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Topic

DETERMINING MEASURES TO IMPROVE QUALITY AT THE DESIGN STAGE OF PUBLIC CONSTRUCTION PROJECTS

By

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MASTER OF SCIENCE

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DECLARATION

I hereby declare that this research is my own work towards the award of a MSc. and that to the best of my knowledge, it contains no materials which have been accepted for the award of any other degree at this university or elsewhere, except where due acknowledgement has been made in the text.

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ABSTRACT

The design stage of the construction industry is the source of documents which serves as quality control during the construction stage. The main purpose of the study is to identify factors affecting quality at the design stage, the effects of poor quality at the design stage on construction project delivery and also the measures to improve quality at the design stage. The questionnaires were distributed to 120 respondents made up of 40 public clients, 40 consultants, and 40 D1K1 contractors. The response rate for the distributed questionnaires was 83.33% with 36 of the public clients responding, 34 of the consultants responding and 30 of the contractors responding back. The data was analyzed using (RII). The conclusion drawn from the data analysis for the most severe causes of deficiencies in quality at the design stage was poor scope definition, lack of effective communication, selection of consultants based on lowest cost, leadership problems and delay payments of consultants. The most frequent factors which affect quality at the design stage lack of effective communication, Poor Scope definition, delay in payment of consultants, Last minute changes by clients and Unrealistic demands from the project cost. The highest ranked effects of poor quality designs produced at the design stage during construction process led to projects being abandoned, loss of financial resources, contract disputes, and lack of satisfaction by the end user and failure of structures. The highest ranked measure to improve quality at the design stage was efficient communication between project team members, the next was the increased level of commitment by project team members, Increased Level of Planning at the design stage, selection of consultants based on merit and not only on cost for works which are not routine and efficient use of design software. Recommendation to the client and the consultants is to pay consultants on time, the selection of consultants should not be based on least cost only but also on merit for works which are not standard or routine and the adoption of design quality indicators during the design stage to help with the communication process.

DEDICATION

I dedicate this whole-heartedly to Almighty God whose guidance and protection have brought me this far in life.

I finally dedicate this manuscript to my parents, Mr. Fred Djokoto and Miss Gladys Sackey for their love and support during this period. I also dedicate this manuscript to my brother, Abeeku Djokoto and sister, Winifred Djokoto for their support and prayers.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Quality is defined as meeting the legal, aesthetic and functional requirements of a project. Requirements may be simple, complex, or they may be stated in terms of end results required or as a detailed description of what is to be done (Mallawaarachchi & Senaratne, 2015). Quality was defined by ISO as the degree to which an inherent characteristic fulfill its requirements. Degree in this definition means the level to which a product or service satisfies. Characteristics are features of the product that are meant to satisfy. Requirement refers to the needs of the customer (ISO 9000:2005). Quality, on the other hand, is described as conformance to agreed standards (Oke, Aigbavboa and Dlamini, 2017). Quality in construction, on the other hand, was defined by Rumane (2011) as the fulfillment of the owner's needs per defined scope of works within a defined budget and within the schedule to satisfy client's requirements.

Ashokkumar (2014) stated quality as one of the critical factors to which construction project success are measured against. Globalization of the world has encouraged more companies to pay close attention to quality in order to have an advantage over competitors in the sector and also to reduce cost. The complex nature of the construction process makes the management of quality very difficult to implement in the industry. The construction process can be subdivided into various project conceptions, project design and construction design (Okpala and Aniekwu, 1988) as cited by Oyedele, Jaiyeoba & Fadeyi (2012).

The design stage of the construction process entails multi-disciplines who come together to produce designs and documents for the construction. The Documents produced at the design stage are used as a quality control. These documents are responsible for controlling quality during the construction phase (Mallawaarachchi & Senaratne, 2015). The design stage is,

therefore, the first stage in which quality must be controlled and managed in order for the final output to match the owner's needs.

The design stage is where decisions are made concerning the actual construction process and what is to be expected during construction. It is in the design stage where the requirements of the client are identified and the constructive aspects and the standards of quality are defined through procedures, drawings and technical specifications (Alarcon & Mardones, 1998) as cited by Choudhry et al. (2016). The design process is well-planned process which enables solutions to be drawn up for it to meet the client's needs. The design of a building has a major impact and influence on the operational performance of a building (Sivanathan et al., 2012). The quality of the design stage is judged based on the product produced which is the tender document.

1.2 STATEMENT OF THE PROBLEM

Construction projects are judged based on these three principles namely the time, cost and quality (Jha & Iyer, 2006). Time and Cost are indicators which project teams can easily measure during each phase of a construction project and therefore most construction industry pay attention to these factors leading to poor performance in quality delivery (Ali and Rahmat, 2010) as cited by Neyestani (2016). Failure at the design stage will show up at the construction stage (Agbenyega, 2014). An assessment made by the Building Research Establishment in the UK cited the fact that 90% of building failures were as a result of Design and construction Failures (Othman & Othuman Mydin, 2014). Design stage decisions have the most impact on project delivery, performance and operation of a building to optimize value for money to its end according to Bourn (2001) as cited by Oyedele, Jaiyeoba & Fadeyi (2012). Gilbertson (2006) argues that design cost is 20% of construction cost as cited by (Knotten et al., 2015).

Implementation of proactive quality systems at the design stage to prevent reworks and failures in construction were seen to save the construction institution about 7% in the total

project cost (Robert, 1991) as cited by (Rumane,2011). Design failures were cited by Love, Edwards & Irani (2008) to cause design reworks and construction reworks. Laryea (2014) cited a perception drop of quality of tender documents. Ghana's public Projects delivery has failed to meet objectives set at the beginning in terms of cost and time according to Royal Institute of surveyors (2013) as cited by Kissi, Mohammed & Diatuo (2018). Ghana being a developing country needs the public sector to effectively utilize its resources well in order to achieve value for money in construction project delivery. Failing to meet these initial objectives of cost, time and defined scope are additional burdens which the country can do without. This is why there is a need for the study for quality management practices at the design stage and reasons for deficiencies in quality at the design stage.

1.3 RESEARCH QUESTIONS

1. What are the factors affecting quality at the design stage of construction projects in Ghana?

2. What are the effects of poor quality at the design stage on construction projects in Ghana?

3. What are the measures to improve quality at the design stage in Ghana?

1.4 AIM OF THE RESEARCH

The main aim of the study is to determine measures to improve quality at the design stage of public construction projects.

1.5 OBJECTIVES

To achieve the aim, the following objectives were set:

1. To identify factors that affect quality at the design stage of a construction project;
2. To identify the effects of the failure of quality on project delivery; and
3. To identify measures to improve design stage quality.

1.6 SCOPE OF THE STUDY

The study will focus on project team members' practices at the design stage of the public construction project in the Greater Accra Region.

1.7 SIGNIFICANCE OF THE STUDY

The significance of the study is to help project management teams to determine the importance of various factors which hinder quality at the design stage, effects of failures in quality at the design stage and various ways to improve upon quality in project delivery at the design stage.

1.8 LIMITATION OF THE STUDY

The main limitation for the research paper was the duration of the research which was to be conducted within the timeframe of three months.

1.9 ORGANISATION OF THE STUDY

1. **Chapter One**: Introduction to the thesis. It states the aims, objectives, and scope of the research paper.
2. **Chapter Two:** It reviews the various literature which has been done on the topic of the factors affecting quality at the design stage in the construction industry.
3. **Chapter Three:** It talks about the methodology which will be used to carry out the research. The research methodology will cover the research approach, sampling and sampling techniques, and sources of data, research instrument, validity and reliability of the data, ethical considerations and mode of analysis.
4. **Chapter Four:** it talks about the analysis and also the discussion of the data collected.
5. **Chapter Five**: It talks about the various recommendations and also the conclusion of the thesis.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter seeks to give a general overview of the topic according to other researchers and literature on issues relating to quality issues at the design stage of a construction project. Chapter two was divided into seven sections as; section 2.2 overview of design stage; section 2.3 design process; Section 2.4 Tender documents; Section 2.5 indicators of quality design and documentation; Section 2.6 Cost of quality; Section 2.7 Design Defects; Section 2.8 Factors affecting Quality; Section 2.9 Effects of failure of quality; Section 2.10 Measures to improve quality; Section 2.11Summary

2.2 OVERVIEW OF DESIGN STAGE

The design stage process is an important part of the project life cycle process. The project success is dependent on the quality output on the delivery of the design process (Mallawaarachchi & Senaratne, 2015). Building designs are the final output of the design process stage. Building Designs refer to the provision of the necessary information needed for the construction of a building which would meet the owner's requirement and also meet public health and safety requirements (Merrits and Ricketts, 2000). Quality in construction is defined as fulfilling the project responsibilities in the delivery of the products and services in the manner that meet or exceed the owner, design professional and constructor. Responsibilities refer to the task that the participants of the project are required to perform in the contractual agreement (ASCE, 2000). Quality in construction, on the other hand, was defined by Rumane (2011) as the fulfillment of the owner's needs per defined scope of works within a defined budget and within the schedule to satisfy client's requirements. Construction design process is a complex task which entails multi-disciplines in order to come up with the desired final output (Azmy, 2012).

The project teams involved in the process of designing the final output are as follows:

a) The owner/client: the one who requires the need and also the one responsible for providing financial resources for the project to start and finish with. They are divided into four, namely: Government (being the major client), Real Estate Developers, Investors and Owner-occupiers (Kissi, 2013).

b) The Designer/ Consultant: are a group of competent personnel's from different fields who come together in order to translate the client's needs into drawings and documents which would be used by the contractor to build the final product. The design consultants include the quantity surveyor, the architect, the engineers and other professions who have attained the necessary academic qualifications from various accredited institutions.

c) The contractor: is the person responsible for converting the drawings into the physical product being buildings from the resources at his disposal to meet the specifications of the consultants and to satisfy the client's needs within the budget.

The relationship between the project team is dependent on the project delivery put in place. The delivery system commonly chosen by clients is the design/bid/build contract also known as the traditional method of project delivery. Once the project delivery is chosen the client then chooses the design professional to prepare the project design (Rumane, 2011). This is the most common project delivery chosen by Public institutions (Kissi, Mohammed & Owusu-Diatuo, 2018)

2.3 DESIGN PROCESS

The design construction stage can be divided into several stages. According to Merrits and Ricketts (2000), the stages involve the briefing or program stage, the schematic or conceptual stage, the design development stage, contract development stage. Rumane (2011) stated that the design stage involves the conceptual stage, the preliminary stage, and the detailed design stage. The design stage might have several classifications of the whole process but the end goal is to produce quality designs to which will satisfy the client needs and also fall within the

agreed project objectives. Tilley, Wyatt, and Mohammed (1997) define the documentation and design process as the ability to provide the contractor with the necessary information needed to enable construction to be carried out as required, efficiently without hindrance. The design and documentation process has a major influence on the completed project. The design process was broken down into several stages by RIBA (2013) which will enable project teams to provide quality designs after the process.

