress, payment by owners and design changes by owner (Assaf et al. 1995.

In a study by Florida's Office of Program Policy Analysis and government Accountability it was determined that the state suffered from an average 9% cost overrun rate. Avots (1983) in a study conducted indicated that cost overrun occurs when the final cost or expenditure of the project exceeds the original estimation cost. Angelo and Reina (2002) pointed out that cost overrun is one of the main problems in construction industry. The problem may be found in both developing and developed countries. There are some contributing factors to cost overrun in construction industry which are found from the researcher's study. The factors are presented in the sections that follow.

2.8.2 Time Overrun

Time overrun is defined as the extension of time beyond planned completion dates traceable to the contractors (Kaming et al., 1997). Delays are incidents that impacts a project's, unavailability of resource, design delays, etc. in general, projects delays occur as a result of projects activities that have both external and internal cause and effects relationship (Vidalis et al., 2000). Choudhry (2004) and Chan (2001), defined time overrun as the difference between the actual completion time and the estimated time. It was measured in number of days. Elinwa and Joshua (2001) defined it as the lapse between the agreed estimation or completion date and the actual date of completion. If the project works complete less than 100% but more than 80% the contractor could ask the owner to extend the project and the additional cost handles by them. If the owner agrees with the contractor's request, the contractor has to finish the work on time with the extended time requested. If the contractor still cannot finish the project on time the contractor must pay a sum of money referred as a penalty maximum 5% from the contract values per-day to the owner. In general project delays occur as a result of project activities that have both external and internal cause and effect relationship. Project delays are those that cause the project completion date to be delayed, (Al-Gahtani et al., 2007). Delay could be defined as the time overrun either beyond completion date specified in a contract or beyond the date that the parties agreed upon for delivery of a project.

It is a project slipping over its planned schedule and is considered as common problem in construction projects. In some cases, to the contractor delay means higher overhead costs because of longer work period, higher material costs through inflation and due to labor cost increase. From above, time overruns are defined as the time increase to complete the project after planed date which caused by internal and external factors surrounded the project.

2.8.1.2 Quality Degradation

According to Construction Quality in South Africa (CQSA) (2011), value to clients is a very complex and often a subjective issue, but it is recognized that quality of construction is a key component of perceived value to clients. As noted by FIDIC, lack of quality in construction is manifested in poor or non-sustainable workmanship and unsafe structures, and in delays, cost overruns and disputes in construction contracts. Mastenbroek (2010) stated that rework often means that parts of a structure have to be scrapped and new material needed to rebuild, a result of compromise with quality which leads to wastage of resources.

2.9 Conceptual Framework

A conceptual framework is necessary to develop and order to de4pict how the relation is correlated and the direction between the pairs. The conceptual outline below shows the factors or causes of construction rework.

The diagram below illustrates the causes of construction rework project is a dependent variable which means it is the variable whose value depends on another such as the independent variables. The variables whose variation does not depend on that of another whiles the government policies has a moderating effect on the strength of the relationship between the independent and the dependent variables. This is illustrated in figure**2.3**

Independent VAriables

Client-related factors

- Lack of experience
- Lack of funding
- Lack of client involvement
- Inadequate time

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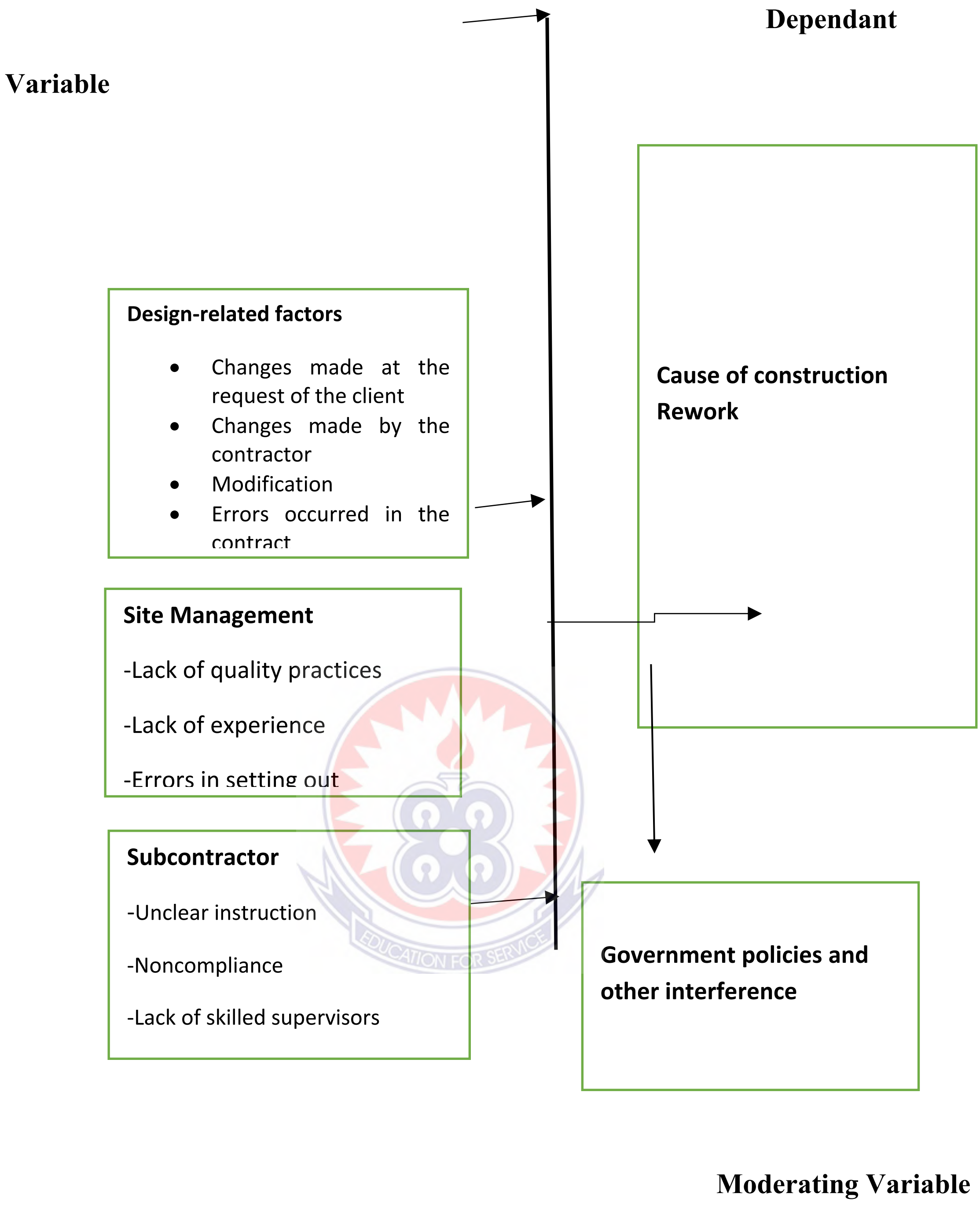

Figure 2.3: Conceptual Framework

Source: Authors Own Construct, 2018

2.10 Chapter Summary

The literature examines the causes and burden of rework in the structure industries in several lands. The ultimate purpose of the Confederacy African expression companies should be to eliminate all incidents of rework in order to maximize profits and provide adequate customer satisfaction. The first literature provides context for the study by reviewing a brief history of rework pertaining to the South African construction diligence. The literature study indicated that little is known about rework causes, and because of this, there are no mechanics in place for tracking the cost and impact on undertaking performance.

Rework in construction labor has the potential to unnecessarily absorb resource without adding value to the project I which case rework is waste. Rework can potentially occur on all construction projects, as its pervasiveness is due to the coordination compound nature of the industry. It was also noted that the fragmented nature of the industry intensifies the frequency of rework because activities performed are divided between master and business deal field of study which frequently operate independently of one another and have different objective lens to achieve. Coupled with that, the design mental process is separated from the construction process. The literature suggested that the nature of the works, the procurement method and the complexity of the project were genes that influence the occurrence of rework in construction projects.

A knowledge and understanding of how rework emanates will possibly inform how the incidence of rework can be reduced and even possibly eliminated. Node-related, design related and contractor-related factors including site management and subcontractor's factors were established, including human resource capability, leadership and communication, engineering and follow-up, construction planning and schedule, and textile and equipment supply. Moreover, restudy monetary value is dependent on a number of factors, such as the extent of timber management practices implemented, the type of project, the form of procurement method used, and project complexity. Rework can potentially increase the totality cost of twist. Therefore, the literature suggested the design business firm and building governance must establish mechanisms for tracking rework cost and implement quality arrangement in order to minimize rework costs. Two types of cost associated with rework were identified, direct and indirect costs. However, little is known about the indirect (intangible) costs in construction because it is difficult, if not impossible, to quantify such costs in pure monetary terms.

Finally, the literature highlighted that rework adversely affects construction project performance by contributing to cost and time overruns. It was established that the frequent occurrence of rework can affect the overall quality of work and tarnish the professional picture of company involved (consulting business firm, design team and construction organizations) in the labor. Rework in many instances also gives rise to disputes between contracted parties. The next chapter will propose a research design best suited to identify the causes and effects of rework in construction projects.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The methodology chapter discuses and outlines the research strategies, the research methods, the research approach, the selection of the sample, the research process, the type of data analysis, the ethical consideration as well as the data collection procedure which includes the questionnaire design and administering the questionnaire. In addition, the data analysis techniques, testing of the hypotheses and reliability of the data collection instrument have been outlined.

3.2 Research design

The research design refers to the overall strategy that you choose to integrate the different components of the study in a coherent and logical way, thereby, ensuring you will effectively address the research problem; it constitute the blueprint for the collection, measurement, and analysis of data Bell (2005) stated that the research design methodology chosen is an important part of any research project, as it gives the overall framework for collecting and formulating the data needed for the research. The argument presented by Leedy and Ormrod (2010) concerning the choice of research methods is used as a basis, where consideration should be given to the nature of the data that will be collected in the resolution of the problem. Moreover, Leedy and Ormrod (2010) suggested that a pragmatic presentation regarding the data may be perhaps most expeditiously handled if the following four principle questions with respect to research data are answered. The quantitative research design was adopted because it concerned with measuring quantity or amount and involving statistical manipulation, or hypothesis testing. It deals with members and their manipulation in order to gain insight in that which is being studied.Data collecting techniques included questionnaires, and actual physical measurements of the phenomena such as weight, ages and duration of projects.

