ASSESSMENT OF THE EFFECTIVENESS OF QUALITY MANAGEMENT PRACTICES IN MANAGEMENT OF REINFORCED CONCRETE STRUCTURES IN GHANA.

By

Bright Delali Siayor
(BSc. Architecture; M. Architecture)

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MASTER OF SCIENCE IN PROJECT MANAGEMENT

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DECLARATION

I hereby declare that this submission is my own work towards the MSc. Project Management and any part thereof has not previously been submitted in any form to the University. I confirm that the intellectual content of this work is the result of my own efforts and no other person.

Siayor, Bright Delali (PG 5048518)	…………………………..	…………………………..
Student name (ID Number)	Signature	Date

Certified by:

Dr. Kofi Agyekum	…………………………..	…………………………..
Supervisor	Signature	Date

Certified by:

Prof. B. K. Baiden	…………………………..	…………………………..
Head of Department	Signature	Date

ABSTRACT

The construction industry is a highly lucrative industry, which has attracted a large spectrum of investors and person of interest. Poor quality in reinforced concrete can result in life threating consequences and a threat to public safety. The research aims at exploring the effective quality management practices in project management for reinforced Concrete Structures in the construction industry. The aim of the research were met with these set objectives, to first of all identify the quality standards related to the construction industry, and secondly, to examine the barriers that impede quality control and assurance while executing construction projects through which we can assess how quality management can improve quality control and assurance during the construction of reinforced concrete structures. A quantitative research approach was used using a sample size of 85 to undertake this study, through which questionnaires was used to collect relevant data from construction project participants such as; Project/Construction Managers, Project Engineers, Site Engineers, Clerks of Works, and Quality Control and Quality Assurance Mangers. The data sought from the respondents was analyzed using descriptive statistics. The analysis of data revealed that quality management systems were of less use to most D1K1 and D2K2 contractors and the poor adherence to quality standards as well as no ISO certification of most firms. Most firms practiced quality management by the use of experienced personnel with vast practical expertise. There was a much narrowed perception of what quality meant. The study was limited to predominantly D1K1 contractors and D2K2 contractors. The study emphasized that, commitment from top management was paramount to the maintenance of quality, and the periodic training of a project team participants not withstanding their level of skill or knowledge and involvement in the project.

Keywords: Quality, Quality Management, Quality Control, Quality Assurance, Reinforced Concrete

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DEDICATION

This project is dedicated to the Siayor family through whose encouragement and support that this work has been successful

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Quality management focusses on ensuring that the efforts to attain the appropriate level of quality for a product are properly premeditated in order to ensure that they are achieved. From the construction industry perspective, quality management means upholding the standards set in relation to quality management practices in order to achieve long term competitiveness and overall survival. (Tan and Abdul-Rahman, 2005).

The last two decades, according to Al-Ani and Al-Adhmawi (2011), have shown that quality is a competitive and very important factor when it comes to the construction industry. As human civilization advances, quality is also advancing and can be seen to have an immense impact in businesses (Ying, 2010). Even though quality has been defined in varied ways by various researchers, it is simply defined as the capability of the aspects of a project to satisfy the requirements specified by the final user (Ayandibu, 2010). Thorpe and Summer (1990) argued comprehensively that quality can be defined in different ways depending on the context in which it is required and some researchers define quality as "the best or value for money‟, whilst others refer to it as "the fitness for a defined purpose‟. Quality has remained at the forefront amongst the various elements used to define the degree of success or failure of a project (Feigenbaum, 1993).

All the activities that determine the quality policy, objectives, responsibilities and implementation by way of quality planning, quality control, quality assurance and quality improvement as part of the quality system, are referred to as quality management and must be an essential part of an organizations overall approach towards management (Zairi, 1991; Ayandibu, 2010).

The adaptability, high strength and sturdiness of concrete has led to its widespread use in the construction industry (Lomborg, 2001).

The construction and services sector accounts for more than 50% of the Nation's output (Granado, 2015). Massive infrastructural developments, mostly high-rise buildings, are springing up in the country, most of which are constructed using reinforced concrete. This is to say that, the use of reinforce concrete is catching on pretty fast. However, in spite of the popularity of concrete structures, if it is not properly constructed and maintained, it can deteriorate prematurely, most often referred to as "crumbling infrastructure" (Meyer, 2002).

1.2 STATEMENT OF PROBLEM

With inefficient and inadequate quality management procedures, expending time, money and resources are more often than not considered as a wasted venture in the construction industry (Rounds and Chi, 1985) cited in Battikha (2002). The construction industry has been described as lagging behind other industries when it comes to quality and efficiency. Various researchers are of the opinion that opportunities exist for improvement within the industry. Mostafa (2015) in his research on quality management stated that the failures and errors in the construction industry have manifested in various ways and various reasons have been attributed to it. Mostafa (2015) further explains that the failure happens at different stages of the construction process. Tasker (1985) has also asserted that most defects in concrete are as a result of ignorance of the accurate mix of the constituents, lack of adequate concrete cover and curing requirements.

The need to raise the level of quality in the industry is paramount as this will help improve the construction process, thereby resulting in less cost and efficient ways of executing projects (Mostafa, 2015). This clearly spells out the need for quality management practices to be adopted by construction teams in concrete construction or works involving the use of concrete.

This research seeks to explore the level of knowledge with regards to the application of quality management systems and to identify the useful measures to help improve quality control and quality assurance in the construction of reinforced concrete structures in carrying out project management practices.

1.3 RESEARCH QUESTIONS

To enable the researcher undertake this study, the research questions below were formulated;

1. What are the existing quality standards pertaining to the construction industry?
2. How can the barriers that impede quality control and quality assurance be overcome?
3. How can quality management in project management aid in improving quality control and quality assurance in the construction of reinforced concrete structures?

1.4 AIM

The research aims at exploring the quality management practices in project management for reinforced Concrete Structures in the construction industry.

1.5 OBJECTIVES

In order to achieve the aim of the research some objectives have been formulated and these are outlined below:

1. To identify the quality standards related to the construction industry.
2. To examine the barriers that impede quality control and assurance in construction projects.
3. To assess how quality management in project management can improve quality control and assurance in reinforced concrete structures.