2.3.1 The strategic definition stage

The strategic stage according to RIBA (2013) entails the client and the consultant to carry out appraisals to look at various solutions to the need which could include the refurbishment of an old building or putting up a new structure to meet the need. The stage may also look at various sites which could be looked at for a new building. The stage entails initial considerations to be made for selecting the project team, the program of works and getting feedback for various past projects undertaken. The information exchange between the project team within this stage is to come out with the strategic brief. The information exchange is to allow the client and the rest of the project team to agree on the strategic Brief before proceeding to the next stage.

The stage involves the team developing a project program which will stipulate the time period for briefing, design, construction and post completion of the project.

2.3.2 Preparation and brief stage

Project brief can be explained as a document which captures and defines the core project objectives, scope, deliverables, budget, and schedule so that agencies and clients alike can work together to achieve a focused, desired outcome (Taraborrelli,2013).

The Project brief is an important document to which consultants will use to develop conceptual designs and other related documents in order to meet the client's needs. The importance of the brief can't be understated as a failure to understand the client's brief would lead to a dissatisfaction of the final proposals from the consultants (Johansen and Carson, 2003). Knotten et al. (2015) cited El. Reifi and Emmitt (2013) revealed that issues related to

the design brief were responsible for almost 30% of the rework and also revealed that it was largest hindering of the design value by over 60%.

This stage core activity entails the development of the project objectives including quality objectives, project outcomes, sustainability aspirations, Project budget and other constraints as its core objectives (RIBA, 2013). The preparation and the brief stage will also entail selecting of various team members, determination of the project delivery method, the project roles and responsibilities, carrying out a various risk assessment to determine various risk carrying out feasibility studies to the related project and determining the procurement route whether it is traditional, design and build or others. Important at this stage is the communication of various consultants to give feedback for various discussions. The communication strategy adopted within this stage will enable consultants and clients to be able to communicate effectively and protocols for issuing out information exchanges. After selection of the Architect and agreeing upon the project delivery system Terms of reference (TOR) is issued out to the consultant/ designer to prepare a design proposal and also contract documents (Rumane, 2011).The terms of reference describe the purpose and structure of the project which gives a clear understanding of the project team. The terms of reference usually state the following as actions for which the consultants are to perform:

- Predevelopment studies, which includes data collection and analysis related to the project
- Development of conceptual alternatives
- Evaluation of conceptual alternatives and selection of preferred alternatives in consultation with the owner.

2.3.3 Concept design

The concept design stage is a stage where the consultants come out with various outlines from the initial project brief, project strategies, cost planning, information exchanges in order to

come out with the final brief and a review of the cost information of the project (RIBA, 2013). Cost planning is a system of bringing cost advice to bear on the design process according to Nwachukwu (2003). Cost planning entails all aspects of the control processes undertaken during the design stage in order to deliver the structure meet the quality at the desired budget (Eliufoo, 2000) as Cited by (Kissi, Adjei-Kumi & Badu, 2016).

The concept design basically shows the following features:

1. The general layout of the facility;
2. The required number of buildings/ area of the floor;
3. Electromechanical services;
4. Type of landscape;
5. And others (Rumane, 2011)

The delivery of the concept design would be based on the following while preparing the preliminary design:

1. The concept design deliverables
2. Calculations to the support design
3. Authorities requirements
4. Constructability
5. Reliability
6. Sustainability
7. Optimized life cycle (value engineering)

And others (Rumane, 2011)

2.3.4 Developed design

The designer translates requirements into spaces, relates the spaces and makes sketches, called schematics, to illustrate the concepts. When sufficient information is obtained on the size and

general construction of the building, a rough estimate is made of construction cost (Merrits and Ricketts, 2000). As the design is being developed there should be a change control procedure in order to cater for any changes that might occur (RIBA, 2013). The cost estimate developed at this stage would enable the project team to know whether the project is within the financial constraint and help them to make adequate changes should the need arise through information exchanges.

2.3.5 Technical stage

The stage is also known as the detailed design involves the development of various drawings which have been approved by the owner. The designs done at this stage involve the refinement of the drawings to give technical details for the specialist subcontractors (RIBA, 2013). During this phase, detail design of the work, contract documents, detail plan, budget, estimated cash flow, regulatory approval, and tender/bidding documents are prepared (Rumane, 2011). The success of the project will be dependent on the quality of the designs produced at this stage (Tilley, Wyatt & Mohammed, 1997)

2.4 TENDER DOCUMENT

Smith (1986; p3) defined tender documents as documents which contain all the necessary information about the proposed contracts, rules, conditions, etc. to the contractor which will enable him to price the work as accurately as possible taking into account all the special requirements which every building project possesses as cited by Laryea (2014). Tender documents are the final output of the design process. The tender document becomes the contract document after evaluation of the priced tender presented by the contractor. The tender document then becomes a contract document. This serves as a quality control of the actual works being done at the construction stage to be a measured against. The specifications stated in the documents by the consultant are meant to serve this purpose (Mallawaarachi & Senaratne, 2015). Tender documents consist of drawings, specifications, Bills of quantities and other relevant information necessary for pricing of works. According to Rumane (2011)

quality, the tender document must state the scope of works, Location of construction projects, quality, and duration of the completion of the Facility.

2.5 INDICATORS OF QUALITY DESIGN

A design quality indicator (DQI) is a process for evaluating and improving the design and construction of new buildings and refurbishment of old buildings (DQI for Education: Guidance, 2018). Design Quality indicators tools were developed to assist building design teams to define and check the evolution of design quality at key stages in the development process. Tilley, Wyatt & Mohamed (1997) research cited the following as key indicators for good quality design (drawings, specification, etc)

a) timeliness - being supplied when required, so as to avoid delays;
b) accuracy - free of errors, conflicts, and inconsistencies;
c) completeness - providing all the information required;
d) coordination - through coordination between design disciplines; and
e) Conformance - meeting the requirements of performance standards and statutory regulations.

DQI for Education: Guidance (2018) also developed key indicators for which quality can be measured by. They are

a) Functionality: this talks about the how spaces and the inter-relationship between the spaces designed will be useful.
b) Build Quality: this talks about how the building is constructed: its structure, fabric, finishes and fittings, its engineering systems, coordination of all these and how well they performed.
c) Impact: these talks about the ability to create a sense of belonging and have a positive impact on the environment.

DQI for Education: Guidance (2018) developed indicators which are meant to aid in measuring quality and reduce the subjective nature of quality measurement. Design qualities indicators are determined using weighted averages against the categories stated above by various participants. The participants who take part in the assessment of awarding the scores are the designers and the end users in other to help them identify areas of the developed designed where there are major differences in opinion. This enables better communication between project teams and end users. The resulting application of such indicators will lead to end users being satisfied by the end of the design process.

2.6 COST OF QUALITY

Cost of quality was cited by Juran (1951) as the 'cost of poor quality'. Crosby (1979) defined the cost of quality as the 'price of non-conformance'. PMI (2000) defined the cost of quality as efforts required to acquire the quality of product and services. Waje and Patil (2016) defined 'cost of poor quality' as the cost associated with the delivery of poor services or product. Waje and Patil (2016) suggested that the cost of quality to range from 10% - 40% of the business cost. Indhira Devi & Chitra (2013) cited (Parker, 2009) that one dollar spent on prevent cost will save 10 dollars on appraisal cost and save you a further 100 dollars on failure cost. This, therefore, lays emphasis on project design teams to place much emphasis on prevention rather correction and also for companies to do likewise in order to make more profits. Indhira Devi & Chitra (2013) quoted (Dale and Plunkett, 1991) that 95% of the cost is spent on appraisal and failure which rather increases the cost of construction. Indhira Devi & Chitra (2013) cites that on the average a contractor spends 5-10% of the project cost on doing the wrong thing and correcting them. This statement lays emphasis on the need to provide quality design at the design stage.

Cost of Quality can be defined into 2 categories. They are conformance and non-conformance cost.

2.6.1 Conformance Cost

Prevention cost

Prevention cost refers to the cost incurred to prevent defects from happening or to keep appraisal to the minimum. Examples of Prevention cost at the design stage are

(a) Training for project team (b) Update use of design software

(c) Conduct technical meetings for proper coordination.

Appraisal Failure cost

Appraisal Cost refers to the cost of measuring and controlling concurrent production. Examples of appraisal cost at the design stage are a) Review of design drawings b) Review of specifications c) Review of building codes and review of specifications.

2.6.2 Non-conformance Cost:

External Failure Cost

Cost generated after shipment as a result of non-conformance to requirements. Examples of Prevention cost at the design stage. Examples of external failure cost at the design stage are:

a) Resolve request for information (RFI) b) Include design review comments c) Include comments by regulations.

Internal cost

It can be described cost generated before a product is shipped as a result of non-conformance. Examples of internal cost at the design stage are a) redesign to meet trade standards b) Rewriting specifications to meet requirements of all trades.

2.7 DESIGN DEFECTS

According to Navigant (2017), a design defect is the failure to produce complete drawings and accurate well-coordinated set of design and construction documents by design professionals. These designs can be classified into two categories:

2.7.1 Design errors:

A design error is defined as a mistake in design which was either constructed or under construction and required replacement of some component to correct the error. As such the entire cost is attributed to design professional which makes it a design error (Navigant, 2017).According to Couto (2012) as cited by (Brito & Sequeira, 2005) explained design errors are those whose origins can be traced to the non-existence of information relevant to the construction work and construction methodologies recommended.

2.7.2 Design Omission:

Design omissions are defined as the scope that was either missed or either omitted by the design professionals in its design and was later discovered and later added to the scope of work by a change order (Navigant, 2017). According to Navigant (2017), 15% of costs of change orders were as a result of design omissions by design professionals. The lack of adequate detailing could be an example of design omission.

2.8 FACTORS AFFECTING QUALITY AT DESIGN STAGE

Ishak, Chohan & Ramly (2007) cited that there are hidden factors which have the tendency to affect the design process. Communication was one of the factors which were cited by Ishak, Chohan & Ramly (2007). Communication was explained as the written ideas which explained the design stage or the corrective ideas during the construction phase. The communication gap happens when project parties are not able to communicate effectively and therefore what one party presents is different from the one party wants. The main purpose of the design stage is the interaction of the design team to come out with solutions (Vegard, 2015)

Ishak, Chohan & Ramly (2007) cited Masterman (2002) that the traditional approach which was used in construction project delivery in Malaysia affected quality. The need for coordination within this stage is to remove future faults as designs which will occur are as a result of contractors and other tradesmen not being aware of the designer’s intent. Ishak,

Chohan & Ramly (2007) cited the need for value engineering and effective cost planning during the design phase in order to prevent cost-cutting and also unacceptable design solutions from other professionals during the construction process.