"*The type of data needed"* Data pertaining to the underlying causes of rework during construction and its impact of cost and overall project performance will be gathered. "*The location of the data needed"* Data will be collected through engaging with senior management staff from both construction and consulting firms in the Ghanaian construction industries in Ahanta West District and Sekondi-Takoradi Metropolitan Assembly.

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"How will the data be obtained" Data will be obtained through a self-administered questionnaire, containing both open and closed-ended questions, which will be formulated and distributed to get the data. *"How will the data be interpreted"* Field data will be analysed and compared to the literature and suggestion will be made as to effective strategies for rework reduction/elimination. Leedt and Ormrod (2010) concluded that the research methodology must help to explain what the nature of the data is, and what method is used to process them to arrive at final conclusions.

The design was exploratory and descriptive using quantitave methods. It was exploratory because knowledge about examine rework and its effects on construction project was researched in depth and descriptive because effective strategies for rework reduction/ elimination are described. The response from the questionnaire was coded and assigned numerical values to describe the data. Also information gathered was described using frequencies and percentages.

3.3 Population of the study

A study of a group of individuals taken from the general population who share a common characteristic, such as age, sex, or health condition. A research population is generally a large collection of individuals or objects that is the main focus of a scientific query. In order to assess the effect of rework on construction project performance in Ghana, a wide range of personnel (Stakeholder in the construction industry) involved in construction of projects were targeted (managers, architects, quantity surveyors, project managers and engineers. The target population of the study was therefore consultants to assemblies and construction professionals who are permanent staff of assemblies. The field studies carried out revealed the population size to be 72 for the Ahanta West District and Sekondi-Takoradi Metropolitan Assembly.

3.4 Sampling Technique and Sample Size Determination

Sampling is a procedure, where in a fraction of the data is taken from a large set of data, and the inference drawn from the sample is extended to whole group. The sample method involves taking a representative selection of the population and using the data collected as research information. A sample is a "subgroup of a population" (Frey et al. 125). It has also been described as a representative "taste" of a group (Berinstein 17). The sample should be "representative in the sense that each sampled unit will represent the characteristics of a known number of units in the population" (Lohr 3).

The technique of non-probability sampling was adopted for this study. In non-probability sampling, there is no way of guaranteeing that each element of the population will be represented in the sample. Furthermore, some members of the population have little or no chance of being sampled (Leedy and Ormrod, 2010) However, Kothari (1995) argued that when using non – probability sampling, the particular units of the population which constitute the sample is purposively chosen on the basis that the small mass selected will be representative of the whole population.

A selected number of cases in a population are referred to as the sample (Walliman, 2005). Fellows and Liu (2008) stated that, where the research study is concerned, it is necessary to obtain data from only a portion of the total population. Fellows and Liu (2008) further asserted that an important aspect of sampling is the determination of the size of the sample to be studied. Moreover, Leedy (1997) argued that sample size is dependent on the degree to which the sample population embodies the qualities and characteristics of the general population. More specifically, the first step is sampling for any research study would be to define the population. If the population is sufficiently small, a full population may be researched. However, in the majority of research projects, a sample must be taken as a representation of the population (Fellows and Liu, 2008). This study covered all the 72 project Stakeholders in the Ahanta West District and Sekondi-Takoradi Metropolitan Assembly. The sampling technique adopted was therefore a census since the population size was small.

3.5 data collection Instrument

Data was collected from the population using the questionnaire techniques or instrument.

The researcher used questionnaire because apart from being inexpensive and flexible, questionnaires are also a practical way to gather data and can be targeted to groups of your choosing and managed in various ways. You can pick and choose the questions asked as well as the format (open-ended or multiple choice). They offer a way to gather vast amounts of data on any subject and large audience

Most questionnaire providers are quantitative in nature and allow an easy analysis of results. With built-in tools, it's easy to analyze your results without a background in statistics or scientific research. Tools like Survey Anyplace are easy to interpret reports and visualizations, meaning that you'll quickly be moving forward to turn your data into results. A built-in analysis also speeds up data gathering

3.6 Data Collection

A questionnaire needs to be governed by certain practical guidelines (Leedy and Ormrod, 2010). Firstly, the language used must be unmistakably clear, because what may be stated clearly in the questionnaire may be meaningless to the respondent. Secondly, questionnaires should be designed to fulfill a specific research objective, as questions are often inexpertly written, and this result in a low response rate (Leedy and Ormrod, 2010). Moreover, according to Fellows and Liu 2008), questionnaires should be unambiguous and uncomplicated for the respondent to answer. More specially, questionnaires should not require extensive data gathering by the respondent to facilitate answering the questions.

The researcher personally administered the questionnaire. Respondents were allowed sufficient days to complete the questionnaires. The questionnaires were series of structured questions which were related to the research work and directed to respondents with the aim of gaining firsthand information. The questionnaire consisted of both open ended and close ended questions. Thus, in some cases respondents were required to respond to a number of questions.

The project Stakeholder; managers, architects, quantity surveyors, project managers and engineers. were asked to respond to thirty (30) questions. The questionnaire afforded respondents much flexibility and privacy in answering the questions without any problem as regards interpretation. The researchers personally traveled to construction industries of companies in Industrials Area of the Ahanta West District and Sekondi-Takoradi Metropolitan Assembly.

3.5.1 Development of Questionnaires

The questions for the survey were formulated according to the research objectives and model established during the literature study. The questionnaire is comprised of seven sections, namely: profile or respondents, project characteristics, organizational management practices of participants, causes of rework, impact of rework, measurement of rework costs and rework containment strategies.

The first section (section A) of the questionnaire requested information about the profile of respondents. The information gathered includes the role of the organization and the current position of the respondents. Section B obtained information concerning the project and facility type, the contract value and duration, procurement method and the size of the project. Section C collected data from construction professional regarding their organization management practices. Section D solicited information regarding the causes of rework. The causes of rework were categorized into factors such as client-related, design-related, site management and subcontractors related and gathering of data was carried out using a five point Likert-scaled type questions. Section E obtained data pertaining to the rework. Likert-scaled type questions were designed to ascertain the level of impact of rework on cost. Time and organizational and project performances. Section F was designed to quantify the costs of rework, and the questions were based on a five point Likert-scaled type. Finally, section G requested information relating to the need for reducing/preventing rework. This area was examined by asking participants to suggest suitable strategies that can be adopted in reducing/preventing the causes of rework. The questionnaire for the main study can be found in Appendix A.

Table 3.1 present a summary of how the research objectives were address and proposed guideline for the design of the questionnaire. Respondents and participants to be used in this survey will include the following: contractors, architects, site engineers, consulting engineers, quantity surveyors and project managers. The questionnaires were administered by hand delivered. Fellows and Liu (2008) identified two forms of questionnaires which are opened or closed questionnaires, both of which were formulated to collect data.

Table 3.1: questionnaire design

Section	Title	Objectives to be addressed
A	Profile of respondents	To determine the role of the firm
B	Project characteristics	Type of project and facility, as well as other relevant details.
C	Organisational management practices	
D	Causes of rework	Objective 1
E	Impact of rework	Objective 2

According to Fellows and Liu (2008), an open-ended questionnaire is designed to enable the respondent to answer the questions fully y answering in any manner and to the extent the respondent chooses. Furthermore, the natives, expectations and true feelings of the respondent surface when open-type questions are asked. However, strewing and stead (2001) argued that open questions may demand a difficult and time-consuming tabulation of responses

A closed-ended questionnaire allows one to limit the number of responses by offering specific alternative from which the respondent must choose one or more. It simplifies the recording, tabulation and editing process considerably (Struwig and Stead 2001) Furthermore, closed-type questions are exact and to the point, and therefore the responses are clear, ending the responses of a similar nature to e grouped and quantified easily. Fellows and Liu (2008) claimed that closed-type questions force the respondent to make artificial choices because the questions.

3.5.2 Validity and Reliability of Questionnaire

According to Kirk and Miller (1986) and Silverman (2001), the issues of validity and reliability are important, for the reason that in them the objectivity and credibility of research is at stake. Perakula (2004) stated that enhancing objectivity is a very concrete activity. It involves efforts to guarantee the accuracy and inclusiveness of recordings that the research is based on, as well as efforts to test the truthfulness of the analytic claims that are being made about those recordings. Validity and reliability take different forms depending on the nature of the research problem, the general methodology that will be used to address the problem and the nature of the data that are collected (Leedy and Ormrod, 2010).

According to Leedy and Ormrod (2010), validity of a measurement instrument is the extent to which the instrument measures what it is supposed to measure. Similarly, research validity simply refers to the correctness or credibility of the research findings (Maxwell, 1996). Golafshani (2003) stated that engaging various methods and data sources will lead to more valid, reliable and diverse construction of realities. According to Yin (2003), exploratory case studies involve two areas of validity namely: construct and external validity. Construct validity refers to the assertions about the effectiveness of the operational measures used in a study (Sackett and Larson, 1992). External validity refers to aspects of study the language used was unmistakably clear secondly, questionnaires were designed to fulfill the specific research objectives. According to Grummesson (1991), reliability is the extent to which a method can be replicated by others under similar conditions. Likewise, Leedy and Ormrod (2010) defined reliability as the consistency with which the measuring instrument yields a certain result when the entity being measured has not changed.

In this research, an internal reliability test will be done on Likert-scaled where the data reliability is related to the data source and the identification of the position held by the person who completed the questionnaire.

To improve the level of construct validity in this study, questionnaires administered during the exploratory study would be kept and subsequently transcribed. The transcribed documents were given to each person that had been interviewed to check and resolve any discrepancies that may have arisen and eliminate any interviewer partiality.

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3.6 Data Analysis

To ensure accuracy in the information, the data gathered from the field of study were edited by the researcher. The data collected were analysed in themes as they emerged from literature and match with the response from the questionnaire. The researcher generated these themes from the literature, reviewed and looked for data that matched or agree with these predetermined themes. The collected data was analyzed using quantitative data analysis methods. Quantitative method involved both descriptive and inferential analysis. Descriptive analysis such as frequencies and percentages present quantitative data in form of tables. Statistical analyses including descriptive statistics was carried out using the Statistical Product for Service Solution (SPSS) version 21.0. The inferential statistics involving the use of t-test and Analysis of variance (ANOVA).

CHAPTER FOUR

PRESENTATION AND ANALYSIS OF RESULTS AND DISCUSSION

4.1 Introduction

This chapter of the study deals with the analysis of the data obtained from the field. The data analysis is grouped under the various themes formulated from the objectives of the study. The data analysis also considered the personal data of the respondents of this study. A total of 72 questionnaires were distributed and 52 were completed and returned. Of the returned questionnaires, 2 were not useable and therefore did not form part of the analysis of the data. The response rate was therefore 69%.