1.6 SIGNIFANCE OF STUDY

This study will benefit Building Contractors and Consultants who aspire to know the impact of effective Quality Management systems on the construction of reinforced concrete structures. Quality management has become an important function so as to achieve success in the Construction industry having transitioned from a reactive nature to a strategic business function (Harris *et al*., 2013). When a particular structure crumbles or is not accepted by a client, human lives may be lost, planned for profit will be sacrificed and the company more or less loses its reputation in the eyes of the society. The life cycle cost that come with concrete of poor quality are also exorbitant. There is therefore a need to follow good quality management practices which will consequently lead to profitability. According to Juran and Deming (1964) as cited in Ashford (1989), quality training and education costs are tremendous and achieving value for money comes with an increase in efficiency as well as output produced. This research is therefore important as it will bring to the light the emerging trends in quality management practices applicable to reinforced concrete works. Quality management systems will lead to safe and cost-effective structures which are not prone to high rates of damage or deterioration.

1.7 RESEARCH METHODOLOGY

The study will require that the researcher collects primary and secondary data for assessment and analysis. Having carefully studied the research objectives, a quantitative research methodology was adopted. The respondents were be selected based on their expertise in the construction industry and their practical experience in reinforced concrete structure and as quality control consultants on construction projects. The study took on a descriptive approach with the help of a field survey with questionnaires handed over to sampled project participants and interviews with professionals in the field of study. Photographs were also taken as and when the need arises.

Secondary data was be based on literature, journals, academic database and internet pages to examine their underlying theories related to quality management and quality control and quality assurance. Data analysis was carried out using the Statistical Package for Social Science. Which involve the tabulation and cross analysis of mean scores and standard deviations.

1.8 SCOPE

The dissertation intends to assess the Quality Management Practices in the construction industry aiming at D1K1and D2K2 contractors in the Greater Accra Region of Ghana who work with reinforced concrete. Consultants who play a major supervisory role in these projects will also be a target for this research. This is because the Region has the highest concentration of D1K1 and D2K2 Contractors in the Country.

1.9 STRUCTURE OF THESIS

This thesis is structured in a five chapter format. Below are details of these chapters:

- Chapter One – The Introductions and Background to the research.
- Chapter Two – The knowledge body in the field of quality management practices written in literature.
- Chapter Three – Methodology on how the research will be carried out. This entails a

detailed description of the research approach and design used in this study. The chapter outlines the methods employed in undertaking the empirical research either the use of the qualitative, quantitative approach or the mixed approach.

- Chapter Four – Analysis of empirical data sought from the research participants and discussions of the results.
- Chapter Five – The Summary of the Findings, Conclusion of the research findings and appropriate Recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 AN OVERVIEW OF THE CONSTRUCTION INDUSTRY IN GHANA

The construction industry in Ghana is faced with myriads of obstacles, amongst them are a weak material supply base, excessive bureaucratic conditions, an unregulated labour market, financial uncertainties, poor management practices and emphasis on skilled artisanship and expertise (Amoa Mensah, 2002).

With these challenges still prevailing, the construction industry has recorded significant contribution to both overall Gross Domestic Product (GDP) and industrial output in Ghana over the past years.

The Ghanaian built environment sector is modeled on the UK regulatory system from observations and reference to legal and regulatory documents, such as the Building Regulations (Republic of Ghana 1996). The Ghanaian construction sector was developed based on the UK construction sector about 20 years ago and as such has some similarities. There are serious challenges in materials handling, safe working practices, quality, design specifications and timeliness of construction. Another widely known feature of the Ghanaian built environment sector which is common to other developing countries, is the availability of cheap labour. This places greater emphasis on selection of materials and other components by price rather than cost of installation (Osei, 2013).

2.2 CONCEPT OF REINFORCE CONCRETE PRODUCTION

2.2.1 Historical overview

Ancient material components like crude cements were developed by various means such as burning gypsum and crushing of limestone. The Lime used is referred to as a crushed or burned limestone material. When a mixture of sand and water are made and additives of these kind are added to cements, they create a sludge mixture used as a binding agent known as cement mortar, which is a plaster-like material used to bind stones to each other for building purposes. Over thousands of years, these materials have been improved to highly, and further combine with other materials to produce a more developed material known as concrete (McKnight, 2004).

Concrete in today's modern world, is made by combining proportions of Portland cement, coarse and fine aggregates of stone, sand, and water.

The inventions of Admixtures is a modern and more developed approach in concrete which are chemicals that are added to the concrete mix to facilitate and increase its setting properties are used primarily when placing concrete rapidly changing environmental conditions, such as high and low temperatures, windy conditions or working in water bodies (McKnight, 2004).

The development of concrete gradually began in the year 1300 BC when Middle Eastern master builders discovered an approach to binding clay with burnt limestone which caused a chemical reaction that resulted in the rapid hardening that created a hard surface. This was not known as concrete initially, but it began the development of the common material known as cement (McKnight, 2004).

The development of cement as a building material was further enhanced with the development of carved stones, bricks and molded blocks (McKnight, 2004).

Cement being a key ingredient in concrete, cement has been in existence for about 12 million years ago in the ancient city known today as Israel, which had large natural deposits that were formed by chemical reactions between oil shale and limestone to produce a spontaneous combustion. However, cement as a biding agent is not concrete. Concrete therefore is a building material which consists of aggregates, of which cement is key component with combination of other aggregates. With the passing of time, theses constituents have evolved and are still changing rapidly for much better and quality oriented products. The performance characteristics could be developed to achieve higher resistance to the forces the concrete will be subjected to. The forces to concrete may vary due to their purpose. These forces may be from below (soil heaving), above (gravity), the sides (lateral loads), abrasion or chemical attack or heavy traction (friction). Design mix is defined as proportional distribution of the aggregates or constituents of concrete (McKnight, 2004).

2.2.2 Definition of reinforced concrete

This is a mixture of three basic carefully proportioned materials, cement, fine aggregate, coarse aggregate and water (Seeley, 1987). The proportions of each material contribute significantly to the strength and quality of the resultant mixture known as concrete.

Cement and lime are generally mixed in proportions as binding materials, whereas sand is used as a fine aggregates and crushed stones, gravel, broken bricks are used as coarse aggregates in the preparation of concrete.