McDonald & Leed (2013) cited pressures from clients, timeline expectations, client demands, eagerness by consultants to move towards the next phase of the project delivery process, the procurement process used for public bidding and handing over incomplete drawings to the contractor as main elements to cause design induced rework. McDonald & Leed (2013) also cited carelessness and negligence, intent (due to greed), poor knowledge as a result of lack of experience, ineffective use of aided design, low design task awareness in changes in design standards, failure to have design verifications, fees of consultants, selection of staff contracting strategy, design interface management and time boxing all can contribute to design errors which will lead to design induced reworks.

BIM (2009) cited the fact that the use of 2D and 3D cad and paper-based review, analysis and work product delivery are affected due to the fact that there is limited information sharing during the design phase. BIM (2009) cited the fact that with the use of 2D and 3D cad software there are challenges which project participants are able to integrate properly in order to come out with quality documents and drawings. The use of BIM software reduces the effort in being able to complete the scope of works by reducing the duration in the time spent in the delivery of the work. The use of BIM design tool during the design stage was to ease the difficulties at the design stage and also to understand the complex problems and solutions.

Baiden, Price & Dainty (2006) cited the use of the traditional process of project delivery affects the quality of projects. The traditional approach which technically separates the design process and the construction process leads to a fragmentation of the whole project delivery process.

Baiden, Price & Dainty (2006) stated the fragmented process by which project teams are procured and project teams are delivered led to the adversarial relationship being developed amongst team members and a common mistrust. This thereby led to a reduction in quality of the project design phase and also the construction phase and also the failure of project participants to fully integrate into achieving a common goal.

Choudhry et al. (2018) cited the following factors as major causes of discrepancies between design and construction phases of Pakistan projects which were the unrealistic commitment by consultants to finish the design within a time frame, Approving authorities failing to check designs against building codes, Owner proposes changes to design due to financial problems, too little time is given to the designer for completion of design.

Oyedele, Jaiyeoba & Fadeyi (2012) cited the communication, design changes, unrealistic project constraints, inadequate professionals at the design stage, poor level of Knowledge by design professionals and also making poor value for money decisions at the design stage as the major causes of the poor quality at the design stage for Nigeria's Construction industry.

In a study conducted by Katikahi (2013) highlighted the following factors affecting the design process are the limited participation of the design brief by end users, considerable design changes specification revision to finishes.

Tilley, Fallan & Tucker (1999) cited that the reduction of quality in design and documentation quality was as a result of reducing fees of designers, decreasing project design time, an increasing number of clients with unrealistic expectation and an inability to define project objectives. The research paper also cited the fact that due to the reduction in fees of designers both contractors and designers were using junior staff designers to design buildings who do not have adequate experience and also a lack of supervision of the design process when completed.

Ahmad et al. (2012) cited the following characteristics as qualities of the design team which are essential to the delivery of quality designs which understands of clients, Teamwork within the design, experience of the design team, commitment.

In a study conducted by Kissi, Mohammed and Owusu- Diatuo (2018) the selection process of contractors based on solely lowest tender price by Metropolitan Municipal and District Assemblies also affected the project delivery process. The study also cited the fact that contractors are forced to head to the site to start work without project designs being readily available and a lack of communication within the project planning stage also affecting project delivery. Quality practices at the design stage are important to remove failure at the construction stage and also satisfying the client's needs without compromising on overall Quality.

Agbenyega (2014) revealed that to provide a quality building project the three most important factors were the delivery of a quality contract document, complete drawings and improved schedule performance which were ranked by various Consultants. These documents lay emphasis on the need by various design teams to put in place quality systems in order to ensure that the delivery of quality designs and documents at the end of the design stage.

Baiden and Tuuli (2004) cited that consultants within the local industry barely put in place quality assurance or technically competent staff to monitor or check against standards during the design stage. The study also revealed the lack of updated local standards to improve quality in the production of local products such as concrete blocks. The un-updated local standards, therefore, do not encourage local consultants to improve on quality designs. The country, in the end, does not benefit from in terms of value for money for designs and products produced using local standards. The reason for building codes at the design stage is

to establish the minimum standards for the components for building projects and also to establish the final quality of the building project (Arditi & Gunaydin, 1997).

Designs, funding, geological location, aesthetic, nature statutory changes were cited as factors that cause variations by Hanna et al. (2002) as cited by Ayirebi Dansoh, Oteng & Frimpong (2017). Variations were explained as the difference between planned work and actual work by (Russel et al, 2014) as cited by Ayirebi Dansoh, Oteng & Frimpong (2017). The major factors causing variation in Ghana as cited by Ayirebi Dansoh, Oteng & Frimpong (2017) were weak management skills, divergent motivational skills, Problems with coordination, inflexibility attributable to lack of trust communication problems and lastly bureaucratic barriers.

Table 2.1 Summary of factors affecting quality at the design stage from literature read.

REFERENCES	FACTORS AFFECTING QUALITY AT THE DESIGN STAGE
Ishak, Chohan & Ramly (2007) &	Communication gap, traditional approach, coordination between project teams, Lack of value engineering and poor cost planning, Unacceptable design solutions at the design stage.
McDonald & Leed (2013)	Pressures from client, timeline for delivery, eagerness of consultants to move to the next phase, procurement process, lack of experience, carelessness, intent (due to greed), poor knowledge as a result of lack of experience, ineffective use of aided design, low design task awareness in changes in design standards, failure to have design verifications, fees of consultants, selection of staff contracting strategy, design interface management and timeboxing
BIM (2009)	Use of 2D and 3D cad software instead of using BIM software
Baiden, Price & Dainty (2006); Choudhry et al., (2018)	Traditional approach used in project delivery affect the quality of building designs and leads to a fragmentation of project teams Unrealistic commitment by consultants to finish the design within a time frame, Approving authorities failing to check designs against building codes, Owner proposes changes to design due to financial problems, too little time is given to the designer for completion of the design.

REFERENCES	FACTORS AFFECTING QUALITY AT THE DESIGN STAGE
Oyedele, Jaiyeoba & Fadeyi (2012)	Communication, design changes, unrealistic project constraints, inadequate professionals at the design stage, poor level of Knowledge by design professionals and also making poor value for money, Lack of project definition.
Katikahi (2013)	Limited participation of the design brief by end users, considerable design changes specification revision to finishes.
Tilley, Fallan & Tucker. (1999)	Reducing fees of designers, decreasing project design time, an increasing number of clients with unrealistic expectation and an inability to define project objectives. The research paper also cited the fact that due to the reduction in fees of designers both contractors and designers were using junior staff designers.
Ahmad et al. (2012)	Teamwork within the design, experience of the design team, commitment.
Kissi, Mohammed, and Owusu- Diatuo (2018)	lack of communication within the project planning stage
Baiden and Tuuli (2004)	Local standards are not updated
Ayirebi Dansoh, Oteng & Frimpong (2017)	Weak management skills, divergent motivational skills, Problems with coordination, inflexibility attributable to lack of trust communication problems and lastly bureaucratic barriers.

2.9 EFFECTS OF THE FAILURE OF QUALITY

The effects of the failure in quality might seem like an inconsequential to the initial total construction project cost. Studies have shown otherwise with Fifty percent (50%) of errors in buildings coming as a result of design errors by Building Research Establishment in the UK in 1981 as cited by McDonald (2013). Reworks resulting from poor design work leads to a loss in productivity and also a loss of financial resources. Love (2002) and Love, Edwards and Irani (2008) conducted a research which indicated rework cost actually is 10% of the

contractual value. With project having constraints attached to them the loss of time and other resources are also indicative of the value lost due to poor design works (McDonald, 2013). Also according to McDonald (2013) errors which are as a result of poor designs are manifested at the end of the construction process. The errors resulting from designs can lead to disastrous consequences like the Tay bridge disaster in the year 1879 which led to the loss of life and other infrastructural damages, London Millennium footbridge in the year 2000 synchronized lateral excitation causing a swing in a sideways motion.

According to Doloi (2013), 15.4 % of the variance in cost estimates is attributed to extent of completion of pre-contract designs, discrepancies in design documentation, client initiation variations, design changes and buildability issues in the construction phase. Cost planning is an essential element in budgeting for the project and also to help the client to be able to prepare finances for the project in totality. Failure to effective plan, therefore, causes the client not to appreciate the final product and an element of quality is lost. Quality, as described by Rumane (2011), is the ability to satisfy the client's needs within an estimated project cost and also within the estimated budget.

In another study conducted by Ishak, Ramly & Chohan (2007) cited the following cases as a result of poor design which led to failures in structures built Florida high rise collapse, Thailand Towers collapse in Kuala Lumpur, The sinking of Kansai Airport in Japan, the collapse of terminal 3 at Dubai International airport and the collapse of terminal 2E at Paris Charles de Gaulle Airport. Ishak, Ramly & Chohan (2007) also cited the fact failure in the design can result in unplanned maintenance after the construction of the building project and also the effect of the poor selection of materials affecting the lifecycle of the building project.

In a study conducted by Alaryan et al. (2016) the research cited causes of changes in order were as a result of an omission in the design and also an additional element to cause changes in order were also as a result of changes to the scope, poor design and also poor working

drawings in details by the project participants. It also revealed that the effects of these changes were as follows increasing project cost, delay in completion, an additional payment to the contractor and delay in payment in the Kuwait construction industry.

Suleiman and Luvara (2016) also cited changes in design during the construction stage of the project resulted in the delay of building projects, changes in the cost of building projects, abandonments in projects as a result of an increase in cost which the clients are not able to cater to, wastage in materials, conflicts between project team in the Tanzanian construction industry.

A study conducted by Fatawu (2016) revealed that contract deficiency led to project abandonment, delays (time overrun), delay in payment, payment claims problems, variations/change orders in the Northern region. These situations were all ranked by various project participants as major causes of design deficiencies.

In another study by Baiden and Tuuli (2004), it was cited that consultants within the local industry consultant barely put in place quality assurance or technically competent staff to monitor, check against standards. The failure to put in place quality assurance program within the design process ensured the sandcrete products used by local contractors are not up to standards thereby causing quality to be compromised.

Failure in the designs was stated as one of the causes for variation by Ayirebi Dansoh, Oteng & Frimpong (2017). Variations were explained as the difference between planned work and actual work by (Russel et al, 2014) as cited by Ayirebi Dansoh, Oteng & Frimpong (2017).