4.2 Personal Particulars of Respondents and Project Characteristics

This section provides background data of the respondents. There were a total number of fifty (50) respondents. These includes Architect, Consulting Engineer, Project manager, Contractor, Quantity surveyor and Site Engineers. The bio data (personal data) of respondents considers the category of personnel best describes you, work experience, construction projects have you been involved in and the type of projects has your organization been engaged in.

4.2.1 Field of Specialization of Respondents

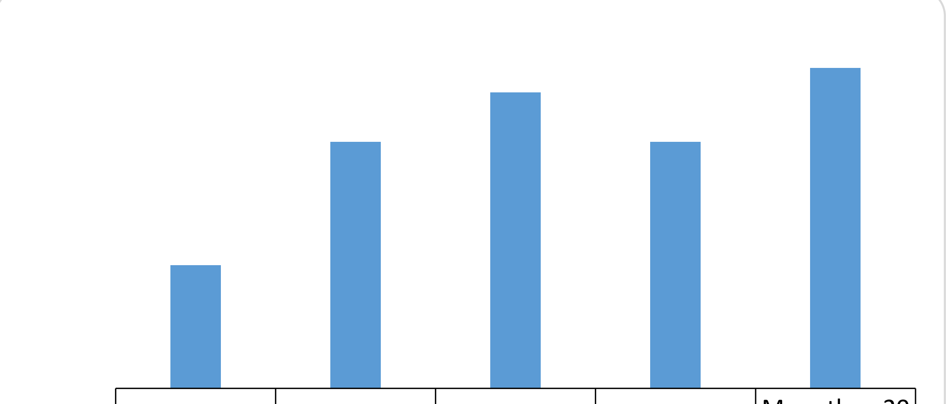
Table 4.1 indicates the category of work the respondents engages in. data shows that majority of the respondents were project managers representing 11(22%) whilst the minority were quantity surveyor and site engineer constituting 7(14%) each.

Table 4.1: Specialization of the survey respondents

Variables	Frequency	Percentage
Architect	8	16.0
Consulting Engineer	8	16.0
Project manager	11	22.0
Contractor	9	18.0
Quantity surveyor	7	14.0
Site Engineer	7	14.0
Total	**50**	**100.0**

4.2.2 Experience of the Respondents

The respondents were asked to indicate their years of working experiences that is worked in the construction industry. Amazingly majority 26% confirmed they had worked for more than 20 years and above. The least however had been or worked below 5 years representing 10% (See Figure 4.1)



	Below 5 years	6-10 years	11-15 years	16-20 years	More than 20 years
series	10%	20%	24%	20%	26%

Figure 4.1: Years of Working Experience

4.2.3 The Number of Projects Undertaken by Respondents

The number of construction projects the respondents had involved in is demonstrated in Table 4.2. The responses indicated that majority of them had 6-10 projects which depicts 30%. Also the least respondents' recorded 11-15 projects making a total of 12%.

Table 4.2: Number of construction projects respondents are involved in

Variables	Frequency	Percentage
1-5	9	18.0
6-10	15	30.0
11-15	6	12.0
16-20	10	20.0
More than 20	10	20.0
Total	**50**	**100.0**

4.2.4 Type of Projects Undertaken by Respondents

The type of projects the companies engaged in reflect the results in Table 4.3. Data shows that majority of the respondents had engaged in project for education. This represented 20% of the total responses. The least on the other hand engaged in hospital projects constituting 8%.

Table 4.3: Type of organization projects engaged in

Variables	Frequency	Percentage
Hospital	4	8.0
Banks	8	16.0
Education	10	20.0
Administrative	7	14.0
Commercial	6	12.0
Hotel/Motel/Resort	9	18.0
Entertainment	6	12.0
Total	**50**	**100.0**

4.2.5 Nature of Projects Undertaken by Respondents

The respondents were asked to indicate the nature of projects as to whether it was a new project of refurbishment/renovation. Slightly above half of the respondents agreed to new buildings indicating 52% whereas the remaining respondents attested to refurbishment/renovation that indicates 48% (Figure 4.2)

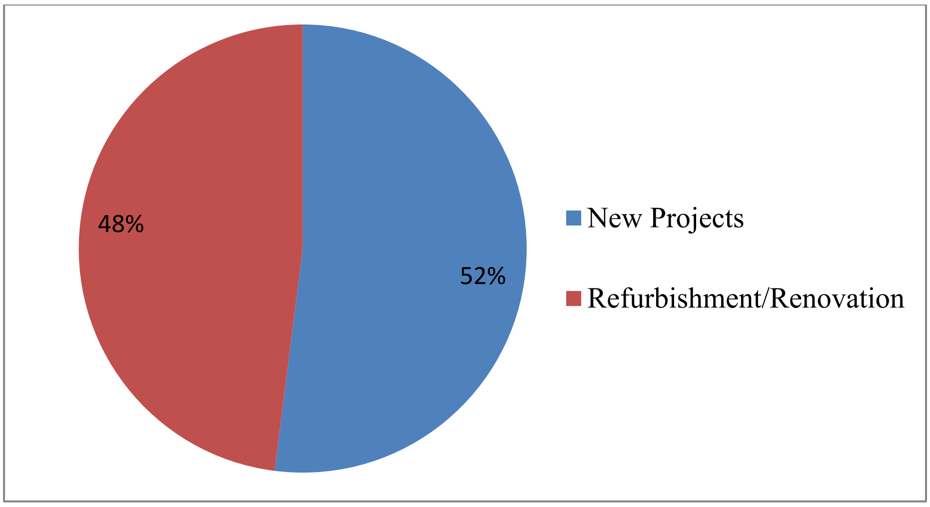


Figure 4.2: Nature of project undertaken

4.2.6 Number of Projects Recently Undertaken by Respondents

Table 4.4 Summarizes the number of projects recently undertaken by the respondents. The majority of the respondents had undertaken up to 3 projects whilst the least number undertaken was 1 representing 12%.

Table 4.4: Number of recent project

Variables	**Frequency**	**Percentage**
1	6	12.0
2	11	22.0
3	15	30.0
4	11	22.0
5 and above	7	14.0
Total	**50**	**100.0**

4.2.7 Methods of Procurements Adopted on Projects

Table 4.5 indicates the method of procurement used by the contruction industries. Traditional lump sum and turnkey method of procurement were recorded the highest.

These constitute 20% respectively. Design and build and traditional cost plus were the least depicting 6% correspondently.

Table 4.5 : Method of procurement used for projects

Variables	**Frequency**	**Percentage**
Traditional lump sum	10	20.0
Turnkey	10	20.0
Design and manage	9	18.0
Design and build	3	6.0
Traditional cost plus	3	6.0
Management contracting	9	18.0
Traditonal with	6	12.0
Total	**50**	**100.0**

4.2.8 Organizational Management Practices

Respondents were requested to indicate their perception concerning the quality management practices that were implemented using a 5-point Likert Scale where 1= not at all; 2 = to least extent; 3 = to some extent; 4 = to larger extent; and 5 = to a very large extent. Table 4.6 shows the rankings on quality practices in organizational management Practice by the respondents. Measurement of quality cost was ranked first with the mean score value of 4.8, followed by international standard organisation which was ranked second with mean value of 4.78 and quality function deployment was ranked third with 4.64 mean. Total quality management was 4.48 mean value whilst improvement to team/work teams recorded least 4.37 (Table 4.6)

Table 4.6: Quality practices in organizational management practice

Statements	1	2	3	4	5	Total	∑W	Mean	Rank
Measurement of quality cost	0	0	5	0	45	50	240	4.8	1
International standard organisation	0	0	0	11	39	50	239	4.78	2
Quality function deployment	0	0	0	18	32	50	232	4.64	3
Total quality management	0	3	0	17	30	50	224	4.48	4
Improvement to team/work teams	2	1	10	0	36	49	214	4.37	5

Learning practices are implemented in your company, the Respondents were requested to indicate their perception using a 5-point Likert Scale where 1= not at all; 2 = to least extent; 3 = to some extent; 4 = to larger extent; and 5 = to a very large extent. From able 7, data indicates that training programmes for staff and development and research were ranked first with the mean score values of 4.8 respectively. Self-learning of individual's workers and project reviews recorded the mean values of 4.78. Finally, the mean score value of 4.64 was recorded against internal seminars as the learning practices (Table 4.7).

Table 4.7: Learning practices are implemented in your company

Statements	1	2	3	4	5	Total	∑W	Mean	Rank
Training programmes for staff	0	0	5	0	45	50	240	4.8	1
Development and research	0	0	5	0	45	50	240	4.8	1
Self-learning of individuals workers	0	0	0	11	39	50	239	4.78	2
Project reviews	0	0	0	11	39	50	239	4.78	2
Internal seminars	0	0	0	18	32	50	232	4.64	3

4.3 Causes of Rework

In this section, the researcher sought to find out the knowledge of respondents about the causes of rework. From the data, the respondents were asked to indicate the extent to which the following client-related factors might be the cause of rework. From Table 4.8, lack of experience and knowledge of the design process was ranked first with the high mean score values of 4.8, lack of funding allocated for site investigations recorded 4.78, lack of client involvement in the project was 4.64, the mean value of 4.48 was recorded against inadequate time and money spent on the briefing process, poor communication among consultant, architect and engineer came with the mean value of 4.37 whiles the least low payment of fees for preparing contract documents was ranked least with the mean value of 4.08.