2.2.3 Aggregates

Aggregates are the sand, crushed stones or gravel that are mixed with some batched proportions of cement and water to create a homogeneous mixture known as concrete. Some essential characteristics these aggregates must possess are workability, durability, and free from impurities: being free from impurities includes the absence of organic impurities and easily decomposed materials from soil. Aggregates are classified based on this sizes and workable features and are basically known as fine or course (Seeley, 1987).

Fine Aggregates: This consists of naturally crushed stones into find smooth particles commonly known as sand and its known by its physical character of being able to pass through a standard sieve of size 5mm, with an appreciable proportion of the bigger particle.

Coarse Aggregate: This is primarily made up of natural boulders of rock crushed into a size of 5mmm and above.

All types of aggregate should comply with the British standards of grading requirements BS 882. Artificial coarse aggregates such as clinker and slag are used for lightweight concrete. The maximum size of coarse aggregate is dependent on the work to be executed. With reinforced concrete works the aggregate must be able to filter through the reinforcement bars or mesh and it rarely exceeds 20mm. For blinding foundations and mass concrete work the size can be maximum to 40mm sixe of aggregate (gravel). The type of aggregates used directly influences the strength qualities and the look and feel of the concrete (Seeley, 1987). In concrete production, aggregates must be graded based on their sizes to aid smaller particles of the fine aggregates fill the voids created by the coarse aggregate. To achieve quality concrete finish, the cement paste must fills the voids in the fine aggregate to achieve a homogeneous dense mix.

2.2.4 Water

Water for concrete mixture has to be clean and free of impurities which could affect the concrete mix in any way. To achieve maximum quality in concrete this quality of water quality must be fit for drinking. A proportion of the water creates a chemical reaction which aids in the hardening of cement and other aggregates. An excess use of water when mixing will produce a porous concrete of reduced workability, durability and strength (Seeley, 1987).

2.2.5 Cement

Cement in a substance which is made up constituents that bind together the aggregates (sand and gravel) to produces a resultant mass of high compressive strength. The most commonly used cement known is Portland cement which may be of different variety or be rapid-hardening depending on the work it will be used for. There are several types of cements that will produce concretes with more specialized properties. Portland cement which is a key binding material in concrete, is produced by mixing substances containing calcium carbonate (chalk or limestone), with other substances containing silica and alumina (clay or shale), and heated with a binding agent additive know as clinker and finally grinded to a smooth powdery substance known as cement powder. The basic characteristics of Portland cement include chemical composition, sampling procedures and tests, compressive strength, setting time and structural soundness (Seeley, 1987).

The cement creates a chemical reaction when water is added to form a hydrated calcium silicate. Without the addition of admixtures, the set takes place in a 45 minutes time frame and finally hardens rapidly within an eight to ten hours' time frame, and strengthens sufficiently for most concrete work (Seeley, 1987).

2.2.6 Curing

The chemical reaction which is as a result of the cement setting in a concrete mix and hardening of concrete and this is highly dependent the addition of water in concrete. This process is known as curing and is also defined as the process of preventing the loss of moisture from the concrete while maintaining a satisfactory temperature regime. The hardening of concrete, and the development of the strength of concrete and its ability to be impermeable is associated with the presence of water in the mixture. When concrete is placed, there is always an appreciable quantum of water present for full hydration, but it is necessary to ensure that this water is retained so that the chemical reaction continues until the concrete has developed the necessary degree of permeability and strength. Therefore, in order to prevent rapid loss of water and adverse effect of weather conditions, placed concrete must be covered with quilts of thermal plastic with fibres or bubble plastic sheets, straw, or any appropriate material. This protects the concrete from the direct sunshine and hot dry winds for a minimum period of seven days (Seeley, 1987).

There are two types of curing namely;

1. By moisturizing the surface of concrete by keeping close contact with the surface of the concrete through spraying or by sprinkling damp sand and damp hessian on the surface of the concrete.
2. By keeping the formwork on casted concrete in place and sprayed-on curing membranes

2.2.7 Site testing of materials

When all materials are delivered to site, it is vital to carry undertake a random site test on materials in order to determine their workability and suitability. The following tests outlined below could be adopted to illustrate the approach (Seeley, 1987).

Cement

1. Examine by tapping with a soft mallet, this is to examine whether it is free from large lumps of hardened cement and is of a smooth flour-like nature which means it is free from dampness.
2. Check temperature of cement by placing a finger in it to observer warm body temperature of satisfying condition and consistency.
3. Mix a small portion with water to observe sludge in a water jar to see whether it will

contract or expand.

4. By rubbing the sand in your palms; observe that it should not stain the palms excessively, and shall be deficient of any coarse or rough particles.

5. With the aid of a standard sieve undertake a test to observe if more than 20 % of the particles is retained in a 1.25mm sieve, if otherwise it renders the material unsuitable for use.

6. Perform a silt/organic test by using a bottle or tube half filled with a sample of sand and fill up to the three-quarters marks with water; shake vigorously to get a homogenous mixture and leave for an hour; then measured the amount of silt on top of the sand which should not exceed six percent.

2.2.8 Concrete mixes

Concrete in its set stage, must be strong enough to resist the various stresses to which it will be subjected to and it should be able to withstand weathering action. When freshly mixed, it must maintain a consistent nature that can be readily handled by its user without segregation and can also be easily compacted within the formwork. The strength of concrete is associated with some critical factors (Arora and Gupta, 2003).

These factors consist of the following:

1. The aggregate ratio (proportions) and cement type;

2. Type, grading and quality of the aggregates;

3. Water consistency and quality;

4. Consistency of batching, method of mixing, transporting, placing, vibrating and the rate of curing the concrete.

In mixing concrete there are two approaches; manual means or machine mixed (concrete mixer) on the site or as a ready mixed sludge as transported to the site from a batching plant with concrete mixing truck with specially designed revolving containers. Hand mixed concrete is only used for minimal quantities of concrete for small scale jobs (Seeley, 1987). The aggregates are mixed dry on a clean on hard surfaces and appropriate amounts of water is added for further mixing, until a uniform colour and consistency of the mixture is obtained.

Concrete mixing ratios are developed for their type of work to be used for (tilting, non-tilting). The normal mixing time is between one to three minutes after all materials, including water, have been placed in the mixer.