Table 2.2 Summary of Effect of Failure of Quality

REFERENCES	EFFECTS OF FAILURE OF QUALITY
McDonald & Leed (2013);Love(2002); Love, Edwards & Irani 2008)	Failure of structures, Cost overruns, Reworks, Loss of productivity
Doloi (2013)	Variance
Ishak, Ramly & Chohan (2007)	Failure of structures
Alaryan, Elshahat, & Dawood (2016)	Change orders, increase in project cost, increase in project duration
Suleiman and Luvara (2016)	changes in the cost of building projects, delay of building projects, abandonments in projects, wastage in materials and conflicts between project team.
Sivanthan et al. (2012)	The reduced Life cycle of the buildings, delay in construction, poor communication of information to the contractor.
Fatawu (2016)	Project abandonment, delays (time overrun), delay in payment, payment Claims problems, variations
Baiden and Tuuli (2004)	Poor construction elements being produced (sandcrete blocks)
Ayirebi Dansoh, Oteng & Frimpong (2017).	Variations

2.10 MEASURES TO IMPROVE QUALITY DESIGNS AT THE DESIGN STAGE

According to ACIF & APCC (2002) identified various factors which were to be adopted at the design stage to improve the quality of the designs. It stated that to obtain quality designs the client must clearly define the project brief which must state the budget, Quality and sustainability issues. ACIF & APCC (2002) also cited the need for documents to be regularly

checked and also for clearly articulating what is needed by the client to the consultants. ACIF & APCC (2002) also cited the fact that clients should pay the consultants based on the effort put in and not selecting consultants based on non-price and price criteria to establish value. The study also stated the fact adequate plans should be put in place in order for quality documents to be achieved.

BIM (2009) study to improve the quality of designs at the final stage the use of BIM software will highly reduce the process involved at the design stage. BIM (2009) also stated the fact the use of the software will reduce the workload and help with the coordination of activities which are concerned at the design stage.

Community and Government services technical division (2013) identified the following as points during the design stage to help produce quality designs which include independent review designs by technical officers, good design review is advisory, Good design review which should be clearly stated that decision-makers can understand and use, Good timely designs which means that producing drawings within the stipulated time in order for changes to be made early and reduce cost implications of such changes. The research paper also cited the need for more stringent measures to be applied relative to the national building code of Canada. The research study also cited the need for increased reviews for the design stage.

Jha and Iyer (2006) cited the fact that management must be committed to the fact of delivering quality during the construction process. The study also revealed that there must be the interaction of project participants for the success to be achieved during the process.

Tilley, Fallan & Tucker (1999) cited the need for clients and developers to provide adequate time and financial resources for the planning phase and design phase of projects in order to maximize the construction process efficiency and minimize the overall project cost.

Dosumenu and Adenuga (2017) cited the following factors as ways to which quality can be improved they included the provision of comprehensive information, Good communication among the construction team, effective and efficient project management, constructability review, design review management, adequate financial provision, adequate contingency allowance and also partnering. These solutions were recommended by the authors of the research to help improve the quality of designs at the design stage of Nigeria's construction industry.

Fatawu (2016) cited communication between all parties at the design stage for quality designs, continuous of involvement of management of the design, selection of consultant based on merit not only on lowest cost and spending enough time and money at the planning stage

2.11 SUMMARY

In summary, Quality in construction is defined as the process of satisfying the client's needs within the stated budget, time frame and within the stated requirements of the client and the consultants. A Quality design process is one which is able to produce drawings that are completed on time, conforms to requirements, accurate and there is coordination between disciplines. Design Quality indicators are tools used by professionals to help establish the quality of designs and also to help the communication process between professionals and clients and also to improve the design stage. Producing Quality designs will mean putting in place various strategies in order to achieve this goal. Cost of Quality was defined as the total cost of making sure the designs conforms to standards and also the cost of making corrections due to non-conformance. Design defects were explained as the failure to produce a complete, well-coordinated design and accurate designs by professionals to be used by contractors to produce the final products. From the various literature read we established that failure of designs was as a result of lack of coordination by project teams, communication gap, inefficient of technology, design fees being reduced, use of junior staff to produce major

works, lack of reviews by consultants, difficulties in sharing information and others. The failure in producing Quality designs has also led to the collapse of structures, increase in the cost of projects, reworks on both the site and also at the design stage, disputes between team members and variations in works. The literature revealed that failure in designs is an international problem where its effects were felt at various countries like Malaysia, UK, Nigeria, Tanzania and another host of countries. Literature searches revealed that to improve quality of designs at the design stage there was the need of project team commitment at the design stage of project delivery, efficient use of design technology, independent review of designs, comprehensive information and involvement of management. The Literature review also revealed that there should be proper planning at the design stage to produce quality designs and also for proper coordination between project team members to produce quality designs.

The Literature, therefore, gives purpose to why there is a need for research in Ghana.

CHAPTER THREE

METHODOLOGY

3.1 INTRODUCTION

This chapter discusses the research methodology which was used in the Project work. This chapter states the tools and techniques used to collect and analyze the data in order to meet the objectives of the study.

3.2 RESEARCH DESIGN

The research design articulates what type of data is required, what methods are going to be used to collect and analyze the data, and how all of this is going to answer your research questions (Wyk, 2009). The research design adopted for the study is a descriptive research. Descriptive research is the type of research that relies on observations as a means of collecting data according to Walliman (2011). This examines the situation and tries to identify whether this is the norm.

3.3 RESEARCH STRATEGY

Research strategy can be taken to mean the way in which the research objectives are questioned. The research strategy can be classified under two distinctions namely the quantitative and the qualitative approach (Bell, 2010) &. Quantitative research approach refers to the process by which researchers collect facts and study the relationship of one set of facts to another (Bell, 2010). The qualitative research approach is concerned about individuals' perception of the world (Bell, 2010). Sukamolson (n.d.) cited Creswell (1994) explaining quantitative research as a type of research that explains the phenomena by collecting numerical data that analyzed using mathematical methods. In order to be able to use the data has to be in numerical form to be able to explain a particular phenomenon. The study adopted a quantitative approach as its research Strategy.

3.4 SOURCES OF DATA

According to Bernard et al. (1986), data collection is important to the research. This is because it helps to bring clarity and understanding to the theoretical background (Bernard, 2002). It is therefore important to collect data which is reliable, accurate by using various data instruments.

3.4.1 Primary data

Primary data refers to data which has been observed, experienced or recorded close to the event are the nearest one can get the truth to the truth (Walliman, 2011). Primary data was explained by Bernard et al. (1986) as data which is collected at first hand. The primary data was collected from the various respondents (clients, Consultants, and contractors) through the use of a data instrument of a questionnaire.

3.4.2 Secondary information

Secondary data refers to the data which has been interpreted and recorded (Walliman, 2011). Secondary data refers to data obtained from books, journals, magazines etc. Secondary data collected during the undertaking of the research paper was the data collected from different literature sources.

3.5 TARGET POPULATION

The target population in research refers to a collective used to describe the total quantity of things (or cases) of the type which are the subject of the study according to Walliman (2011). The research study is interested in the various stakeholders who are involved in public construction project delivery in the Greater Accra Region, Ghana. According to the Government of Ghana (2018), the number of public institutions in the country is 136. Registered Consultants in Ghana who were of good standing with the GHIA was 104 as of 2015 (GHIA, 2015). The population for registered consultants with GhIE was estimated to be around 150 companies who were of good standing according to GIPC (2018). According to

Ofori -Kuragu (2013) the number of D1K1 contractors in Accra alone as of 2010 alone was 139. The current estimated population will, therefore, be higher than the figure stated by Ofori Kuragu (2013).

3.6 SAMPLE FRAME

The sample frame refers to the part of the population to which the researcher is interested in (Walliman, 2011). The sample frame for the public clients was a list obtained from the public procurement Authority which contained names of organizations which undertook public construction projects within Greater Accra Region in the previous years. The sample frame for the consultants was a list obtained from the various institutional bodies of registered members. The list contained names of consultants who had previously worked with public clients at various stages of the design process. The various institutional bodies of consultants include the Ghana Institute of engineers, Ghana Institute of Architecture and Ghana Institute of Quantity Surveyors. The sample frame for the contractors was a list obtained from the public procurement of various D1K1 contractors who had been awarded various contracts to carry out construction works in the Greater Accra Region.

3.7 SAMPLING TECHNIQUE

In identifying the various respondents needed for the study, the clients, the contractor and consultant purposive sampling were used for the study. Multi-stage sampling technique is one that involves multiple stages (Nyasulu, 2014). The use of a multi-stage sampling technique was used with the first stage using purposive sampling to identify the various clients, consultants, and consultants who satisfy the criteria stated. Convenience sampling was then used to select the subsequent sample size required due to the issue time constraint and financial constraints.

3.8 SAMPLE SIZE

According to Wade (2016), central limit theorem states that if you have a population with mean μ and standard deviation σ and take sufficiently large random samples from the population with replacement, then the distribution of the sample means will be approximately normally distributed. This will hold true regardless of whether the source population is normal or skewed, provided the sample size is sufficiently large (usually $n \geq 30$). If the population is normal, then the theorem holds true even for samples smaller than 30. This was the reason for choosing the number forty (40) as the sample size for the various respondents. The client institutions which received the various questionnaires were GETFUND, Ministry of Education and SSNIT.

Table 3.1 Sample Size for Client size

Clients	Number of questionnaires Distributed
GETFUND	**10**
Ministry Education	**15**
SSNIT	**15**
Total	**40**

Source: Author's source

Table 3.2 Sample Size for consultants and contractor

Consultants	**40**
D1K1 contractors	**40**

Source: Author's source

3.9 DATA COLLECTION INSTRUMENT

3.9.1 Questionnaires

The questionnaires were developed using the information obtained from the literature review. The questionnaires were made up of open-ended questions and closed-ended questions. Respondent was asked respond to various questions posed to them by the questionnaire by selecting an appropriate answer using the Likert scale. The questionnaires were distributed personally and also with the use of electronic mails. The questionnaires were structured as follows:

a) Respondent Information

b) Factors affecting Quality at the design stage

c) To identify the effects on quality

d) To identify measures that can improve quality at the design stage

3.10 ANALYSIS OF DATA

The data were analyzed using the SPSS and Excel. The objectives of the study were analyzed using the relative important index.

$$RII = \frac{\sum A}{WN}$$

Where:

W – is the weight given to each factor by the respondents and ranges from 1 to 5, (where "1" is "strongly disagree" and "5" is "strongly agree");

A – is the highest weight (i.e. 5 in this case)

3.11 RESEARCH LIMITATION

The research limit for the study was that the study cannot be used to generalize all public institutions in the Greater Accra Region that undertake construction project delivery.