Table 4.8: Client-related factors and cause of rework

Statements	1	2	3	4	5	Total	∑W	Mean	Rank
Lack of experience and knowledge of the design	0	0	5	0	45	50	240	4.8	1
Lack of funding allocated for site investigations	0	0	0	11	39	50	239	4.78	2
Lack of client involvement in the project	0	0	0	18	32	50	232	4.64	3
Inadequate time and money spent on the briefing process	0	3	0	17	30	50	224	4.48	4
Poor communication among consultant, architect and	2	1	10	0	36	49	214	4.37	5
Low payment of fees for preparing contract documents	0	1	3	37	9	50	204	4.08	6

Table 4.9 is the demonstration of the respondents' perception to the extent of their agreement on whether design-related factors leads to cause of rework. Majority of the respondents confirmed to the changes made at the request of the client. This represented a high mean score value of 4.8. Changes made by the contractor during construction followed with the mean score value of 4.78 and modification initiated by the regulatory bodies was 4.64. The respondents again gave their views on errors occurred in the contract documentation recording the mean value 4.37 and omissions of items from the contract documentation was 4.08. The mean score value of 3.9 was assigned to ineffective use of quality management practices, poor planning of work load was 3.8 and the mean score value of 3.48 was against insufficient time

Table 4.9: Design-related factors and cause of rework

Statements	1	2	3	4	5	Total	∑W	Mean	Rank
Changes made at the request of the client	0	0	5	0	45	50	240	4.8	1
Changes made by the contractor during construction	0	0	0	11	39	50	239	4.78	2
Modification initiated by the regulatory bodies	0	0	0	18	32	50	232	4.64	3
Errors occurred in the contract documentation	0	3	0	17	30	50	224	4.48	4
Omissions of items from the contract documentation	2	1	10	0	36	49	214	4.37	5
Ineffective use of quality management practices	0	1	3	37	9	50	204	4.08	6
Ineffective use of information technologies	0	5	0	40	5	50	195	3.9	7
Poor planning of work load	4	0	3	38	5	50	190	3.8	8
Insufficient time	5	7	0	35	3	50	174	3.48	9

From Table 4.10, the data presents the results relative to site management factors that contributed to rework. By ranking the means, the results show that lack of quality management practices was recorded first 5, followed by lack of experience with 4.8 and errors in setting out was 4.64. Constructability errors according to the respondent views recorded the mean value of 4.6, poor planning of resources was 4.5, lack of safety and excessive overtime recorded 4.26 respectively.

Table 4.10: Site management and cause of rework

Statements	1	2	3	4	5	Total	∑W	Mean	Rank
Lack of quality management	0	0	0	0	50	50	250	5	1
Lack of experience	0	0	0	10	40	50	240	4.8	2
Errors in setting out	0	0	0	18	32	50	232	4.64	3
Constructability errors	0	0	0	20	30	50	230	4.6	4
Poor planning of resources	0	0	0	25	25	50	225	4.5	5
Lack of safety	0	0	6	25	19	50	213	4.26	6
Excessive overtime	2	3	10	0	35	50	213	4.26	6

Subcontractor-related rework was examined and Table 4.11 reveals the findings. After ranking the means of the responses, unclear instruction to workforce was rated as the most predominant subcontractor-related factor that contributed to rework and noncompliance with specification with the mean value of mean 4.4, respectively, followed by lack of skilled supervisors with mean was value of 4.1 and low labour skill level was 3.9. Defective workmanship came with the mean value of 3.8 whiles damage to other trades work due to carelessness recorded 3.5.

Table 4.11: Subcontractors-related factors and cause of rework

Statements	1	2	3	4	5	Total	∑W	Mean	Rank
Unclear instruction to workforce	0	3	0	17	30	50	220	4.4	1
Noncompliance with specification	2	1	10	0	36	49	214	4.4	1
Lack of skilled supervisors	0	1	3	37	9	50	204	4.1	2
Low labour skill level	0	5	0	36	5	46	179	3.9	3
Defective workmanship	4	0	3	38	5	50	190	3.8	4
Damage to other trades work due to carelessness	5	7	0	35	3	50	174	3.5	5

4.4 Effects of Rework on Construction Project Performance

The researcher sought to find out the effects of rework on performance of construction industries in table 4.12. The high mean score values of 4.4, 4.4 and 4.08 with its corresponding statements disputes among parties, time overrun and contractors dissatisfaction indicating rework affects performance. The statements such as end-user dissatisfaction, design team's dissatisfaction, contractual claims, quality degradation and cost overrun were ranked with the low mean score values of 3.9, 3.8 and 3.5 respectively.

Table 4.12: Effects of Rework on Performance

Statements	1	2	3	4	5	Total	∑W	Mean	Rank
Disputes among parties	2	1	10	0	36	49	214	4.4	1
Time overrun	2	1	10	0	36	49	214	4.4	1
Contractors dissatisfaction	0	1	3	37	9	50	204	4.08	2
End-user dissatisfaction	0	5	0	40	5	50	195	3.9	3
Design team's dissatisfaction	0	5	0	36	5	46	179	3.9	4
Contractual claims	4	0	3	38	5	50	190	3.8	4
Quality degradation	5	7	0	35	3	50	174	3.5	5
Cost overrun	5	7	0	35	3	50	174	3.5	5

From Table 4.13, the respondents were requested to indicate the extent to which rework impacted on their organization's performance. The high-ranking values of 5, 4.9, 4.84, 4.8 and 4.6 respectively. These corresponds with the statements such as absenteeism of workforce, reduced profit, loss of future work, inter-organisational conflict, de-motivation of workers and poor morale of workforce. This is an indication that all respondents agreed to the fact that rework has effect on the construction organizations.

Table 4.13: Effects of Rework on your Organization

Statements	1	2	3	4	5	Total	∑W	Mean	Rank
Absenteeism of workforce	0	0	0	0	50	50	250	5	1
Reduced profit	0	0	0	5	45	50	245	4.9	2
Loss of future work	0	0	0	7	36	43	208	4.84	3
Inter-organisational conflict	0	0	0	10	40	50	240	4.8	4
De-motivation of workers	0	0	0	10	40	50	240	4.8	4
Poor morale of workforce	0	0	0	20	30	50	230	4.6	5

4.5 Assessing the Cost of Rework

Figure 4.3, the respondents were asked if they do Record the Incidence of Rework for the Project. A high number 68% indicated sometimes, followed by 22% who said never and 10% confirming always.

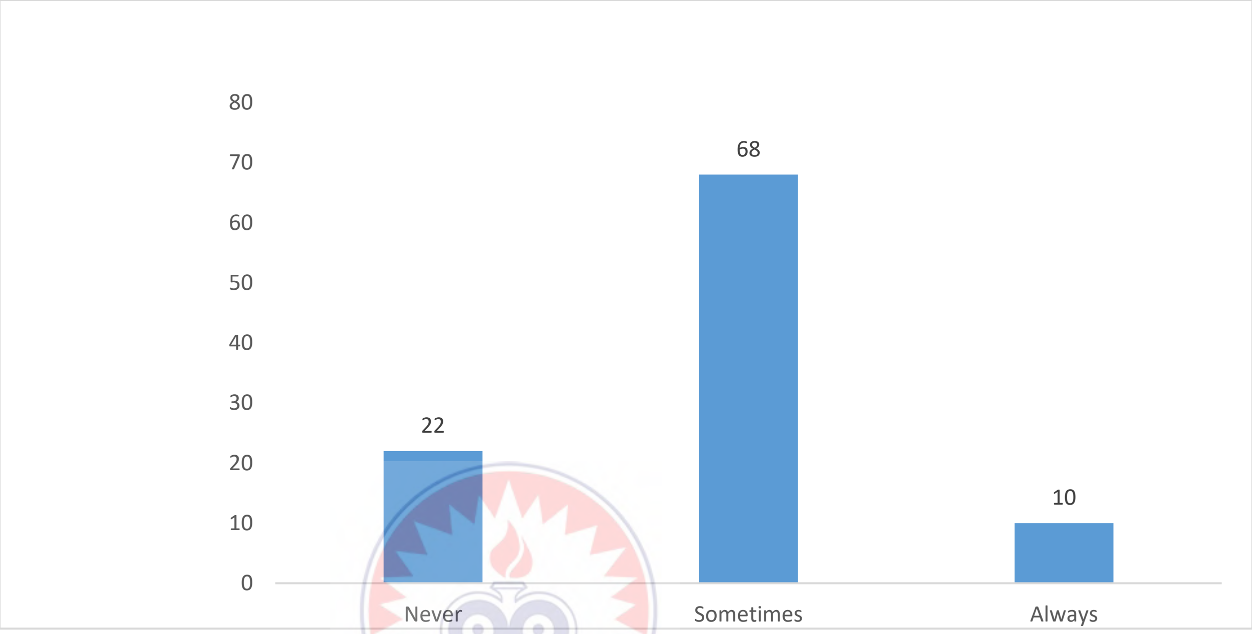


Figure 4.3: Record the incidence of rework for the project

Table 4.14 indicates the measurement of rework cost. Data shows that all the statements the system used for calculating direct cost of rework was efficient, the adverse impact of the cost of rework on profit has not been clearly reported, the method of recording rework occurrence was efficient and the mode of calculating indirect cost of rework was efficient were agreed all respondents indicating the low mean score vales of 1.6 and 1.7 respectively.

Table 4.14: Measurement of rework cost

Statements	1	2	3	4	5	Total	∑W	Mean	Rank
The system used for calculating direct cost of rework was efficient	24	21	5	0	0	50	83	1.7	1
The adverse impact of the cost of rework on profit has not been clearly reported	41	0	0	3	6	50	83	1.7	1
The method of recording rework occurrence was efficient	40	0	0	10	0	50	80	1.6	2
The mode of calculating indirect cost of rework was efficient	42	0	0	0	8	50	82	1.6	2

Table 15 demonstrate the extent to which rework costs attributable to each of the following design related sources for the project. All the respondents agreed to the statements modification made at the request of the contractor during construction, changes made at the request of the client, changes initiated by an end-user, errors made in the contract documentation and omission of clients from the contract documentation as attributable to rework costs. These affirms the high mean score values of 4.8. 4.6, 4.37 and 4.26 respectively.

Table 4.15: Design-related sources and cost of rework

Statements	1	2	3	4	5	Total	∑W	Mean	Rank
Modification made at the request of the contractor during construction	2	1	10	0	36	49	214	4.37	3
Changes made at the request of the client	0	0	6	25	19	50	213	4.26	4
Changes initiated by an end-user	2	3	10	0	35	50	213	4.26	4
Errors made in the contract documentation	0	0	0	10	40	50	240	4.8	1
Omission of clients from the contract documentation	0	0	0	20	30	50	230	4.6	2

In understanding how construction-related sources relates cost of rework is demonstrated in Table 4.16. From the table, only changes in construction methods due to site conditions as construction-related sources in relation cost of rework was agreed by majority of the respondents. The low rank values of 2, 3, 4 and 5 with its corresponded variables such as changes initiated by the client or an occupier after some work had been undertaken on site, changes initiated by the client or an occupier when a product or process had been completed, changes initiated by a contractor to improve quality, damages caused by a subcontractor and omission of some activity or task as its relation to cost of rework was affirmed minority of the respondents.