Concrete mixes are specified by ratios which involve the volume of the constituent materials or by their minimum strengths required for the task it is required for. Nevertheless, the strength of concrete varies considerably under site conditions. For A more realistic consistency of concrete it is important to specify a minimum strength of the required concrete, with which the proportions of cement, sand, coarse aggregate and water will be selected accordingly to achieve it the stated strength (Arora and Gupta, 2003).

The water/cement ratio is vital in concrete production for quality purposes. It should be kept as appropriate level and balance as much as possible. To maintain consistency with sufficient workability it is necessary to secure full compacted concrete with a poker vibrating equipment to be purchased the site. The higher the proportion of water, the weaker the concrete will turn out to be. Water/cement rations vary within the ranges of 0.40 to 0.60 (a ratio of the weight of water to the weight of cement). Considerations has to be made for the rate of absorption by dry and porous aggregate and the presence surface moisture on wet aggregate. Poorly proportioned aggregates require an added amount of water to give balance to its workability, and this may result in low strength and poor durability of the concrete when placed. The slump test a common test for measuring water consistency and workability of concrete on the site, although for a much more realistic accuracy in measurement the compacting factor test or consist meter test is recommended. The slump test is undertaken by filling a 300mm height of an open ended metal cone with layers of concrete after which the cone is lifted off the concrete to measure the amount of slump or drop of the concrete suffers after the cone-shaped is displaced of concrete. Slumps vary from 25mm for vibrated mass concrete to 150mm for heavily reinforced non-vibrated concrete (Arora and Gupta, 2003).

2.2.9 Reinforced concrete

Concrete in it raw state hardens and is very good to take loads in compression, with its major challenge of cracking or giving way when loads or forces applied which cause it to stretch or perform in tension it is much more workable when it is reinforced. Reinforcements come in various sizes, and compositions, and all these have to be designed for, with respect to the loads they are subjected to. The specifications concerning the number, diameter, spacing, shape and type of bars to be used have to be adequately designed. Reinforcement is placed as near to the outside fibres as practicable, the cover of concrete over the reinforcement is required to protect the steel bars from the adverse weather conditions which may result in corrosion and to further provide a degree of fire resistance during emergency fire situations (Arora and Gupta, 2003).

Concrete gains it maximum strength in compression and a high amount of weakness when subjected to some amount of tensile forces, whereas steel is much stronger in tension but weak in compression. A long steel bar can develop its full strength in tension but not in compression due to tendency of its buckling. Therefore, steel bars are embedded in cement concrete to take up tensile or excessive shear stresses (Arora and Gupta, 2003).

Concrete is strong in compression but weak in tension, and where tension occurs it is usual to introduce steel bars to provide the tensile strength which the concrete lacks to prevent structural failure. For example, with a concrete suspended slab in drainage structures, compression occurs at the top and tension at the bottom, so the reinforcement is placed about 25mm up from the bottom of the beam and the ends are often hooked to provide a grip. The 25mm cover prevents rusting of the reinforcement (Seeley, 1987).

The steel must be free from grease, oil, loose rust, paint, mud, plant roots and other substances which impair the bond between the steel and concrete. The most common form of reinforcement used is the mild steel bars to BS4449 or BS 4482. Medium and high tensile steel bars are also available and deformed bars which are twisted and/or ribbed to provide a better bond and much greater frictional resistance. It is important that the reinforcement is fixed tightly to avoid displacement during the placing of the concrete (Seeley, 1987).

The bars are knotted together with the aid of binding wire at intersections, and spacers of small pre-cast concrete cubes or plastic fittings are placed to ensure that the standard correct cover of concrete is achieved in equilibrium (Seeley, 1987).

2.3 CONCEPT OF QUALITY IN CONSTRUCTION

The notion of quality has been in existence for years, but with changes in time, materials as well as what people prefer, the subject of what quality actually ease has taken a new form. The concept of quality management, before the twentieth century, dealt with making sure that goods and services made available met the standards required by both the customer and producer (Sabah 2011). This is evident in the meticulousness applied in the cutting of stones used for the Egyptian pyramids such that not even a knife could go through as well as paintings made with precise measurements during the 1450's (Sabah, 2011). According to Sabah (2011), around the time when the 2nd World War took place, quality progressed and included statistics. Statistical sampling techniques were adopted to evaluate quality, and quality control charts were developed and used to track and monitor the production process. In the 1960s, with the help of so-called "quality gurus," the concept took on a broader meaning. Quality was further viewed as something that goes be young the entire organization, and not only restricted to the production process only. All functions were responsible for achieve product quality and all parties where susceptible to the costs of poor quality. However, in the years 1970s and 1980s a huge number of U.S. industries experienced variations in their quality policies caused a drastic loss of market shares to foreign companies with the auto industry suffering the most. A large number of consultants and quality management training programs were instituted for employees in these institutions (Sabah, 2011).

Hoonakker, (2006) in his study about quality management and improvement, further established that a huge number of the management practices used in construction organizations has shortfalls. The industry's clients are becoming more enlightened and knowledgeable. Clients were demanding optimum service quality, faster construction of buildings and modern innovative technology. In Kaufmann and Wiltschko (2006) document on Quality Management Concepts IT is said to have structured things in general according to the "International Organization for Standardization" ISO 9000-series and the "Plan, Do, Check, Act" PDCA-cycle. It illustrates the two main structures stated above as follows;

ISO 9000-series: EN ISO 9000 defined quality management as "coordinated activities aimed at directing and controlling of an organization with primary focus on quality". The Direction and control with reference to quality involves the establishment of a quality policy with orientation on the quality planning, quality objectives, quality assurance, quality control, and constant quality improvement mechanisms:

- **Quality planning** is focused on setting quality objectives and specifying necessary operational processes and related resources to fulfill the quality objectives
- **Quality control** is focused on fulfilling quality requirements
- **Quality assurance** is focused on providing confidence that quality requirements will be fulfilled
- **Quality improvement** is focused on increasing the ability to fulfil the quality requirements

PDCA-cycle

The PDCA-cycle is an important tool in quality management. This cycle encompasses the four components:

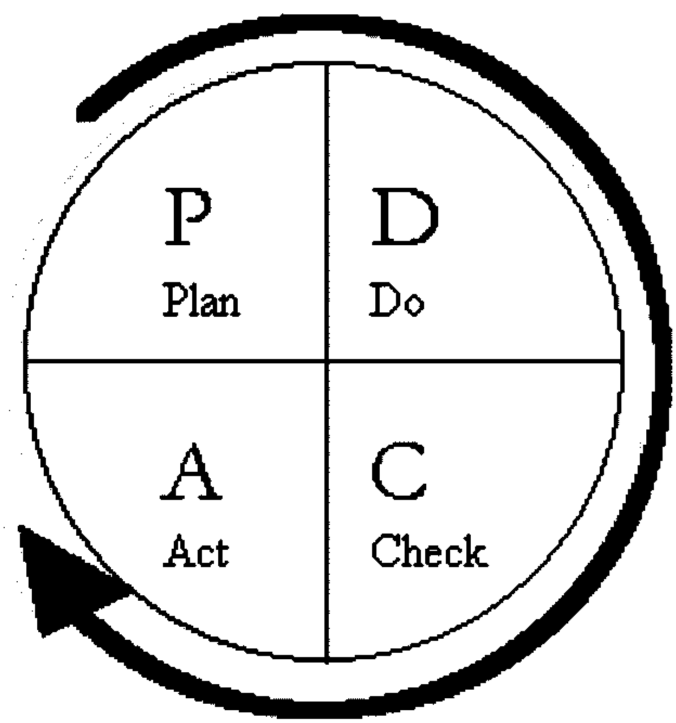

Figure 2.1 Plan-DO-Check-Act Cycle (PDAC cycle)

The PDCA cycle, was conceived by Walter Shewhart in the years 1930, and later improved upon by W. Edward Deming. The model is designed in general a framework with the sole aim at the improvement of a system known as the four-step quality strategy (Kaufmann and Wiltschko, 2006).

- **Plan:** Outline objectives and processes aimed at delivering results pre the design specifications formulated.
- **Do:** implementation through processes
- **Check:** Continuously Monitor and evaluate the processes analyze the results against the set objectives and specifications.
- **Act:** Take decisive actions to the outcome. And make necessary improvements.

2.3.1 Purpose of quality management in construction

The U.S. Army Corps of Engineers (2004) defines Construction Quality Management (CQM) as the performance of deliverables that are aimed at ensuring the construction or manufacturing of any tasks are performed with well outlined principles and procedures or specifications, which is within time, with a specified budget, and under safe working conditions. This study focuses mainly on quality as the total conformance to properly developed specifications.

Construction projects require a different approach to quality, quality management begins with a carefully developed outline, reviewed with the codes and standards for adherence to universally outlined existing guidance which must reflected in design documentation and accurately addressing the need of the user or occupant. Therefore, the designer is sole responsible for the quality standards when designing and the contractor while undertaking the building construction is to adhere to the quality standards specified in the plans and working details to controls the quality of the output (Kaufmann and Wiltschko, 2006).

2.3.2 The Principles of Quality management

Quality Management encompasses three fundamental principles Sabah (2011); these are:

1 Customer oriented and stakeholder involvement;

2. Teamwork and commitment;

3. A process to continuously improve and learning new ways to improve quality.

2.4 QUALITY MANAGEMENT PRACTICES/PROCESSES

It is described by the American Society of Quality (ASQ) as cited in Rumane (2011p.24) as "the application of quality management system in managing a process to achieve maximum customer satisfaction at the lowest overall cost to the organization whilst continuing to improve the process*"*. The concept of quality management which emerged after the Second World War strives to develop initiatives which engages the entire workforce in a systematic way so as to achieve quality. Extension of these concepts led to the development of total quality management (TQM). Thus quality has transformed through different stages from inspection, quality control, quality assurance and TQM (Rumane, 2011).

In the Construction industry, quality management is defined as maintaining a quality standard that meets customer satisfaction (Chin-keng and Hanuzah, 2011) and which subsequently make the Company financially viable to survive competition in the market; thus it leads to long term competitiveness and survival of organizations (Harris *et al*., 2013; Chin-keng and Hanuzah, 2011; Juran and Godfrey, 1999).

The use of quality management concepts has an influence on the cost effectiveness of projects and yields positive results in terms of project performance and this view is supported by research (Rumane, 2011).

Project Management Institute (2013) have three sub-divisions for quality management:

- Quality Planning
- Quality Assurance
- Quality Control

The main feature of these processes is the concept of continuous improvement which is referred to as PDCA- Plan – Do – Check – Act. Harris *et al*. (2013) illustrate this in the construction industry as shown in Figure 2.1

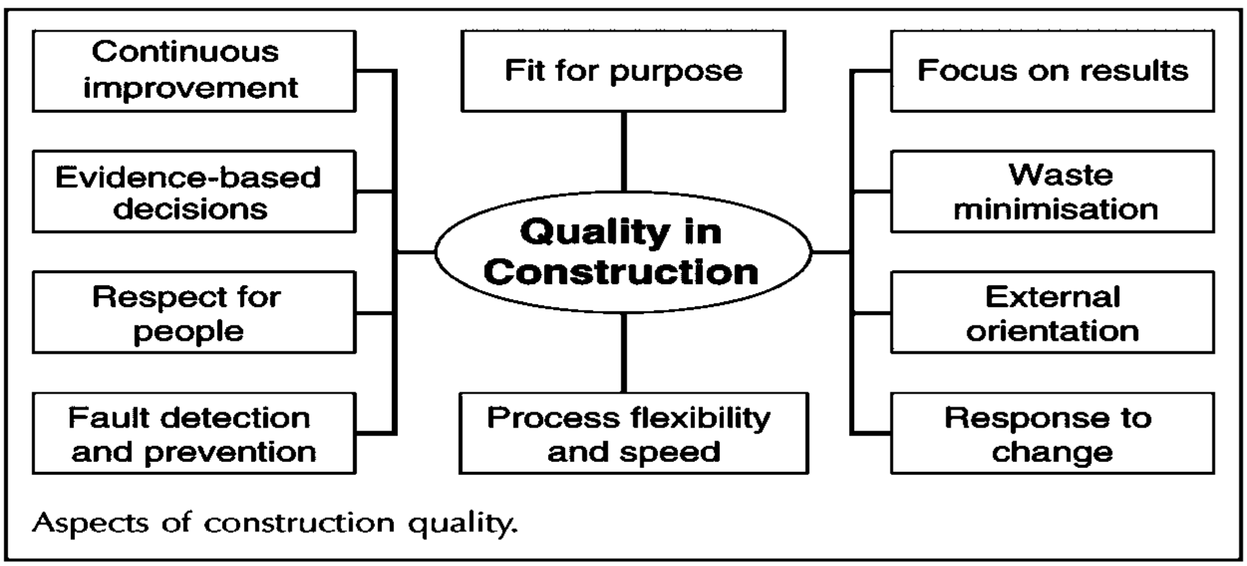

Figure 2.2 Aspects of Construction Quality

Source: Harris *et al*. (2013 p.67)