3.12 SUMMARY

The importance of this chapter was to explain the research methodology thus the sample selection and the procedure adopted in designing the data collection instrument. It further seeks to provide an explanation of the statistical procedure used to analyze the data.

CHAPTER FOUR

ANALYSIS AND DISCUSSION OF SURVEY RESULT

4.1 INTRODUCTION

This chapter deals with the statistical analysis, discussions, and findings of the data collected from the survey.

4.2 SURVEY RESULTS

One hundred and twenty (120) questionnaires were distributed out to the various respondents. One hundred questionnaires were received which represents a response rate of 83.33%. The clients and the consultants were asked to answer all the questions. The contractors were asked to answer section A and Section B.

Table 4.1 Respondents questionnaire return rates

RESPONDENTS	QUESTIONNAIRES DISTRIBUTED	QUESTIONNAIRES RECEIVED	PERCENTAGE (%)
CLIENTS	40	36	90.00
CONSULTANTS	40	34	85.00
CONTRACTORS	40	30	75.00
SUM	120	100	83.33

Source: Author's source

4.2.1Respondents background information

Table 4.2 shows the background information of the various respondents. The table shows that thirty-seven percent (37 %) of the respondents are civil engineers; thirty-six percent (36 %) of the respondents are quantity surveyors; twenty-one percent (21%) are architects and the remaining six percent (6 %) are electrical engineers.

Table 4.2 Respondents professional backgrounds

PROFESSIONAL BACKGROUND	FREQUENCY	PERCENTAGE (%)
Architects	21	21
Civil Engineers	37	37
Quantity Surveyors	36	36
Electrical engineers	6	6
TOTAL	100	100

Source: Author's source

4.2.2 Respondents educational level

The survey revealed that twelve percent (12 %) of the respondent educational level being HND. Sixty percent (60%) of the respondents having a degree and the remaining and Twenty-eight percent (28 %) of the respondents having a Master's degree. The data shows that the population is able to appreciate the reasons for the research.

Table 4.3 Educational levels

EDUCATIONAL LEVEL	FREQUENCY	PERCENTAGE (%)
HND	12	12
DEGREE	60	60
MASTERS	28	28
TOTAL	100	100

Source: Author's source

4.2.3 Respondents years of experience

From the survey the analyzed it showed that thirteen percent (13%) had a working experience of 1-5 years. Twenty-six percent (26 %) of the respondents had a working experience of 6-10 years.

It also revealed that thirty-four percent 34% of the respondent had a working experience of 11-15 years and the remaining 27 had a working experience above 15 years. The results show that the respondents have experience at the design stage and also its effects of the failure of quality of design.

Table 4.4 Respondents years of experience

Years of Experience	Frequency	Percentage (%)
1-5	13	13
6-10	26	26
11-15	34	34
above 15	27	27
Total	100	100

Source: Author's source

4.2.4 Respondents recognition of problems with design process at the design stage

Ninety-seven percent of the respondents responded to the fact that they encountered various problems with the use of the various problems at the design stage. Only three percent stated otherwise. This, therefore, shows that there are challenges at the design stage of project delivery.

Table 4.5 Problems encountered at the design stage

PROBLEMS	Frequency	Percentage (%)
Yes	97	97
No	3	3
Total	100	100

Source: Author's source

4.2.5 Respondents response to responsibility

Forty-two percent (42 %) of the respondents blamed both the clients and the consultants as main sources of challenges at the design process. Forty-one percent (41 %) blamed the consultants as the main cause for challenges experienced at the design stage. Seventeen (17

%) put blame on the clients as the main cause for the challenges experienced at the design stage.

Table 4.6 Respondents response to responsibility

RESPONDENTS	Frequency	Percentage (%)
Client	17	17
Consultant	42	42
Both	41	41
Total	100	100

Source: Author's source

4.3 EFFECTS OF QUALITY ON PROJECT DELIVERY

Table 4.7 shows the Relative important index (RII) and the ranking of the severity of the various effects of quality at the design stage of various projects undertaken in the Greater Accra Region.

Table 4.7 Relative important index (RII) and rank on the severity of effects of design stage quality on project delivery

EFFECTS	SEVERITY							
	CLIENTS		CONSULTANT		CONTRACTOR		OVERALL RESPONSE	
	RII	RANK	RII	RANK	RII	RANK	RII	RANK
Increased Project cost	68.5	5th	70	7th	73.1	5th	70.39	**6th**
Increased Reworks during and after the design stage	52.9	12th	69	9th	73	6th	64.4	**11th**
Loss of Productivity during Construction stage	57.6	11th	68.3	10th	67.5	12th	64.21	**12th**
Loss of financial resources in carrying out reworks	77	1st	74	2nd	74	3rd	75.08	**2nd**
Increased variance	65	8th	67	11th	72.4	7th	67.9	**9th**
Lack of satisfaction by the end user	74	3rd	71	6th	68	11th	71.18	**4th**
Failure of the ongoing construction project	68	6th	73	3rd	71	8th	70.6	**5th**
Delay in completion of project	64	9th	72	5th	70.5	9th	68.67	**8th**
Delays in payment to contractors	60	10th	65	12th	77	2nd	66.8	**10th**
Project abandonment	75.6	2nd	75	1st	79	1st	76.42	**1st**
Payment claims problems	67.3	7th	72.3	4th	70.3	10th	69.9	**7th**
Contract disputes	70	4th	69.7	8th	73.77	4th	71.03	**3rd**

Source: Author's source

DISCUSSIONS

The following are the effects of quality at the design stage which can affect project delivery.

4.3.1 Project Abandonment

From table 4.7 project abandonment was ranked as the first with an overall relative important index of 76.42 by the respondents. The contractors and the consultants ranked project abandonment as the first with RII of 79% and 75% respectively. The clients ranked it as second with an RII of 75.6%. The results, therefore, show that if there is a failure of quality at the design stage the projects are usually abandoned. This is in line with the works of Fatawu (2016) and also the work of Dosumu and Adenuga (2017).

4.3.2Loss of Financial Resources in Carrying out Reworks

The loss of financial resources was ranked as the second most severe effect on project delivery by the respondents with an RII of 75.08%. The clients ranked as the factor as the most severe factor of the failure of the design stage whiles the consultants and the contractors ranked them as 2nd and the third respectively with an RII of 74%. This is said to negatively to affect the financial resources needed for further stages of the project delivery process.

4.3.3 Contract Disputes

Contract dispute was ranked as the third most severe effect on project delivery due to the failure of quality at the design stage. The Relative Important index RII was 71.03 %. Contract dispute was ranked as 4th by both the contractor and client respondents. The Contractor and the client both had a relative important index of 73.77 and 70 respectively. The consultants had an RII of 69.7 and were ranked 8th. This agrees with the work carried out by Suleiman and Luvara (2016).

4.3.4 Lack of Satisfaction by the End User

: The goal of a quality is to produce the project within the limited budget, time frame and within the scope given to the consultants and the contractor which will lead to client satisfaction. The overall response was ranked fourth with a relative importance index of 71.18 %. The Client and consultants ranked it 3rd and 6th respectively with an RII of 74% and 71% respectively. The lack of satisfaction at the initial design stage could further hinder the project delivery from continuing to another stage.

4.3.5 Failure of Ongoing Construction Project

With mostly being made at the design stage in terms of materials to be used on the site and the type mixtures to be used for the various batching process. Failure of the design process to deliver effective designs and documents will lead to the failure of the project during construction. The relative important index of 70.6 %.The client, consultant, and contractor had RII of 68 %, 71 % and 73 % respectively. The rankings for the RII for the client, consultant and contractor are as follows 6th, 3rd and 8th. This is also in line with research carried by McDonald & Leed (2013) and Love (2002) & Love, Edwards & Irani (2008).

The rest of the effects of deficiencies in the design process in terms of the severity of project delivery increased project cost which was ranked as 6th with a relative importance index of 70.39 %, Payment claims was ranked 7th with a relative importance index of 69.9%, Delay in completion of projects was ranked 8th with an RII of 68.67 %., Increased variance was ranked 9th with a relative importance index of 67.9%, Delay in payment of contractors being ranked 10th with an RII of 66.8%, Increase in rework during and after design stage being ranked 11th and having a relative important index of 64.4% and lastly loss of productivity during the construction phase with an RII of 64.21 %.

4.4 FACTORS AFFECTING QUALITY AT THE DESIGN STAGE OF CONSTRUCTION PROJECT DELIVERY

Forty factors were identified that affect quality at the design stage of construction projects. The clients and consultants were asked to rate the factors accordingly to the frequency and its severity.

Table 4.8 Overall ranking of the factors frequency and its severity affecting quality at the design stage of construction projects by the respondents.

OVERALL

FACTORS		FREQUENCY				SEVERITY			
		RII	MEAN	SD	RANK	RII	MEAN	SD	RANK
1	Unrealistic client demands on time schedule	67.71	3.38	0.62	**10**	67.14	3.35	0.78	**17**
2	Failure of client to check designs at appropriate times	55.71	2.78	0.78	**32**	71.14	2.56	0.67	**10**
3	Poor scope definition	74.57	3.71	0.78	**2**	75.27	3.73	0.58	**1**
4	Missing input information by client	72.29	3.61	0.68	**6**	72.29	3.61	0.54	**9**
5	Delay in payment of consultants	73.43	3.67	0.64	**3**	73.43	3.67	0.6	**5**
6	Unrealistic client demands from the project cost	72.29	3.61	0.7	**5**	63.57	3.23	0.73	**23**
7	Limited participation of end users at the briefing stage	62.86	3.14	3	**19**	62.86	3.64	0.49	**24**
8	Design Changes by client	72.57	3.62	0.7	**4**	63.71	3.19	0.6	**22**
9	Reduction of consultant fees	63.14	3.15	0.61	**17**	70	3.51	0.53	**12**
10	Eagerness of consultant to move onto next phase	55.14	2.75	0.58	**34**	66	3.3	0.57	**21**
11	Poor project planning of work schedule	55.43	2.77	0.73	**33**	68.29	3.41	0.71	**16**
12	Poor Knowledge in the physical properties of materials by consultants	50.86	2.54	0.55	**37**	61.14	3.06	0.78	**25**

Table 4.8 Overall ranking of the factors frequency and its severity affecting quality at the design stage of construction projects by the respondents.