Table 4.16: Construction-related sources and cost of rework

Statements	1	2	3	4	5	Tota	∑W	Mean	Rank
Changes in construction methods due to site	2	1	10	0	36	49	214	4.37	1
Changes initiated by the client or an occupier	44	0	0	6	0	50	68	1.4	5
Changes initiated by the client or an occupier	41	0	0	3	6	50	83	1.7	2
Changes initiated by a contractor to improve	40	0	0	10	0	50	80	1.6	3
Damages caused by a subcontractor	42	0	0	0	8	50	82	1.6	3
Omission of some activity or task	40	0	6	4	0	50	74	1.5	4

The researcher sought to find out how cost source could lead to cost of rework as indicated in Table 4.17. The high rank with the mean score values of 4.8 and 4.6 corresponding to the statements overtime cost, Supervision and Disruption costs indicates majority agreement. The low rank representing 3th and 4th indicates the statements preliminaries (e.g. scaffolding) and fees for design consultants were agreed by minority of the respondents.

Table 4.17: Sources and cost of rework

Statements	1	2	3	4	5	Total	∑W	Mean	Rank
Overtime cost	0	0	0	10	40	50	240	4.8	1
Supervision	0	0	0	10	40	50	240	4.8	1
Disruption costs	0	0	0	20	30	50	230	4.6	2
Preliminaries (e.g.Scaffolding)	0	5	0	40	5	50	195	3.9	3
Fees for design consultants	4	0	3	38	5	50	190	3.8	4

4.6 Rework Containment Strategies

Table 4.18 depicts the Design-Management as Rework Containment Strategies. Data from the table shows that, all respondents disagreed to the strategies. This is evidence with the low mean score values of 2.4, 2.2 and 2.0. The statements such as computer visualization techniques, team building, design for construction, constructability analysis and involvement of subcontractor/suppliers during design represents the mean values.

Table 4.18: Design-management as rework containment strategies

Statements	1	2	3	4	5	Total	∑W	Mean	Rank
Computer visualization techniques	8	32	0	0	10	50	122	2.4	1
Team building	8	32	0	0	10	50	122	2.4	1
Design for construction	30	0	0	20	0	50	110	2.2	2
Constructability analysis	30	0	0	20	0	50	110	2.2	2
Involvement of subcontractor/suppliers during design	32	3	0	15	0	50	98	2.0	3

On site management as rework containment strategies which is displayed in Table 4.19 shows that the low mean score values of 1.7, 1.6, 1.5 and 1.4 with their corresponding statements value engineering, site quality manage system, involvement of subcontractors during construction, quality control and quality audits is an indication that the above rework strategies are nor adhered to.

Table 4.19: Site management as rework containment strategies

Statements	**1**	**2**	**3**	**4**	**5**	**Total**	**∑W**	**Mean**	**Rank**
Value engineering	41	0	0	3	6	50	83	1.7	1
Site quality manage system	42	0	0	0	8	50	82	1.6	2
Involvement of subcontractors during construction	44	0	0	6	0	50	68	1.4	3
Quality control	40	0	6	4	0	50	74	1.5	3
Quality audits	44	0	0	6	0	50	68	1.4	4

4.7 Influence Various of Procurement Methods on Rework Cost

The ANOVA test was used to determine if there was a statistically significant difference between the means of total rework costs for varying procurement methods. The ANOVA test in Table 4.20 revealed no significant differences between various procurement methods and total rework costs, F (6, 43) =0.860, p>0.05. This means that rework costs do not vary significantly with various procurement methods can therefore not be rejected.

Table 4.20: Analysis of variance (ANOVA) rework costs and procurement methods

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	12.458	6	2.076	.422	.860
Within Groups	211.542	43	4.920		
Total	224.000	49			

4.7.1 The Influence Various Project Types on Rework Cost

It was evident from the analysis of the questionnaire survey and case study that reworks are a common occurrence in construction projects.

Table 4.21 shows 49 degrees of freedom with the significance value (0.00) which is lesser than 0.05 indicating that there is significant difference between project types and client-related rework.

Table 4.21: t-test for client-related factors and project types

One-Sample Test						
	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Constructability errors	29.039	49	.000	3.180	2.96	3.40
Lack of experience and	30.91	49	.000	3.220	3.01	3.43
Lack of funding allocated for	52.20	49	.000	3.620	3.48	3.76
Lack of client involvement in	53.08	49	.000	3.640	3.50	3.78
Inadequate time and money	55.22	49	.000	3.680	3.55	3.81
Poor communication among	37.29	49	.000	3.560	3.37	3.75
Low payment of fees for	24.96	49	.000	3.060	2.81	3.31

Table 4.22, it is evident 49 degrees of freedom with the significance value (0.00) which is lesser than 0.05 indicating that there is significant difference between project types and design related rework

Table 4.22: One sample-test for design-related factors and project types

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval	
					Lower	Upper
Changes made at the request	31.45	49	.000	3.160	2.96	3.36
Changes made by the	54.08	49	.000	3.660	3.52	3.80
Modification initiated by the	54.08	49	.000	3.660	3.52	3.80
Errors occurred in the	33.35	49	.000	3.240	3.04	3.44
Omissions of items from the	33.35	49	.000	3.240	3.04	3.44
Ineffective use of quality	66.50	49	.000	3.800	3.69	3.91
Ineffective use of information	48.75	49	.000	3.480	3.34	3.62
Poor planning of work load	38.39	49	.000	3.620	3.43	3.81
Insufficient time to prepare	31.69	49	.000	3.320	3.11	3.53
In complete design at the	29.60	49	.000	3.280	3.06	3.50

From Table 4.23, 49 degrees of freedom with the significance value (0.00) which is lesser than 0.05 indicating that there is significant difference between project types and site management-related rework.

Table 4.23:One sample t-test for Site management-related factors and project types

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the	
					Lower	Upper
Lack of quality	31.742	49	.000	3.380	3.17	3.59
Lack of experience	49.319	49	.000	3.520	3.38	3.66
Errors in setting out	48.596	49	.000	3.460	3.32	3.60
Constructability	29.039	49	.000	3.180	2.96	3.40
Poor planning of	61.627	49	.000	3.760	3.64	3.88
Lack of safety	49.000	49	.000	3.500	3.36	3.64
Excessive overtime	63.875	49	.000	3.780	3.66	3.90

Table 4.24, 49 degrees of freedom with the significance value (0.00) which is lesser than 0.05 indicating that there is significant difference between project types and subcontractor related rework. Clearly, the T-test established that the causes of rework do differ significantly between the projects types.

Table 4.24: t-test for Subcontractor-related factors and project types

One-Sample Test

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of	
					Lower	Upper
Unclear instruction to	53.08	49	.000	3.640	3.50	3.78
Non-compliance with	27.21	49	.000	3.380	3.13	3.63
Lack of skilled	27.19	49	.000	2.840	2.63	3.05
Low labour skill level	49.00	49	.000	3.500	3.36	3.64
Defective	69.60	49	.000	3.820	3.71	3.93
Damage to other	24.68	49	.000	2.680	2.46	2.90

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter concludes the study, highlights the summary of findings that were identified during the survey and causes of rework in construction projects as well as key effects of Rework on Project Performance and effective ways of addressing the effects of rework and makes recommendations based on the findings. The conclusions are comprised of the findings from the exploratory study and the analysis of the questionnaire survey. The recommendation section discusses the outcomes and implications of the study.

5.2 Summary of Findings

The results of the survey analysis indicate that the root sources of rework in construction projects are the result of poor communication, lack of skills, errors, omissions and changes during both the design and construction phase. This was evident in the literature review. The findings also indicate that rework causes and costs can be influenced, to some extent, by the nature and complexity of the project and the procurement method used in acquiring the project. The research instrument revealed that the cost of undertaken rework in renovation/refurbishment projects was higher compared to new build projects due to the complexity of renovation/refurbishments projects. Likewise, the cost of rework for nontraditional procurement methods varies from traditional procurement methods; this was apparent in the literature review as well. The study established that rework can make a significant detrimental contribution to a project's cost and schedule overrun, which will subsequently result in reduced profit, contractual claims and the tarnishing of the reputation of the organisations involved in a project.

It could be deduced that the category of work the respondents engages in. data shows that majority of them project managers representing 11(22%) whilst the minority were quantity surveyor and site engineer constituting 7(14%) respectively and when it come to the years of working experience, 26% confirmed they had worked for more than 20 years and above. The least however had been or worked below 5 years representing 10% and for the number of projects, 6-10 projects which depicts 30%. Also, the least respondents recorded 11-15 projects making a total of 12%. Slightly above half of the respondents agreed to new buildings indicating 52% whereas the remaining respondents attested to refurbishment/renovation that indicates 48% whilst, the majority currently have 3 projects whilst the least has1 one recording 12 and majority agreed their project duration were less than 12 months, 12-18 months and 30-36 months representing 22% respectively. The least 16% however affirmed 18-24 months as the project duration. Traditional lump sum and turnkey method of procurement were recorded the highest. These constitute 20% respectively. Design and build and traditional cost plus were the least depicting 6% correspondently.

. Total quality management was 4.48 mean value whilst improvement to team/work teams recorded least 4.37 and the Self-learning of individual workers and project reviews recorded the mean values of 4.78. Finally, the mean score value of 4.64 was recorded against internal seminars as the learning practices. on whether design-related factors lead to cause of rework. Majority of the respondents confirmed to the changes made at the request of the client. This represented a high mean score value of 4.8. Changes made by the contractor during construction followed with the mean score value of 4.78 and modification initiated by the regulatory bodies was 4.64. The respondents again gave their views on errors occurred in the contract documentation recording the mean value 4.37 and omissions of items from the contract documentation was 4.08.

The mean score value of 3.9 was assigned to ineffective use of quality management practices, poor planning of work load was 3.8 and the mean score value of 3.48 was against insufficient time

The results show that lack of quality management practices was recorded first 5, followed by lack of experience with 4.8 and errors in setting out was 4.64.

Constructability errors according to the respondent views recorded the mean value of 4.6, poor planning of resources was 4.5, lack of safety and excessive overtime recorded 4.26 respectively and the method of recording rework occurrence was efficient and the mode of calculating indirect cost of rework was efficient were agreed all respondents indicating the low mean score vales of 1.6 and 1.7 respectively as well as the modification made at the request of the contractor during construction, changes made at the request of the client, changes initiated by an end-user, errors made in the contract documentation and omission of clients from the contract documentation as attributable to rework costs. These affirms the high mean score values of 4.8. 4.6, 4.37 and 4.26 respectively. On site management as rework containment strategies, the low mean score values of 1.7, 1.6, 1.5 and 1.4 with their corresponding statements.