2.4.1 Quality planning

It is a document specifying quality activities and the resources a project requires; drawn from the quality system, the contract documents and includes training requirements of employees, inspection and quality procedures. Quality plan is usually undertaken before construction activities commences. It is undertaken in conjunction with other project planning activities such as selection of sub-contractors and suppliers, determination of construction methods etc. It is updated periodically to reflect contractual requirements and other changing circumstances (Chung, 1999).

The Project Management Book of Knowledge “PMBOK” 4th Edition (2013) defined quality planning as the process input that is generated by predecessor processes that are known as the Project Scope Statement and the Project Management Plan. The documents are influenced by some factors like Enterprise Environmental Factors and Organizational Process Assets. Quality planning is further define by the Project Management Institute, (2013) as the process of "identifying the quality standards that are relevant to a specific project and understanding how to satisfy these quality based requirements": While planning for the quality there are principles guiding this process, and these are:

- **Customer satisfaction**: Quality is best defined by the user and the user requirements.
- **Prevention repetitive inspection**: Better to avoid initial errors that will be repaired after completion than to undertake routine repetitive inspections which would lead to more cost and time.
- **Management commitment**: The Costs of quality is directly influenced by the commitment of the top management.
- **Periodic improvement**: Becoming better requires a continuously structured process of upgrading and developing one’s self.

These principles place emphasis on the Golding rule, that “gold plating is not an indicator of quality”.

2.5 CONCEPT OF QUALITY CONTROL AND QUALITY ASSURANCE

2.5.1 Quality control

'Quality Control' seeks to ensure the business is at its high by ensuring that products are maintained or developed with minimal deficiencies or the eliminations of errors or mistake as explained by Investopedia. To undertake quality control, it is require that the environment I which management and employees strive to attain perfections be well harmonized to achieve this objective. This can be done through periodic training, developing benchmarks for product and project quality, undertaking test for analysis on quality, and recording quality based indicators for statistical analysis and improvement monitoring (Rumane, 2011). Quality management is deeply rooted in the establishment of well laid down controls that are standardized to facilitate quality results. When the controls are operated within, they limit room for errors by critically outlining the activities for production and reactions to quality related issues. Some of these controls limit room for error by reducing the chance that employees are assigned roles to which they have limited training and skill about, and tasks that require special machinery and equipment's to undertake. Quality controls are prioritized at public safety and the maximum user safety (Rumane, 2011). Quality control also focusses on the reliable and sustainable development of building for future purposes. The use of ISO certification for quality related activities also enhances quality in that it outlines quality control mechanism with various operational techniques and activities prioritized at quality. They manage change and when applied in full detail to quality, it regulates quality performance by preventing undesirable changes in the quality standards set out. The simplest form of quality control is illustrated in the Figure 2.2 below.

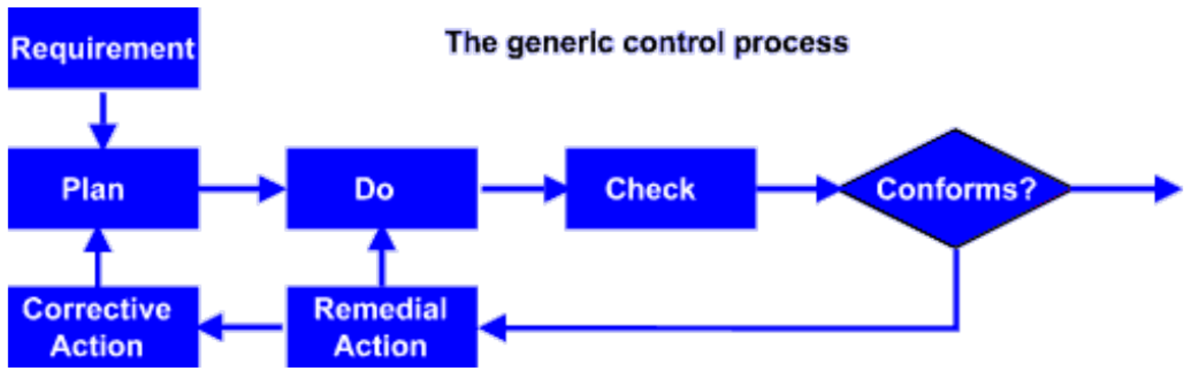

Figure 2.3 The generic control process

Quality control can be applied to particular products, to processes which produce the products or to the output of the whole organisation by measuring the overall quality performance of the organisation.

Quality Assurance aims at not changing the product rather, Quality Control does aims at changing the product to meet requires optimum terms. Harris and McCaffer (2001) defined quality control as activities or techniques aimed at monitoring performance and sove quality related problems.

Inspection during construction projects prevents costly repairs after the completion of a project. A combined effort by the, contractor, engineer, funding agency, legal regulatory agency, and system personnel to inspect, document, and effect changes to defects.

2.5.3 Quality assurance

With the growing demand for building works, there has been a greater proportions of works within the building sector face with criticism over nonconformance to quality standard and performance.

This calls for the need for formal quality systems for the management of quality in construction projects that aim at addressing the performance of works men and overturn the issues of design, constructions, material dynamics and building components. A lot of problems experienced in the building industry results from the technical and aesthetic aspects of the building. Largely all these problems could be alleviated through the heeding of standards and codes pertaining to their installation and maintenance at the design and construction phases of the building processes (Griffith, 1990). In achieving a 100% defects free building, it is important that attention is paid to the application of quality assurance principles during design and construction (Atkinson, 2005).