13	Lack of experience by consultants	57.71	2.88	0.67	**25**	68.86	3.44	0.71	**14**
14	Failure to have design reviews	66.29	3.31	0.67	**13**	51.71	2.59	0.75	**34**
15	Poor cost planning by Consultants	59.43	2.97	0.63	**23**	72.86	3.64	0.76	**7**
16	Complex details and selection of new materials which have not been tested	52.29	2.61	0.49	**35**	50	2.5	0.79	**39**
17	Poor specification detailing	60.29	3.01	0.55	**21**	51.43	2.57	0.79	**35**
18	Inadequate consultants at the initial design stage	55.14	2.75	0.62	**34**	53.14	2.66	0.79	**29**
19	Lack of commitment to quality improvement by design professionals	57.71	2.88	0.63	**26**	50.86	2.54	0.69	**37**
20	Lack of monitoring by technical staff against updated standards	57.43	2.87	0.72	**28**	52.29	2.61	0.65	**33**
21	Lack of Knowledge in building bye-laws, codes and government rules	57.71	2.89	0.69	**24**	52.29	2.61	0.68	**32**
22	Lack of constructability review of design	64.86	3.24	0.67	**14**	52.29	2.65	0.68	**31**
23	Delay in payment of consultants	56.86	2.84	0.6	**31**	73.43	2.54	0.6	**6**
24	Lack of coordination by consultants	69.14	3.45	0.53	**9**	69.71	3.48	0.6	**13**
25	Decisions made are based on cost only and not on value engineering	66.86	3.34	0.51	**12**	72.86	3.64	0.6	**8**
26	Use of junior staff for major works	67.14	3.35	0.72	**11**	66.29	3.31	0.67	**19**
27	Negligence by consultants	50.29	2.51	0.5	**39**	67.14	3.35	0.63	**18**

Table 4.8 Overall ranking of the factors frequency and its severity affecting quality at the design stage of construction projects by the respondents.

28	Unbalance resource allocation	50.86	2.54	0.56	**37**	57.71	2.88	0.55	**28**
29	Reuse of standard details and specifications to minimize workload	69.14	3.45	0.58	**7**	52.57	2.6	0.68	**30**
30	Poor client briefing	46.29	2.31	0.55	**40**	46.29	2.31	0.55	**40**
31	Leadership problems	57.43	2.87	0.61	**29**	73.71	3.68	0.92	**4**
32	Familiarity of the process	57.14	2.85	0.59	**30**	50.86	2.54	0.755	**37**
33	Lack of effective communication between design team	75.14	3.52	0.5	**1**	75.14	3.75	0.46	**2**
34	Difficulties in sharing needed information	57.71	2.89	0.6	**26**	51.43	2.57	0.69	**35**
35	Selection criteria for consultants	62.29	3.11	0.57	**20**	74.57	3.72	0.63	**3**
36	Procurement process used in project delivery	69.14	3.45	0.54	**8**	68.57	3.42	0.6	**15**
37	Selection criteria for contractors	62.9	3.11	0.57	**18**	66.29	3.31	0.71	**19**
38	Standards are not updated by local authorities	64.29	3.17	0.63	**16**	59.43	2.97	0.74	**27**
39	Effects of design code on the standard of quality	59.43	3.38	0.64	**22**	59.43	2.97	0.72	**26**
40	Inefficient use of design software	64.86	3.07	0.6	**15**	70	3.24	0.624	**11**

Source: Author's source

In table 4.9 it shows the various factors affecting quality at the design stage concerning both frequency and severity ranked by the consultants.

Table 4.9 RII rank of factors affecting quality at the design stage by the consultants.

		CONSULTANTS							
		FREQUENCY				SEVERITY			
FACTORS		RII	MEAN	SD	RANK	RII	MEAN	SD	RANK
1	Unrealistic client demands on time schedule	67.7	3.38	0.55	**11**	71.18	3.56	0.8	**11**
2	Failure of client to check designs at appropriate times	58.8	2.94	0.77	**26**	47.06	2.35	0.8	**39**
3	Poor scope definition	78.2	3.91	0.83	**1**	75.29	3.76	0.7	**3**
4	Missing input information by client	74.1	3.7	0.8	**3**	73.53	3.68	0.6	**6**
5	Delay in payment of consultants	74.7	3.73	0.67	**2**	72.35	3.61	0.6	**8**
6	Unrealistic client demands from the project cost	59.4	2.97	0.57	**24**	71.76	3.58	0.6	**10**
7	Limited participation of end users at the briefing stage	60.6	3.02	0.63	**22**	73.53	3.68	0.5	**6**
8	Design Changes by client	73.6	3.67	0.72	**4**	68.24	3.41	0.5	**17**
9	Reduction of consultant fees	61.2	3.05	0.64	**21**	71.76	3.59	0.5	**9**
10	Eagerness of consultant to move onto next phase	54.7	2.73	0.56	**34**	69.41	3.47	0.6	**16**
11	Poor project planning of work schedule	58.8	2.94	0.73	**27**	70.59	3.52	0.6	**14**
12	Poor Knowledge in the physical properties of materials by consultants	52.4	2.61	0.49	**38**	61.18	3.06	0.9	**25**
13	Lack of experience by consultants	64.7	3.23	0.61	**15**	65.88	3.29	0.8	**20**
14	Failure to have design reviews	65.3	3.26	0.75	**13**	50.59	2.52	0.7	**37**
15	Poor cost planning by Consultants	56.5	2.82	0.63	**32**	51.18	2.56	0.8	**35**
16	Complex details and selection of new materials which have not been tested	52.4	2.62	0.49	**37**	51.18	2.56	0.8	**34**
17	Poor specification detailing	59.4	2.97	0.45	**25**	42.35	2.11	0.6	**40**

Table 4.9 RII rank of factors affecting quality at the design stage by the consultants.

18	Inadequate consultants at the initial design stage	52.9	2.65	0.55	**36**	48.82	2.44	0.6	**38**
19	Lack of commitment to quality improvement by design professionals	64.7	3.14	0.55	**17**	51.18	2.56	0.7	**36**
20	Lack of monitoring by technical staff against updated standards	59.4	2.97	0.67	**23**	59.41	2.14	0.7	**27**
21	Low level of Knowledge in building bye-laws, codes and government rules	57.7	2.88	0.67	**29**	52.35	2.82	0.8	**32**
22	Lack of constructability review of design	69.4	3.47	0.51	**8**	52.35	2.62	0.7	**33**
23	Delay in payment of consultants	57.7	2.88	0.64	**30**	57.65	2.41	0.6	**29**
24	Lack of coordination by consultants	68.8	3.44	0.56	**9**	71.18	3.55	0.6	**11**
25	Decisions made are based on cost only and not on value engineering	65.3	3.27	0.57	**14**	76.48	3.82	0.8	**1**
26	Use of junior staff for major works	70	3.5	0.78	**6**	65.29	3.26	0.8	**22**
27	Negligence by consultants	50	2.5	0.5	**40**	70	3.5	0.6	**14**
28	Unbalance resource allocation	50	2.5	0.51	**39**	53.53	2.67	0.5	**31**
29	Reuse of standard details and specifications to minimize workload	65.9	3.29	0.62	**12**	71.18	2.55	0.7	**12**
30	Poor client briefing	53.5	2.67	0.64	**35**	65.29	2.26	0.6	**23**
31	Leadership problems	58.8	2.94	0.65	**27**	74.12	3.7	0.9	**5**
32	Familiarity of the process	57.1	2.85	0.65	**31**	67.06	2.35	0.8	**18**
33	Lack of effective communication between design team	70.6	3.52	0.51	**5**	74.71	3.73	0.5	**4**
34	Difficulties in sharing needed information	56.5	2.82	0.57	**33**	54.71	2.73	0.8	**30**
35	Selection criteria for consultants (Based on Lowest)	67.7	3.38	0.65	**10**	76.47	3.82	0.7	**2**
36	Procurement process used in project delivery	69.4	3.47	0.56	**7**	65.29	3.26	0.5	**21**

Table 4.9 RII rank of factors affecting quality at the design stage by the consultants.

37	Selection criteria for contractors	63.5	3.17	0.57	**18**	64.71	3.23	0.8	**24**
38	Standards are not updated by local authorities	61.8	3.08	0.57	**20**	57.65	2.88	0.6	**28**
39	Effects of design code on the standard of quality	64.7	3.17	0.57	**16**	61.18	3.06	0.9	**25**
40	Inefficient use of design software	62.9	3.14	0.56	**19**	67.06	3.35	0.7	**18**

Source: Author's source

Table 4.9b RII rank of factors affecting quality at the design stage by the clients

CLIENTS

FACTORS		**FREQUENCY**				**SEVERITY**			
		RII	**MEAN**	**SD**	**RANK**	**RII**	**MEAN**	**SD**	**RANK**
1	Unrealistic client demands on time schedule	67.78	3.39	0.68	**13**	63.33	3.16	0.77	**20**
2	Failure of client to check designs at appropriate times	52.73	2.63	0.76	**34**	55	2.75	0.5	**30**
3	Poor scope definition	70.56	3.53	0.69	**7**	75.44	3.69	0.46	**3**
4	Missing input information by client	70.56	3.53	0.55	**6**	71.67	3.58	0.5	**10**
5	Delay in payment of consultants	69.44	3.47	0.62	**10**	74.44	3.72	0.61	**4**
6	Unrealistic client demands from the project cost	71.05	3.55	0.74	**4**	61.11	3.05	0.79	**24**
7	Limited participation of end users at the briefing stage	65	3.25	0.69	**17**	71.67	3.58	0.6	**9**
8	Design Changes by client	71.67	3.58	0.69	**3**	70.56	3.52	0.69	**11**
9	Reduction of consultant fees	65	3.25	0.55	**15**	68.89	3.44	0.57	**13**

Table 4.9b RII rank of factors affecting quality at the design stage by the clients

10	Eagerness of consultant to move onto next phase	55.56	2.77	0.59	**32**	62.78	3.13	0.54	**21**
11	Poor project planning of work schedule	52.22	2.61	0.68	**35**	66.11	3.3	0.66	**18**
12	Poor Knowledge in the physical properties of materials by consultants	0.49	2.47	0.6	**40**	61.11	3.05	0.62	**26**
13	Lack of experience by consultants	51.11	2.55	0.55	**38**	71.67	3.58	0.63	**8**
14	Failure to have design reviews	67.22	3.36	0.59	**14**	52.78	2.63	0.79	**34**
15	Poor cost planning by Consultants	62.22	3.11	0.62	**20**	68.33	3.42	0.73	**14**
16	Complex details and selection of new materials which have not been tested	52.22	2.61	0.49	**36**	48.89	2.44	0.76	**37**
17	Poor specification detailing	61.11	3.05	0.62	**23**	60	3	0.83	**27**
18	Inadequate consultants at the initial design stage	57.22	2.86	0.68	**28**	57.22	2.86	0.71	**29**
19	Lack of commitment to quality improvement by design professionals	52.78	2.63	0.59	**33**	50.56	2.52	0.73	**36**