The ANOVA test was used to determine if there was a statistically significant difference between the means of total rework costs for varying procurement methods. The ANOVA test in Table 18 revealed no significant differences between various procurement methods and total rework costs, F (6, 43) =0.860, p>0.05. This means that rework costs do not vary significantly with various procurement methods can therefore not be rejected.

It was evident from the analysis of the questionnaire survey and case study that reworks are a common occurrence in construction projects. The T-tests in Table 21, 22, 23 and 24 were used to determine if the causes of rework significantly differ between various project types. A t-test (2-tailed) with significant values for client-related rework (0.00), design-related rework (0.00), site management- related rework (0.00), and subcontractor-related factors (0.00).

Table 21 shows 49 degrees of freedom with the significance value (0.00) which is lesser than 0.05 indicating that there is significant difference between project types and client-related rework. From Table 22, it is evident 49 degrees of freedom with the significance value (0.00) which is lesser than 0.05 indicating that there is significant difference between project types and design related rework. From Table 23, 49 degrees of freedom with the significance value (0.00) which is lesser than 0.05 indicating that there is significant difference between project types and site management-related rework. From Table 24, 49 degrees of freedom with the significance value (0.00) which is lesser than 0.05 indicating that there is significant difference between project types and subcontractor related rework. Clearly, the T-test established that the causes of rework do differ significantly between the projects types.

5.2.1 Causes of Rework in Construction Projects

The literature revealed that the root causes of rework can be categorised into different groups such as client-related, design-related and contractor-related factors including site management and subcontractor factors. Therefore, the causes of rework were examined based on the above.

The findings of the study revealed that lack of experience and knowledge of the design process, lack of funding allocated for site investigations, lack of client involvement in the project, inadequate time and money spent on the briefing process, poor communication among consultant, architect and engineer and low payment of fees for preparing contract documents.

This may imply that the above statements one way or the other will cause rework emanating right from the initiation stage, proceeding through an incubation system, and manifesting itself during the implementation stage.

Moreover, in the case of design-related factors, the predominant factor suggested by respondents was changes made at the request of the client. This may imply that most clients lack experience with regard to the design process and because of this their ideas might not be feasible during the design. This claim is supported by Palaneeswaran (2006) who suggested that lack of experience and knowledge of design and construction processes on the part of the client contributed to rework.

Relative to site management-related factors, respondents identified lack of quality management practices as the major factor contributing to rework.

It was reported by respondents that low-skilled labour employed by subcontractors resulted in rework. Lack of quality management practices, unclear instruction to workforce, noncompliance with specification, lack of skilled supervisors, low labour skill level, defective workmanship and damage to other trades work due to carelessness were identified as the subcontractors-related factors and cause of rework.

This is supported by Loxton (2004) who reported that the South African construction industry is under pressure due to a combination of factors, some of which are skills shortages, quality management and defective

5.2.2 Key Effects of Rework on Project Performance

A typical construction project undergoes three stages; pre-construction, construction and post construction stages. Along these stages, there are numerous activities performed to achieve the output and objectives specified by the owner. Therefore, it is crucial for the construction project team, at some extent, to measure its performance on the activities or sub processes performed throughout the construction project, Love (2002). Performance of a project can be considered as a result of the process as well as the presence of the process. Dissanayaka and Kumaraswamy (1999) remarked that one of the principle reasons for the construction industry's poor performance has been attributed to the inappropriateness of the chosen procurement system. The main performance criteria of construction projects as financial stability, progress of work, standard of quality, health and safety, resources, relationship with clients, relationship with consultants, claim and contractual disputes, relationship with subcontractors, reputation and amount of subcontracting.

Chan and Kumaraswamy (2002) stated that construction time is increasingly important because it often serves as a crucial benchmarking for assessing the performance of a project and the efficiency of the project organization. Chan and Kumaraswamy (2002) identified project performance categories such as people, cost, time, quality, safety and health, environment, client satisfaction, and communication and a control system is an important element to identify factors affecting construction project effort. For each of the project goals, one or more Project Performance Indicators (PPI) is needed, both Early Contractor Involvement (ECI) and Early Supplier Involvement (ESI) would minimize constructability-related performance problems including costs associated with delays, claims, wastages and rework, etc. It is obtained by Stewart (1967) that human factors played an important role in determining the performance of a project. The most important practices relating to scope management as obtained by are controlling the quality of the contract document, quality of response to perceived variations and extent of changes to the contract.

This has traditionally been seen as one of the most important areas – if the economy of the project is off, the project can seldom be seen as a success. Overall project cost, i.e. the overall cost that a project incurs from inception to completion, is of major interest as it shows the resource usage in economic terms. Another important aspect regards cost predictability, that is, whether the final overall cost is in line with the initial cost estimate. Cost overruns can be a source for problems for an otherwise successful project as contractors are criticized for the common occurrence of cost overruns (sometimes labelled cost growth) in construction project, (Chan and Chan, 2004). This cost factors can be seen in areas such as; profit rate of project, project design cost, waste rate of material, cost of variation orders, and cost of rework (Alarcon and Ashley, 1999; Love *et al.,* 2005).

The increasing importance of time in our globalized society has affected the construction industry in form of shortened project schedules. Project duration is simply the number of days/weeks/months from start to completion of the project. Since time can be a critical issue for many clients, project duration is often of prime interest. However, schedule overruns may be an even more important issue. Completing projects in a predictable manner on time (within schedule) is an important indicator of project success and the construction industry is frequently criticized for project delays (Chan and Kumaraswamy, 1996). Schedule overruns (sometimes labeled time growth) are often very negative since they hinder the client to start using the end product as planned. This time factors can be seen in areas such as; planned time for completion, average delay in regular payments, time needed to rectify defects (Choudhury and Phatak, 2004; Aibinu and Odeyinka, 2006; Assaf and Al-Hejji, 2006).

Satisfactory time and cost performance is of little value if the project delivers inferior quality. The concept of quality is closely related to customer satisfaction, which has gradually been elevated in importance in the construction industry (Latham, 2004). According to Forsythe (2007), customer satisfaction is commonly described as a comparison between the customer's pre-purchase expectations and their post-purchase perceptions. Hence, it involves the customer's final feelings about whether the outcome provided a satisfying or dissatisfying experience. Since construction industry products are highly customized and co-created during the construction process, the concept of quality regards both the final product and the process during which is created. Therefore, we see two main aspects of quality. First, quality of end product has to do with the users' satisfaction with the finished construction and it is a critical success factor.

Quality management systems can contribute to the mitigation and elimination of rework/nonconformance's; enhance client satisfaction; performance and provide the catalyst for the synergy relative to the project parameters such as client satisfaction, cost, quality, and time. Establishing the project requirement for quality begins at project inception, Yasamis, Arditi and Mohammadi (2002). A careful balance between the owner's requirement of the project costs and schedule, desired operating characteristics, materials of construction and the design professionals' needs for adequate time and budget to meet those requirements during the design process is essential. According to (Smallwood and Rossouw, 2008), the owner will come closest to its desired quality by selecting firm based on the totality of the firm's quality performance including the quality of its corporate service, project service and constructed facility. The contractor is responsible for the means, methods, techniques, sequences and procedure of construction as well as safety precautions and programmes during the construction.

5.2.3 Effective Ways of Addressing the Effects of Rework

Failure to visualize and coordinate designs derails many a project, even before it is actually built. If you want to reduce construction rework due to design errors, employing the visual power of building information modeling (BIM) is critical. It allows everyone to see the plans, update them in real time and work accordingly. Team members are more likely to weigh in on big decisions at the very start of a project, reducing the chance of surprises later down the process

When all stakeholders and subcontractors on a project treat their spheres as independent of others, chaos is likely to prevail. Rather than letting havoc reign, consider implementing more modern and cohesive approaches like integrated project delivery (IPD), a collaborative delivery method that treats everyone on the project as part of one firm. When team members are aligned, at the start of a project, motivations shift from "how can I do my part" to "how can we complete the project together."

Make sure to carefully plan construction schedules, including accounting for labor shortage and any seasonal churns if relevant. Furthermore, it's always wise to have a Plan B. Have a backup plan and also try to leave room to accommodate change. Make sure to add in extra time to the schedule so the pressure of meeting a deadline won't cause faulty work or set project executives and owners up for disappointment.

Paper and outdated systems like Excel spreadsheets and lengthy email chains lead to error and in coordination. They do not reflect changes in real time, and workers are forced to trek long distances into an office to find the information they need–by which time it's often too late to make good use of it. Instead, go digital and adopt technology to automate some of those tedious and typically error-ridden administrative processes like submittals.

Communicating in the field is hampered by many roadblocks: many times paper designs, a central office that doesn't always mesh with on-site needs and more. Instead, if you utilize cloud-based technology and collaboration software, like Plan Grid, you can solve much of that. The cloud will provide instant access to your project documents, on and offline, and collaboration software will keep communications seamless and centralized. In fact, according to a McGraw-Hill study, 76% of contractors using cloud technology reported improved team collaboration.

A laissez-faire approach might sound like a good idea in principle, but in reality, it is nothing of the sort in construction. Instead of hoping for the best, adopt systematic standards for processes, workflows, tools and equipment. Institute a system of checks and balances to ensure quality assurance (QA) and quality control (QC) is met to reduce the potential of construction rework.

If you're looking to improve your standardization in construction, read our recent guide.

Research indicates that the more money you spend on training, the less the rework cost will be. Contractors who have conducted training programs regularly reduce rework costs between 11-22%, according to the same Islamic University of Gaza/Berlin School of Technology report. While training is an upfront cost that can seem high for cost-conscious constructors, the right training will reduce your costs over time by decreasing the likelihood of mistakes and errors, while improving productivity.

At the end of the day, like anything else in life or construction, rework is mostly a matter of understanding and effort–and it starts with early action. If you comprehend the most common causes and take immediate steps to alleviate the potential and problem, you're far less likely to suffer big time at its hands. Keep the above tips in mind, and get ready to avoid cost overruns, missed deadlines and ticked-off owners and investors.

5.3 Conclusion

This study concluded that, the changes made at the request of the client and design team contributed to rework. Love, Edwards and Smith (2005) established that variations during the design process are often captured too late because of the sequential communication structure of supply chains, and the lack of coordination and integration between design team members. This was apparent in the case study, where the lack of coordination among design consultants led to major design-related changes which affected all the design firms involved. This subsequently resulted in changes on site, which affected most of the subcontractors.