Harris and McCaffer (2001) in his study of quality management defined quality assurance as a set of outlined activities with the sole aim at demonstrating the need to meet all quality requirements. Reference to Hendrickson (1999) cited in Khan et al. (2008), quality requirements should be clear so that all participants involved on the project will understand their conformance.

2.5.4 Quality Assurance in the Construction Industry

Quality Assurance is based on the underlying principle of getting it right at the first time. In implementing and maintaining this principle, it requires a continuously improving mindset and Quality Assurance System.

A Quality System is therefore designed to instill into the Clients assurance which is supported through documentary evidence, spelling out all terms and conditions that will be completed in accordance wot a set time, (period) cost (budget) and specification (details). It is important that the system instills in each employee the mindset to develop and maintain an attitude of continuous quality improvement aimed at customer satisfaction. The main goal of Quality Assurance is concerned with the continuous developing and planning of the necessary technical and managerial competence to achieve well laid down results. It involves personnel behavior and discipline, both management and all whom are responsible in the organization (StudyMode.com, 2008)

2.6 TOOLS AND TECHNIQUES FOR QUALITY CONTROL

With the growing competitive markets and rapid globalization, there are constant development of quality concepts and philosophies to aid in the strategic resolutions of quality related issues at all organizational levels in all industries. International quality standards and excellence models such the ISO 9000 standards, the EFQM model, formally known as European Foundation for Quality Management, Deming Prize and the King Abdul-Aziz Quality Award model require organizations' quality systems to be built based on their organizational processes, rather than their requirements, departments or functions. World class organizations place high value on total quality management (TQM) tools as a means to identify and assess qualitative and quantitative data that pertains to their processes that is aimed at the continuous improvement of their processes and the delivery of optimum quality products and services.

There are seven basic tools that are universal in assessing quality, these are;

- Check Sheet
- Flow Chart
- Scatter Diagram
- Histogram
- Cause and Effect
- Control charts
- Pareto analysis

These seven tools can be used to enhance the overall effectiveness, efficiency, standardization and quality of procedures, products and services, in accordance with ISO 9000 standards. Globally accepted standards recognize these tools and techniques in the manufacturing and service delivery organizations as a means to analyze, document and organize quality systems. Through time and rigorous testing these tools and techniques have proved to be suitable for problem solving and process improvements (Dias and Saraiva, 2004)

2.7 ADVANTAGES IN THE APPLICATION OF QUALITY MANAGEMENT PRACTICES

Literature outlines the implementation of quality control approaches that can applied as a solution for impediments to quality (that is costs, productivity, occupational safety and health) that the construction industry faces (Kuprenas and Kenney, 1998; McKim and Kiani, 1995; Schriener et al., 1995). Proof has been given that in implementing quality control processes in the construction industry ther has been a speed-up of projects and also there has been an increase in profitability (Chase, 1998).

Literature further states in a study conducted by Formoso anc Revelo (1999); Lahndt (1999) that the implementation of quality control measures prevents defects and untimely accidents even before they happen, which have resulted in saving a lot of institutions and firms millions of money. This has cut down on the huge sums of cost used for the Reworking of faulty works (Love et al., 1999). Customer satisfaction, improved relationships with architect/engineering, improved schedule performance are the results of an efficient quality control implementation system (Love et al., 1999).

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

Chapter three focusses on the methodology applied to the study. It mainly discusses the means by which data was collected as well as the various methods used in collecting the data. It further explains how these methods helped the researcher in achieving the set aims and objectives. To conclude the chapter, focus is on the respondents sampled as well as the response rate.

3.2 RESEARCH STRATEGY, DESIGN AND PROCESS

According to Fellows and Liu (2008) and Neuman (2014), the research approach can be grouped into three – qualitative, quantitative and triangulation. Naoum (1998) explains that, the quantitative research approach is suitable for gathering data concerning a particular concept, problem or characteristic. He further explains that quantitative data helps in gathering factual information and better helps in understanding the relationship that exists between two theories so as to efficiently examine a particular hypothesis (Naoum, 1998).

The researcher adopted a quantitative research approach as it was deemed fit per the purpose of the research adequately helped in collecting appropriate data to satisfy the studies aim and objectives.

3.2.2 Research Scope

The research was carried out in the Ashanti region as well as the Greater Accra region of Ghana.

Per the census carried out in 2010, the Greater Accra region as well as the Ashanti Region have the highest population respectively (Ghana Statistical Service, 2012). D1K1 and D2K2 contractors are mostly located in the Greater Accra Region. Per data gathered from Association of Building and Civil Engineering Contractors of Ghana (ABCECG) 42 out of every 53 D1K1 contractors are base in the Greater Accra region. Hence the researchers choice to fall on these areas. Literature also revealed that similar studies also chose their scope of study based on these reasons (Ahadzie, 2007, Ofori-Kuragu *et al*., 2016). The population of study comprises Project Managers/Construction Managers, Project Engineers, Site Engineers, Clerk of Works, Site Supervisors and Quality Managers/Quality Assurance/Control Officers who belong to D1K1 and D2K2 contractors according to the ministry of works and housing classification for class one contractors.

Contractors sampled also belong to the (ABCECG) and are also in good standing with the (ABCECG). This classification of contractor was developed by the Ministry of Water Resources Works and Housing and describes the contractor's capability and capacity of work that can be done. This choice of D1K1 and D2K2 contractors was as a result of the level of organisation these contractors have and the professional nature of their team as well as the existence of administrative arrangements

A list of Contractors belonging to the Association of Building and Civil Engineering Contractors of Ghana and also registered with the Ministry of Works Water Resources and Housing available to the researcher indicate that 53 D1K1 and 89 D2K2 contractors are in good standing and operational nationwide as at September, 2017. Out of this, 42 of them operate in the Greater Accra region of Ghana representing 65%.

3.3 POPULATION AND SAMPLING

3.3.1 The research population and sample

According to Collins and Hussey (2003), population describes a group of people that are under consideration for a particular research. He further describes a sample to include the individuals that form part of the population, that is, those individuals that are being targeted (Collins and Hussey, 2003).

Israel (2009) explains that determining the sample size rests on the rationale behind the study, the size of the population, risk involved in selecting a “bad” sample as well as the sampling error allowed. A confidence level of 95% is used by most researchers indicating that out of a100 individuals sampled, it is likely 95% would provide feedback and this passes as a representation of the entire population (Israel, 2009). Israel (2009) further explains that more often than not a precision level of 5% is also adopted which shows the level at which the true value can be found. These values helped in determining the sample size for the study.