Table 4.9b RII rank of factors affecting quality at the design stage by the clients

20	Lack of monitoring by technical staff against updated standards	56.56	2.78	0.76	**30**	47.22	2.36	0.59	**39**
21	Low level of Knowledge in building bye-laws, codes and government rules	58.89	2.47	0.59	**27**	61.67	3.08	0.69	**23**
22	Lack of constructability review of design	60.56	3.02	0.74	**24**	52.22	2.61	0.64	**35**
23	Delay in payment of consultants	69.44	3.47	0.61	**9**	53.33	2.67	0.58	**33**
24	Lack of coordination by consultants	69.44	3.5	0.61	**8**	68.33	3.4	0.64	**15**
25	Decisions made are based on cost only and not on value engineering	68.33	3.41	0.5	**12**	69.44	3.47	0.69	**12**
26	Use of junior staff for major works	64.44	3.22	0.61	**18**	67.22	3.36	0.59	**17**
27	Negligence by consultants	50.56	2.52	0.51	**39**	64.44	3.22	0.68	**19**
28	Unbalance resource allocation	51.67	2.53	0.6	**37**	61.67	3.08	0.73	**22**
29	Reuse of standard details and specifications to minimize workload	72.22	3.61	0.49	**2**	53.89	2.69	0.67	**32**
30	Poor client briefing	62.78	3.13	0.59	**19**	47.22	2.36	0.48	**40**
31	Leadership problems	56.11	2.81	0.57	**31**	73.33	3.67	0.98	**5**
32	Familiarity of the process	57.22	2.86	0.54	**29**	54.44	2.72	0.7	**31**

Table 4.9b RII rank of factors affecting quality at the design stage by the clients

33	Lack of effective communication between design team	77.56	3.52	0.51	**1**	75.56	3.77	0.42	**1**
34	Difficulties in sharing needed information	58.89	2.94	0.63	**26**	48.33	2.41	0.6	**38**
35	Selection criteria for consultants	61.11	3.05	0.58	**22**	72.78	3.63	0.59	**6**
36	Procurement process used in project delivery	68.89	3.44	0.5	**11**	71.67	3.58	0.64	**7**
37	Selection criteria for contractors	61.11	3.06	0.58	**21**	67.78	3.39	0.59	**16**
38	Standards are not updated by local authorities	65	3.25	0.68	**16**	61.11	3.06	0.79	**25**
39	Effects of design code on the standard of quality	70.56	3.52	0.61	**5**	57.78	2.88	0.57	**28**
40	Inefficient use of design software	60	3	0.63	**25**	75.56	3.13	0.54	**2**

Source: Author's source

TABLE 4.10 RII rankings of the five most severe factors affecting quality at the design stage

FACTORS	SEVERITY								
	Clients			Consultants			Overall Response		
	RII	MEAN	RANK	RII	MEAN	RANK	RII	MEAN	RANK
Poor scope definition	75.44	3.69	**3**	75.29	3.76	**3**	75.27	3.73	**1**
Lack of effective communication between design team	75.56	3.77	**1**	74.71	3.73	**4**	75.14	3.75	**2**
Selection criteria for consultants (Lowest Based)	72.78	3.63	**6**	76.47	3.82	**2**	74.57	3.72	**3**
Leadership problems	73.33	3.67	**5**	74.12	3.7	**5**	73.71	3.68	**4**
Delay in payment of consultants	74.44	3.72	**4**	72.35	3.61	**7**	73.43	3.67	**5**

Source: Author's source

DISCUSSION

The most severe factors affecting quality at the design stage of construction projects according to the ranking are:

4.4.1 Poor Scope Definition:

From table 4.10 the most severe factor affecting quality at the design stage was poor scope definition which had an RII rank of 75.27%. Clients and consultants ranked it as 75.44 % which was 3rd and the consultant RII was 75.29 % and its ranking was 3rd respectively. It means the poor scope definition can be detrimental to the delivery of quality at the design stage of a construction project.

4.4.2 Lack of Effective Communication:

From table 4.10 lack of effective communication at the design was ranked second as the 2nd most severe factor affecting quality at the design stage. It had an overall RII of 75.14 %. Clients and the consultants ranked the lack of effective communication with an RII of 75.56% and 74.17% respectively. This means that communication within the design stage is essentially important in the delivery of quality designs at the design stage. This is in line with Oyedele, Jaiyeoba & Fadeyi (2012), Kissi Mohammed and Owusu – Diatuo (2018) and Ayirebi Dansoh, Oteng & Frimpong (2017).

4.4.3 Selection Of Consultants Based On Lowest Cost

From table 4.10 the selection of consultants at the design stage was ranked 3rd with an overall RII of 75.47%. Clients and the consultants ranked the selection of consultants as 6th and 2nd respectively with both having an RII of 72.78% and 74.57%. The selection of consultants respectively to form part of the project team is really important in the delivery of quality at the design stage and therefore emphasis should not be put on price for the selection of consultants. The selection of the consultants should not only be based on the lowest cost when the task at hand is not routine or standard in nature and where least-cost selection is not being used. This agrees with works carried with Tilley, Fallan & Tucker (1999).

4.4.4 Leadership Problem

From table 4.10 the project team leader is important in the delivery of quality at the design stage. The Project team leader is the one responsible for handling coordination of activities of the delivery of quality designs at the design stage. Leadership was ranked as the 4th most severe factor by the overall participants with an RII of 73.48%. The clients and the consultants respectively ranked leadership problems with an RII of 73.33% being 5th and 74.12% being 5th respectively. This is in agreement with Ayirebi Dansoh, Oteng & Frimpong (2017).

4.4.5 Delay in Payment of Consultants

: From table 4.10 the delay in payment of consultants at the appropriate time affects the delivery process of quality at the design stage. The payment of consultants on time serves as a stimulant for delivery of the designs at the appropriate delivery period. Failure to produce quality designs at the appropriate time affects the project delivery. The overall RII for both consultant and client was 73.43%. The RII rank by the consultants is 72.35% and the RII rank for the client is 74.44%. This agrees with the work carried out by Fatawu (2016).

Table 4.11 Highest ranked frequency factors

FACTORS	FREQUENCY								
	Clients			Consultants			Overall Response		
	RII	MEAN	RANK	RII	MEAN	RANK	RII	MEAN	RANK
Lack of effective communication between design team	77.56	3.52	**1**	77.59	3.72	**1**	75.14	3.52	**1**
Poor scope definition	70.56	3.53	7	76.24	3.91	**2**	74.57	3.71	**2**
Delay in payment of consultants	69.44	3.47	**10**	74.71	3.73	4	73.43	3.67	**3**
Last minute design Changes by client	71.67	3.58	**3**	73.57	3.67	6	72.57	3.62	**4**
Unrealistic client demands from the project cost	71.05	3.55	**4**	73.7	3.52	**5**	72.29	3.61	**5**

Source: Author's source

DISCUSSION

The most frequent factors affecting quality at the design stage of construction projects according to the ranking are:

4.4.1b Lack of Effective Communication

From table 4.11 the most frequent challenges at the design stage are effective communication. Communication is essential in the delivery of quality designs and also in allowing each project team member to express themselves adequately to deliver designs which would serve its purpose. Effective communication had an overall relative important index of 75.14% and was ranked 1st. the consultants and the clients ranked effective communication as 1st and 1st respectively with an RII of 77.56 % and 77.59 %. This is in agreement with Oyedele, Jaiyeoba & Fadeyi (2012).

4.4.2b Poor Scope Definition

From table 4.11 the delivery of the right scope in order for consultants to deliver quality designs at the design stage is one of the most frequent challenging issues. The overall rank for RII for poor scope definition was 74.58%. Clients and consultants ranked it as 2nd and 7th respectively with an RII of 70.56% and 76.24% respectively.

4.4.3b Delay in Payment of Consultants

From table 4.11 the third most frequent factor affecting quality at the design stage is the delay in the payment of the consultants. Delay in payment of Clients had an overall rank of RII of 73.43%. The delay in payment was ranked 10th and had an RII of 69.44% whiles the consultants ranked it as the 4th as the most frequent factor with an RII of 74.71%. It, therefore, shows that the consultant who is at the receiving end, consider this frequent factor as one which hampers their performance. This is in agreement with the works of Fatawu (2016).

4.4.4b Last Minute Design Changes by Clients

From table 4.11 Last minute design changes was ranked as the 4th most frequent challenges at the design stage with an RII of 72.57%. Client ranked last-minute design changes as the third most frequent challenges at the design stage with an RII of 71.67% and the consultants ranked last minute changes of an RII with 73.57% respectively. All respondents have accepted that Clients last minute changes during the design and documentation process have been frequent and, therefore, it is critical. Clients should be much aware of their responsibility of making stable requirements to avoid changes at later stages.

4.4.5b Unrealistic Client Demands from The Project Cost

From table 4.11 the 5th most frequent factor affecting quality is the unrealistic demands placed on consultants at the design stage to produce designs which the budget will not be able to meet the need. The overall RII for this factor is 72.25%. The consultants RII rank for the factor was 73.7% which was ranked 5th and the clients were ranked 4th with an RII of

71.05%. This, therefore, shows the importance of clients being realistic in the demands put on consultants to deliver designs which may be above the budget. This is in agreement with the work carried out by Oyedele, Jaiyeroba & Fadeyi (2012).

4.5 MEASURES TO IMPROVE QUALITY AT THE DESIGN STAGE

Table 4.12 shows the Relative important index (RII) and the ranking of the measures to improve quality at the design stage of various projects undertaken in the Greater Accra Region.

Table 4.12 Ranking for Measures to improve quality by Clients and consultants

MEASURES TO IMPROVE QUALITY	CLIENTS			CONSULTANTS			OVERALL		
	RII	Mean	Rank	RII	Mean	Rank	RII	Mean	Rank
Efficient communication between project team members at all stages	69.44	3.47	1st	74.12	3.71	1st	71.71	3.59	1st
Commitment by Project team members in providing quality designs	66.11	3.31	2nd	72.67	3.63	3rd	70.71	3.54	2nd
Increased Level of Planning at the design stage	63.33	3.08	4th	72.94	3.59	2nd	67.43	3.37	3rd
Selection of consultants based on merit and not lowest cost	62.22	3.11	5th	71.18	3.56	4th	66.57	3.33	4th
Efficient use of technological software	65.56	3.28	3rd	68.24	3.5	5th	63.45	3.17	5th

Source: Author's source

4.5.1 Efficient Communication between design members

The highest ranked measure for improving quality at the design stage is the efficient communication between project team members at stages of the design stage. This measure had an overall RII of 71.71 %. Both clients and consultants ranked it as the highest ranked factor needed at the design stage to improve quality with a relative importance index of 69.44% and 74.11 % respectively. This is in agreement with the ACIF and APCC (2012).