Furthermore, setting out errors, due to poor communication and coordination between the main contractor and subcontractors and the lack of skills on the part of the artisans, were identified. In addition, inexperience on the part of the leading hand and trades foremen and their inability to interpret the structural drawing contributed to rework during construction. Similarly, the analysis of the research instrument found that the most predominant source of rework included non-compliance with specification, setting out errors, changes made at the request of the client, poor communication with design consultants and low labour skill levels. Nevertheless, the causes of rework were found not to vary significantly with various project types.

The analysis of the comparative study revealed that reworks caused inter-organisational conflict that led to dilution in supervision and resulted in the de-motivation of workers. The study also revealed that the incidence of rework increased project cost. This was due to additional materials for rework, subsequent wastage handling, costs for covering rework occurrences and additional labour to rectify erroneous activities. Besides, additional time to rework and related extensions of supervising manpower were also identified, ultimately leading to customer dissatisfaction and reduced profit for contractors.

The analysis of the response of the questionnaire revealed that respondents tended neither to agree, nor disagree, that the cost overrun, time overrun and design team dissatisfaction as a result of rework impacted on project performance. Similarly, respondents expressed sentiments of disagreement and neutrality that reduced profit, de-motivation of workers and inter-organisational conflict all impacted on organisational performance.

It was apparent in the findings of the questionnaire survey that the majority of the respondents do not always have systems in place for tracking and recording incidences of rework and its cost impact, especially the indirect costs, as they are problematic to accurately calculate. This was also apparent in the case studies, where the respondents revealed they had experienced lots of rework on site. However, there were no mechanisms in place for recording incidences of rework and capturing their costs. This may imply that the causes of rework have not been fully examined in terms of their frequency and cost impact.

The most conclusive finding may be, however, that the economic benefits of recording incidences of rework and quantifying its costs have been overlooked. The total cost of rework for the projects sampled was calculated, and it was found that the total mean cost was 5.12% of the original contract value. Therefore, it can be concluded that rework can make a significant contribution to a project's cost overrun. Nonetheless, rework costs were found not to vary significantly with project type and various procurement methods used. Thus, the implementation of systems for measuring rework costs will possibly eliminate or reduce the costs of rework and subsequently improve overall cost performance in a construction project.

5.4 Recommendations

Improper differentiation between terms such as quality failure, defects and error with rework has led to inaccurate and incomplete measurements for rework, and possibly inappropriate strategies for reducing its occurrence (Sommerville, 2007). Rework has become the norm and as such it has become inevitable and acceptable in the construction industry. For instance, Atkinson (1998) sees that "making occasional mistakes" is a view accepted by others. Likewise, Love (2002a), Love, Smith and Li (1999) and Josephson, Larson & Li (2002) see rework as endemic in the overall construction process, a view hardly conducive to understanding and eradicating the problem. Therefore, rework reduction and containment strategies can be developed only if a clear distinction is made between what constitutes rework and what does not. Besides this, the industry must change its mindset that rework is inevitable. The study proposes a combination of interventions based on the literature reviewed and the findings of the data analysed.

Creating the awareness as to the impact rework can have on project performance is probably the most obvious intervention and the starting point for establishing an in-depth knowledge of the root source of rework. Therefore, the understanding of the causal structure of rework is an immediate issue that consulting firms and contractors need to grapple with, in order to reduce the causes of rework and its impact on construction project performance.

It was evident from the findings that the economic benefits of quantifying the total costs of rework, both direct and indirect, have been overlooked. Besides, it was established that rework can make a significant contribution to a project's cost overrun. Therefore, to decrease the direct and indirect rework costs and improve overall project performance, it is recommended that construction organisations begin to consider and measure them, so that an understanding of their magnitude can be captured. Also, effort needs to be made to improve skills and knowledge; otherwise the loss of reputation, delays and disruptions to construction and loss of profit will become products of rework that arises on-site.

From the findings, respondents suggested that to reduce rework during the design stage the following strategies ought to be implemented: team building, as well as the involvement of subcontractors, suppliers and designers for construction (e.g. standardised components). In the case of site management strategy, respondents suggested involvement of subcontractors during construction, quality control and with site quality management systems. Therefore, studies are needed to establish how both design firms and contactors can be assisted to implement these strategies.

Love and Sing (2011) stated that foresight and anticipation can enable strategies to be put in place to minimise the impact of rework on project cost and schedule. For this reason, construction professionals need to be more proactive in forecasting the occurrence of rework prior to the design and construction stage. This will enable consulting firms and contractors to undertake a quantitative risk assessment prior to the commencement of construction, as suggested by Love and Sing (2011). A proposed rework containment and reduction flow diagram has been developed for this purpose. This can also serve as a starting point for establishing a comprehensive knowledge of how effective control measures and reduction strategies can be developed.

1) Since creating awareness on the impact of rework is most obvious intervention and the starting point for establishing an in-depth knowledge of the root source of rework. It is therefore recommended that, the understanding of the causal structure of rework is an immediate issue that consulting firms and contractors need to grapple with, in order to reduce the causes of rework and its impact on construction project performance.

2) In order to decrease the direct and indirect rework costs and improve overall project performance, it is recommended that construction organizations begin to consider and measure them, so that an understanding of their magnitude can be captured.

3) The study also suggest that effort needs to be made to improve skills and knowledge; otherwise the loss of reputation, delays and disruptions to construction and loss of profit will become products of rework that arises on-site.

4) In the case of site management strategy, the study suggests involvement of subcontractors during construction, quality control and with site quality management systems.
5) Finally, based on the study findings construction professionals need to be more proactive in forecasting the occurrence of rework prior to the design and construction stage.

5.5 Suggestions for Further Research

The literature and the findings of the study revealed that the economic benefits of measuring rework costs, especially the indirect cost, have been overlooked. Furthermore, there has been limited research that has sought to determine the indirect costs of rework. Further investigation into the costs and impact of rework, especially the indirect costs, is needed to ascertain the hidden costs associated with undertaken rework.

While various studies have ensued, which seek to suggest rework reduction and containment strategies, rework still persists in the industry. Therefore, further research into alternative solutions to mitigate rework occurrence in construction projects could be beneficial to the industry.

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APPENDICES

APPENDIX A – SEMI-STRUCTURED QUESTIONNAIRE FOR THE EXPLORATORY STUDY

Framework of question for contractors

SECTION A: CAUSES OF REWORK Changes initiated by parties involved

1. Do the changes initiated by the client constitute rework?
2. Do the changes initiated by the design team constitute rework?
3. Do the changes initiated by the contractor constitute rework?

Human resource capability

1. How often do you organise training programmes for your employees?
2. What criteria do you use in employing workers on site, for example skilled and semiskilled workers?
3. How often do tradesmen/artisans get supervised during site activities?

Quality management issues

1. Is there any quality system in place to check the quality of work on site?
2. Do you ensure that materials selected conform to the contract specification before using them?

3. Do you get approval from the principal agent in case an alternative material is to be used in place of the one specified in the contract documents?

Audit of site instructions book

1. Does this site instruction constitute rework or not?
2. What was the work implication associated with this site instruction?

SECTION B: IMPACT OF REWORK ON COST AND SCHEDULE

1. Has the client/end-user expressed dissatisfaction about the progress and quality of work on site due to rework?
2. Have any of the consultants expressed dissatisfaction about the progress and standard of work on site as a result of rework?
3. Has there been any dissatisfaction on the part of the contractor due to rework?
4. Is there any litigation between parties involved on this project as a result of rework?
5. Has rework affected the project schedule?
6. Are there extensions of time claims on the part of the contractor as a result of rework?
7. Has rework led to poor morale of workers on site?
8. Has rework led to dilution of supervision on site?

9. Has there been any conflict/dispute on site due to rework?

Audit of cash flow projections and bill of quantities

1. Are there any overtime costs incurred as a result of rework?
2. Have there been any disruption costs incurred as a result of rework?
3. Has there been any increase in preliminaries as a result of keeping scaffolding and plants on site due to rework?

Framework of questions for consultants

Human resource capability

1. How often do you organise training programmes for your employees?
2. What criteria do you use in employing workers?

Quality management issues

1. Do you undertake design verifications, reviews and audits prior to issuing out the drawings?
2. Is there any third-party involvement to audit and review the design and documentation prior to the tendering stage?
3. Do you perform design activities such as architectural, mechanical and structural engineering concurrently?

APPENDIX A– QUESTIONNAIRE FOR THE MAIN STUDY

University of Education, Winneba

College of Technology Education, Kumasi

School of Research and Graduate Studies

Department of Wood and Construction Technology

P. O. Box 1277, Kumasi- Ghana

Telephone: 05153617, 53622

QUESTIONNAIRE SURVEY

Aims and Scope of this Survey

The aim of this survey is to obtain information from Ghanaian construction practitioners in the Ahanta West and Sekondi Takoradi Metropolitan Assembly of Western Region about the causes and effects of rework in construction projects so that effective prevention strategies can be developed. It is a research study undertaken by an M-tech student towards fulfilling a Master's Degree within the wood and construction Department situated at the University of Education Winneba – Kumasi.

To complete the Survey

For the purposes of the survey, rework is defined as "*the unnecessary effort of re-doing a process or activity that was incorrectly implemented the first time*".

Specifically, you should relate the answers that you provide to a **recently completed project** that you have been involved with. It is very important that each question is read carefully and that all questions are answered.

Construction Professionals Approached

The survey has been distributed to randomly selected construction practitioners. You are assured that the information obtained from this survey will be kept strictly confidential and will be only used for research purposes. Data will not be made available to any third party or used in any published material, except as a component in aggregated statistics.