4.5.2 Increased Level of commitment by Project team members in providing quality designs

Increased level of commitment of project team members to provide quality designs at the design stage. The commitment of the project was ranked 2nd at the second most important measure in improving quality at the design stage. Clients and consultants ranked the measures 2nd and 3rd respectively. The RII for the commitment of clients and consultants was 66.11 % and 72.67% respectively. This is in agreement with Jha & Iyer (2006).

4.5.3 Increased Level of Planning at the design stage

Increased level of planning at the design stage was ranked as the 3rd most important measure by all the respondents. Increase the level of planning had an overall relative important index of 67.73%. The clients and the consultants ranked it as 4th respectively and 2nd respectively. This is in agreement with Fatawu (2016) and also Tilley, Fallan and Tucker (1999).

4.5.4 Selection of consultants based on merit and not only on least cost

Selection of consultants based on merit and not only on least cost was ranked as the 4th most important measure to improve quality at the design stage. It had a relative important index of 66.57 %. It was ranked by the clients and consultants as 5th and 4th respectively. The relative important index for both respondents was 62.22 % and 71.18%.Selection of consultants of consultants based on merit and not only on least cost for works which are not routine.

4.5.5 Efficient use of technological software:

Efficient use of technological software at the design stage was ranked as the 5th most important measures to improve quality at the design stage. It had a relative important index of 63.45%. Both client and respondents ranked the efficient use of design software as 4th and 5th respectively. This is in agreement with BIM **(2009).**

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

This chapter presents the final part of the study where conclusions are drawn from the major findings of the analysis and recommendations made to address these findings towards achieving the objectives of the study.

5.2 SUMMARY OF FINDINGS

The survey achieved an overall response rate of 83.33%. It showed that majority of the clients had experience in the delivery of construction project delivery with 97% of the respondents encountering problems at the design stage of construction project delivery in the Greater Accra region and that consultants were mostly responsible for these problems.

5.2.1 To identify factors affecting quality at the design stage in the Greater Accra region.

Based on the rankings of the various factors and the analysis of the study using relative important index it was established that the most severe factors affecting quality at the design stage were Poor scope definition, Delay in payment of consultants, Selection of consultants based on least cost, leadership problems and Lack of effective communication.

Again using relative important index against the factors it was determined that the following factors as the most frequent factors affecting quality at the design stage which were effective communication, Poor scope definition, delay of consultants, Last minute design changes by clients and unrealistic client demands from the project cost

5.2.2 To identify the effects of quality at the design stage on the construction project delivery in the Greater Accra region.

From the analysis of the various effects of quality at the design stage of project delivery the following factors were identified as the most severe effects of poor quality at the design stage of construction project delivery were Project abandonment, Loss of financial resources in

carrying out reworks, Contract dispute, Lack of satisfaction by end user and Failure of structures on ongoing construction projects.

5.2.3 To identify measures to improve quality at the design stage.

From the analysis of the various effects affecting quality at the design stage of project delivery the following factors were identified as the measures that can improve quality at the design stage of construction project delivery were; Efficient communication between design members, Increased level of commitment by project team members in providing quality designs, selection of consultants based on merit and not only on least-cost selection and Efficient use of technological software.

5.3 CONCLUSION

Based on the findings of the study, it has been concluded that there are factors affecting quality at the design stage in the Greater Accra Region. These problems have usually led to project abandonment, loss of financial resources in carrying out reworks contract disputes, lack of satisfaction by the end user, and failure of structures on ongoing construction projects.

Based on the factors affecting quality at the design stage it established the following factors as the most severe factors affecting quality at the design stage was poor scope definition, Delay in payment of consultants, selection of consultants based on least cost, Leadership Problem and Lack of effective communication. The clients and consultants also ranked the following factors as the ways to which quality at the design stage can be improved to help deliver quality designs at the end of the design process efficient communication between design members, Increased level of commitment by Project team members in providing quality designs, increased level of planning at the design stage, Selection of consultants based on merit and not only on lowest cost and efficient use of technological software

5.4 RECOMMENDATIONS

From the conclusions, it is evident there are challenges at the design of construction project delivery and that the degree of the adverse effects of this on project quality. Therefore, stakeholders (notably Clients and Consultants) of projects should realize the need to tackle these critical factors and the effects thereon in a timely manner.

- Clients must clearly define their scope of works in order for consultants to come out with adequate designs to meet client needs.
- Clients should also make sure that consultant fees are paid at appropriate times. This would enable consultants to deliver the designs at the right time and also serve as an incentive for consultants to do deliver quality designs at the design stage.
- Clients are to select consultants based on merit and not on the lowest cost when least-cost selection is not being used. The time required for the selection of consultants should be adequate for proper evaluation of consultant based on their past experience, competency, and other relevant factors.
- Project teams are to clearly define themselves using various Design quality indicators to be able to communicate effectively when it comes to designs and also clearly define channels from which project teams will be able to express their concerns.
- Project Team leaders are also to make sure they are able to define the various roles and outputs for various project team members in order for there to be the quality delivery of designs at the design stage.

5.5 RECOMMENDATION FOR FUTURE RESEARCH

Due to time and resource constraint, a survey was conducted in Greater Accra region, Ghana; it is thus recommended that future studies should consider undertaking study factors affecting quality at the design stage in the various regions. It is also recommended that a case study is

conducted on some selected major building construction projects in Ghana regarding the quality at the design stage in the project delivery.

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APPENDICE

DEPARTMENT OF BUILDING TECHNOLOGY

SURVEY QUESTIONNAIRE FOR

Determining measures to improve quality at the design stage of public construction projects.

Dear Sir/Madam,

I am a postgraduate student of the Kwame Nkrumah University of Science and Technology (KNUST) undertaking a research on the above subject area for a Master of Science degree in Procurement Management. The research seeks to achieve the following objectives:

- To identify the factors that affect quality at the design stage of Public construction projects
- To identify the effects of the failure of quality
- To identify measures to Improve quality at the design stage

I would be very grateful if you could spare part of your valuable time in filling this questionnaire. Information supplied by you will be treated as strictly confidential and will be used for only academic work. I shall be happy to provide you with the results of the study once completed if you wish.

Thanks in advance for your cooperation and assistance.

Yours faithfully,

Fred Djokoto

Section A: RESPONDENT INFORMATION

1. 1 Which of the following category of respondent's do you fall under?

   ☐ Client ☐ Consultant ☐ Contractor

2. Respondents professional background

   ☐ Architect ☐ Civil/Structural Engineer ☐ Quantity surveyor
   ☐ Electrical Engineer
3. Highest Educational qualification of respondent

   ☐ HND ☐ First degree ☐ Masters ☐ other please specify……
4. How many years of experience do you have in the construction industry?

   ☐ 0-5 years ☐ 6-10 years ☐ 11- 15 years ☐ above 15 years
5. Have you ever encountered any problem regarding error/deficiency in design
   ☐ Yes ☐ No
6. If yes, who was responsible for it?

   ☐ Client ☐ Consultant ☐ Both

From your experience, please thick appropriately the severity and frequency factors affecting quality at the design stage using the Likert scale listed below:

1 = No effect 2 =Low severe 3= Fairly severe 4=Severe 5 =Highly Severe

	FACTORS AFFECTING QUALITY AT DESIGN STAGE	**FREQUENCY**					**SEVERITY**				
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
1	Unrealistic client demands on a time schedule										
2	Failure of the client to check designs at appropriate times										
3	Poor scope definition										
4	Missing input information by the client										
5	Delay in payment of consultants										
6	Unrealistic client demands from the project cost										
7	Limited participation of end users at the briefing stage										
8	Design Changes by the client										
9	Reduction of consultant fees										
10	The eagerness of consultant to move onto next phase										
11	Poor project planning of work schedule										
12	Poor Knowledge in the physical properties of materials by consultants										
13	Lack of experience by consultants										

14	Failure to have design reviews										
15	Poor cost planning by Consultants										
16	Complex details and selection of new materials which have not been tested										
17	Poor specification detailing										

From your experience, please thick appropriately the severity and frequency factors affecting quality at the design stage using the Likert scale listed below:

1 = No effect 2 =Low severe 3= fairly severe 4=Severe 5 =Highly Severe

	FACTORS AFFECTING QUALITY AT DESIGN STAGE	**FREQUENCY**					**SEVERITY**				
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
18	Inadequate consultants at the initial design stage										
19	Lack of commitment to quality improvement by design professionals										
20	Lack of Knowledge in building bye-laws, codes and government rules										
21	Lack of monitoring by technical staff against updated standards										
22	Lack of constructability review of design										
23	Delay in payment of consultants										
24	Lack of coordination by consultants										
25	Decisions made are based on cost only and not on value engineering										
26	Use of junior staff for major works										

27	Negligence by consultants										
28	Unbalance resource allocation										
29	Reuse of standard details and specifications to minimize workload										
30	Poor project briefing to clients										
31	Leadership problems										
32	The familiarity with the process										
33	Lack of effective communication between the design team										
34	Difficulties in sharing needed information										
35	Selection criteria for consultants										
36	Procurement process used in project delivery										
37	Selection criteria for contractors										
38	Standards are not updated by local authorities										
39	Effects of design code on the standard of quality										
40	Inefficient use of design software										

MEASURES TO IMPROVE QUALITY	RELATIVE IMPORTANT INDEX				
	1	2	3	4	5
Better communication between project team members					
Commitment by Project team members in providing quality designs					
Increased Level of Planning at the design stage					
Increased level of Client participation at the design stage					
Appropriate time constraint for the design stage					

SECTION C: To be answered by clients, consultants, and contractors.

From your experience, please thick appropriately the severity the effects of the failure of quality at the design stage will cause to the public construction projects using the Likert scale listed below:

1 = No effect 2 =Low severe 3= fairly severe 4=Severe 5 =Highly Severe

	EFFECTS OF POOR QUALITY	**Severity**				
		1	2	3	4	5
1	Increased Project cost					
2	Increased Reworks during and after the design stage					
3	Loss of Productivity during the Construction stage					
4	Loss of financial resources in carrying out reworks					
5	Increased variance					
6	Lack of satisfaction by the end user					
7	Failure of the constructed project					
8	Delay in completion of the project					
9	Delays in payment to contractors					
10	Project abandonment					
11	Payment claims problems					
12	Contract disputes					