To Return the Survey

Please complete the survey and return to:

Kpegba Mawuena Prince

Beahu D/A Junior High Secondary School

P.O. Box AP 39 - Apowa

Telephone: 0244562060 / 0208179719

Email: kpegba@yahoo.com

Mark your answers by ticking the response as shown:

Example √ 2 3 4 5

Please answer every question

SECTION A: PROFILE OF RESPONDENT

1. Which of the following category of personnel best describes you?

Architect ☐ Consulting Engineer ☐ Project Manager ☐

Contractor ☐ Quantity surveyor ☐ Site Engineer ☐

Other (please specify)

………………………………………………………………………………………………………

2. How long have you worked in the construction industry?

Below 5 years ☐ 6 – 10 ☐ 11 – 15 ☐ 16 – 20 ☐

21 and above ☐

3. How many co☐ruction projects hav☐u been involved i☐

(a) 1 – 5 (b) 6 – 10 (c) 11 – 15 (d) 16 – 20 ☐

(e) more than 20 ☐

4. What type of projects has your organization been engaged in? Please tick

Hospital ☐ Banks ☐ Education

Administrative ☐ Commercial ☐

Hotel/Motel/Resort ☐ Entertainment ☐

Other (please specify)

………………………………………………………………………………………………………

SECTION B: PROJECT CHARACTERISTICS

5. What was the project type?

New Build ☐ Refurbishment/Renovation ☐

Other (please specify)

………

6. Number of recent project not more than two (2) years?

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 and above ☐

7. How much was the original tender sum?

GHC

8. How much was the final contract sum?

GHC

9. What was the project duration? Please tick where appropriate

Less than 12month ☐ 12month – 18 month ☐

18 months – 24 months ☐ 24 months – 30 months ☐

30 months – 36 month ☐

Other (please specify)

………

10. What was the projects actual duration?

Less than 12month ☐ 12month – 18 month ☐

18 months – 24 months ☐ 24 month – 30 mont ☐

30 months – 36 ☐

Other (please specify)

………

11. What method of procurement was used for the project?

Traditional lump sum ☐ Turnkey ☐ Design and manage ☐

Design and build ☐ Traditional cost plus ☐

Management contracting ☐ Traditional with provisional qualities ☐

Other (please specify)

………

12. What was the project's floor area (m^2)?

……………………………………………………………………

13. How many floors did the project have?

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 and above ☐

SECTION C: ORGANISATIONAL MANAGEMENT PRACTICES

14. Please to what extent does the following practices are implemented in your company?

Please use the following scales to answer the questions below. Please tick where appropriate.

Not at all =1, sometimes =2, to some extent =4, very often =4, always =5

Quality practices	**Ranking**				
Measurement of quality cost (e.g. prevention and appraisal cost)	1	2	3	4	5
International standard organisation (ISO)	1	2	3	4	5
Quality function deployment	1	2	3	4	5
Total quality management	1	2	3	4	5
Improvement to team/work teams	1	2	3	4	5
Other (please specify) ……………………………………………………………	1	2	3	4	5

15. Please to what degree does the following learning practices are implemented in your company:

Please use the following scales to answer the questions below. Please tick where appropriate.

Not at all = 1, to a small extent= 2, to some extent=3, to a moderate extent = 4, to a great extent =5

Learning	**Ranking**				
Training programmes for staff	1	2	3	4	5
Self-learning of individuals workers	1	2	3	4	5
Development and research	1	2	3	4	5
Project reviews	1	2	3	4	5
Internal seminars	1	2	3	4	5
Other please specify ……………………………………………………………….	1	2	3	4	5

SECTION D: CAUSES OF REWORK

16. The client-related factors below might be the cause of rework. Indicate to which extent you agree with the various statement:

Please use the following scales to answer the questions below. Please tick where appropriate.
Strongly disagree = 1, Disagree = 2, Neutral=3, Agree = 4, strongly agree =5

Client-related factors	**Ranking**				
Lack of experience and knowledge of the design process	1	2	3	4	5
Lack of funding allocated for site investigations	1	2	3	4	5
Lack of client involvement in the project	1	2	3	4	5
Inadequate time and money spent on the briefing process	1	2	3	4	5
Poor communication among consultant, architect and engineer	1	2	3	4	5
Low payment of fees for preparing contract documents	1	2	3	4	5
Other (please specify) …………………………………………………………………..	1	2	3	4	5

17. The following design-related factors might be the cause of rework. Indicate the extent to which you agree with the following statement

Please use the following scales to answer the questions below. Please tick where appropriate.

Strongly disagree = 1, Disagree = 2, Neutral=3, Agree = 4, strongly agree =5

Design-related factors	**Ranking**				
Changes made at the request of the client	1	2	3	4	5
Changes made by the contractor during construction	1	2	3	4	5
Modification initiated by the regulatory bodies	1	2	3	4	5
Errors occurred in the contract documentation	1	2	3	4	5
Omissions of items from the contract documentation	1	2	3	4	5
Ineffective use of quality management practices	1	2	3	4	5
Ineffective use of information technologies	1	2	3	4	5
Poor planning of work load	1	2	3	4	5
Insufficient time to prepare contract documents	1	2	3	4	5
In complete design at the time of tender	1	2	3	4	5
Other please specify	1	2	3	4	5

18. The following are examples of site management-related factors which might be the cause of rework. Indicate the extent to which you agree with the following statement.

Please use the following scales to answer the questions below. Please tick where appropriate.

Strongly disagree = 1, Disagree = 2, Neutral=3, Agree = 4, strongly agree =5

Site Management	**Ranking**				
Lack of quality management practices	1	2	3	4	5
Lack of experience	1	2	3	4	5
Errors in setting out	1	2	3	4	5
Constructability errors	1	2	3	4	5
Poor planning of resources	1	2	3	4	5
Lack of safety	1	2	3	4	5
Excessive overtime	1	2	3	4	5

19. The following examples are subcontractors-related factors which might be the cause of rework. Show/indicate the extent to which you agree with the following statements:

Please use the following scales to answer the questions below. Please tick where appropriate.

Strongly disagree = 1, Disagree = 2, Neutral=3, Agree = 4, strongly agree =5

Subcontractor	**Ranking**				
Unclear instruction to workforce	1	2	3	4	5
Non compliance with specification	1	2	3	4	5
Lack of skilled supervisors	1	2	3	4	5
Low labour skill level	1	2	3	4	5
Defective workmanship	1	2	3	4	5
Damage to other trades work due to carelessness	1	2	3	4	5

SECTION E: IMPACT OF REWORK

20. Please indicate the extent to which rework affected the performance of the project that you have selected for each of the following factors: Where

Not at all = 1, to a small extent= 2, to some extent=3, to a moderate extent = 4, to a great extent =5

Project performance	**Ranking**				
Disputes among parties to the contract	1	2	3	4	5
Quality degradation	1	2	3	4	5
Design team's dissatisfaction	1	2	3	4	5
Contractors dissatisfaction	1	2	3	4	5
End-user dissatisfaction	1	2	3	4	5
Contractual claims	1	2	3	4	5
Time overrun	1	2	3	4	5
Cost overrun	1	2	3	4	5

21. Please indicate the extent to which rework affected your organization in relation to each of the following factors: where

Not at all = 1, to a small extent= 2, to some extent=3, to a moderate extent = 4, to a great extent =5

Organisation	**Ranking**				
Absenteeism of workforce	1	2	3	4	5
Reduced profit	1	2	3	4	5
Loss of future work	1	2	3	4	5
Inter-organisational conflict	1	2	3	4	5
De-motivation of workers	1	2	3	4	5
Poor morale of workforce	1	2	3	4	5
Other (please specify) ………………………………………………………………	1	2	3	4	5

SECTION F: MEASUREMENT OF REWORK COST

22. Please how frequent did you record the incidence of rework for the project you have selected?

Never ☐ Sometimes ☐ Always ☐

23. With reference to the project you have selected, to what extent do you agree with the statements below where,

Strongly disagree = 1, disagree = 2, neutral=3, agree = 4, strongly agree =5

Statement	**Ranking**				
The method of recording rework occurrence was efficient	1	2	3	4	5
The system used for calculating direct cost of rework was efficient	1	2	3	4	5
The mode of calculating indirect cost of rework was efficient	1	2	3	4	5
The adverse impact of the cost of rework on profit has not been clearly reported	1	2	3	4	5

24. Please indicate to extent rework costs attributable to each of the following design related sources for the project you have selected

Please use the following scales to answer the questions below where

Not at all = 1, to a small extent= 2, to some extent=3, to a moderate extent = 4, to a great extent =5

Design-related sources	**Ranking**				
Modification made at the request of the contractor during construction	1	2	3	4	5
Changes made at the request of the client	1	2	3	4	5
Changes initiated by an end-user	1	2	3	4	5
Errors made in the contract documentation	1	2	3	4	5
Omission of clients from the contract documentation	1	2	3	4	5
Other please specify ………………………………………………………………	1	2	3	4	5

25. To what extent were rework costs attributable to each of the following various construction related sources for the project that you have selected:

Please use the following scales to answer the questions below where

Not at all = 1, to a small extent= 2, to some extent=3, to a moderate extent = 4, to a great extent =5

Construction-related sources	**Ranking**				
Changes in construction methods due to site conditions	1	2	3	4	5
Changes initiated by the client or an occupier after some work had been undertaken on site	1	2	3	4	5
Changes initiated by the client or an occupier when a product or process had been completed	1	2	3	4	5
Changes initiated by a contractor to improve quality	1	2	3	4	5
Damages caused by a subcontractor	1	2	3	4	5
Omission of some activity or task	1	2	3	4	5

26. Indicate the areas which cost increased as a result of rework for the project that you have selected:

Please use the following scales to answer the questions below where

Not at all = 1, to a small extent= 2, to some extent=3, to a moderate extent = 4, to a great extent =5

Cost-source	**Ranking**				
Preliminaries (eg. Scaffolding)	1	2	3	4	5
Fees for design consultants	1	2	3	4	5
Overtime cost	1	2	3	4	5
Supervision	1	2	3	4	5
Disruption costs	1	2	3	4	5
Other (please specify) …………………………………………………………	1	2	3	4	5

27. Please provide an estimate for the following rework cost for the project that you have selected as a percentage of the project's original contract value (%)

Direct cost [ ] Indirect cost [ ]

SECTION G: REWORK CONTAINMENT STRATEGIES

28. Please identify which of the following design management strategies were adopted in the project you have selected for reducing the incidence of rework:

Please use the following scales to answer the questions below where

Highly ineffective = 1, Ineffective = 2, Quite effective=3, Effective = 4, Highly effective =5

Design-management	**Ranking**				
Design for construction (e.g. Standardised components)	1	2	3	4	5
Computer visualization techniques	1	2	3	4	5
Involvement of subcontractor/suppliers during design	1	2	3	4	5
Constructability analysis	1	2	3	4	5
Team building	1	2	3	4	5
Other (please specify) …………………………………………………………………	1	2	3	4	5

29. Please indicate which of the following site management strategies were implemented in the project you have identified. Also indicate how effective the strategy was for reducing the incidence of rework:

Please use the following scales to answer the questions below where

Highly ineffective = 1, Ineffective = 2, Quite effective=3, Effective = 4, Highly effective =5

Site management	Tick	Ranking				
Involvement of subcontractors during construction	☐	1	2	3	4	5
Site quality manage system	☐	1	2	3	4	5
Quality control	☐	1	2	3	4	5
Quality audits	☐	1	2	3	4	5
Value engineering	☐	1	2	3	4	5
Other (please specify)	☐	1	2	3	4	5

30. Please provide details of any issues that you feel was not addressed

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