In order to determine an appropriate sample size, various methods exist as to how this can be done. This includes using a census when the population can be seen to be a small size, using tables that have been published already, applying sizes used in similar studies as well as the use of a formula. This research adopted the formula for calculating sample size in order to come by an appropriate sample size.

$$n = \frac{n^1}{1 + n^1/N}$$

Where;

n = sample size

N = total population size

$$n^1 = \frac{s^2}{v^2}$$

s = standard deviation in the population element at a confidence interval of 95%

$$s^2 = p(1 - p)$$

p = the proportion of population elements

v = maximum standard error of the distribution at 0.05

$$s^2 = 0.5(1 - 0.5)$$

$$s^2 = 0.25$$

$$n^1 = \frac{0.25}{0.05^2}$$

$$n^1 = 100$$

Now, N = 190

Therefore, sample size, $n = \frac{100}{1+100/190}$

n = 66.5, which is approximately 67

However, since every Contractor must be represented by a team made up of five professionals, it implies 13 contractors will be selected (66/5 =13.2). Adjusting this number by 30% increase to cater for non-responsive rate (Israel, 2009), it implies 17 contractors will be selected to satisfy this condition. Therefore, a total of 85 questionnaires were sent out (17X5=85)

3.3.1 Sampling technique

Macdonald and Headlam (2006) explain that because the population is more often than not larger and cannot be fully sampled, it is appropriate that sample techniques are adopted in order to come by an appropriate sample size for a study. Fellows and Liu (2008) also explain that it is rare that the entire population will be samples and for realistic purposes, sampling is done mainly to gain a representative part of the entire population. To gain an unbiased representation of the population, a purposive sampling method was adopted which led to the selection of 17 contractors of D1K1 and D2K2 contractors. Purposive sampling according to Newman (2014) is a non-probability sampling technique that helps in selecting particular individuals owing to their expertise in the subject matter.

Five questionnaires were issued to each of the 17 firms and using purposive sampling technique the following professionals employed with the Contractors, were targeted; Project Manager, Project Engineer, Site Engineer/Clerk of Works, Site Supervisor, And Quality Manager/Quality Assurance/Control Officer. This is repeated till all 85 questionnaires were distributed.

The Project Manager or Construction Manager is the head of the project team and mostly undertakes the planning, resource allocation and general monitoring of the progress of work. The Project Engineer, Site Engineer and Site Supervisor were in charge of the day to day technical activities of the site. Whilst the Quality Manager/Quality Assurance/ Control Officer was in charge of managing the quality activities of the Contractor.

3.4 DATA COLLECTION AND INSTRUMENTATION

3.4.1 Data sources

Data was collected both through a desk survey as well as on the field. Literature, which covers the desk survey, set the stud in motion and was very essential to the study and helped in the development of questionnaires and an interview guide to assist with the field study.

Information was gathered from the respondents with the help of a close ended questionnaire.

3.4.2 Questionnaire design

According to Oppenheim (1996), it is important to first plan what sort of information is required in order to determine what questions to set. The questionnaire was designed to include scaled-response questions and close-ended questions.

All efforts were made to ensure that questions were written in simple language and all technicalities explained as much as possible so as to ensure maximum response rates. Similarly, the researcher tried to keep the question in a section as minimal as possible so as to encourage respondents to take time in answering the questions and complete the questionnaire. The questionnaire was also made electronically available to those participants who couldn't be engaged personally.

3.5 DATA PREPARATION AND ANALYSIS

This section explains the various methods used in the analysis of data so as to help in the achievement of the overall aim of the research as well as the objectives set.

3.5.1 Data analysis

To recap, the study is an exploratory one. Analysis therefore focusses on what exactly the data was saying. Cohen et al. (2007) explains that with exploratory studies, description is key and reliance is on percentages as well as frequencies, graphical representations are employed as and when to provide a better representation of the data.

3.5.2 Reliability and validity

Cohen et al. (2007) explains that for the sake of reliability, there are two main ways to determine this: split half coefficient and Cronbach's alpha coefficient (Cohen et al. 2007). This study used Cronbach's alpha coefficient which provides the consistency that exists among the various elements (Cohen *et al*. 2007). Bryman and Crammer (1990) cited by Saunders *et al*. (2009) for the sake of reliability, a value of 0.8 is appreciable for an alpha value.

Fisher (2010); Saunders *et al*. (2009) explain that validity as the term suggests indicates how efficiently the questionnaires set answered the research questions as well as achieved the aim of the study. Kumar (2011) explains that validity basically is determined by approximating the manner in which each objective adds to the variations observed.

3.6 SUMMARY OF METHODOLOGY

In summary, this research adopted a positivist stand with the help of structured questions and a sampled population of 17 contractors. This chapter mainly sought to explain how the set objectives were achieved.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 INTRODUCTION

This chapter focuses on analyzing the gathered data from respondents through questionnaire. It discusses the findings from the analysis of the data collected. It used methods of data analysis discussed under the previous chapter- methodology. The descriptive statistics of the data provide quantitative insight to this investigation and as such provides an invaluable contribution to the aim of this research. To this regard, the analyses presented here are based on data from the demographics of respondents‟ firms and respondents, quality management practices of respondents‟ firms.

The results are actually structured to assess the level of knowledge and the level of usage of the seven basic quality control tools and also identify practical measures to improve quality control in the production of reinforced concrete.

The findings have been presented here in a statistical format such as charts and tables to enable examination and description on the pattern of the responses.

4.2 PROFILE OF RESPONDENTS

The research participants surveyed including their institutions are discussed in this section of the study. The data sought from the respondent regarding their profile were; 'level of education, position in the firm, experience levels of respondents in the industry'.

In Figure 4.1 below, the respondent's level of education in their respective fields is presented; 55% of the respondents have obtained a degree in the field of study pertaining to their field of operations, 24% have a Diploma/HND, while 21% have a Postgraduate or Master's degree, with the remaining 3% being Technicians by qualification. These respondents are staff within well-established firms with some high level of practical experience. The all qualify as respondents for the research of study.

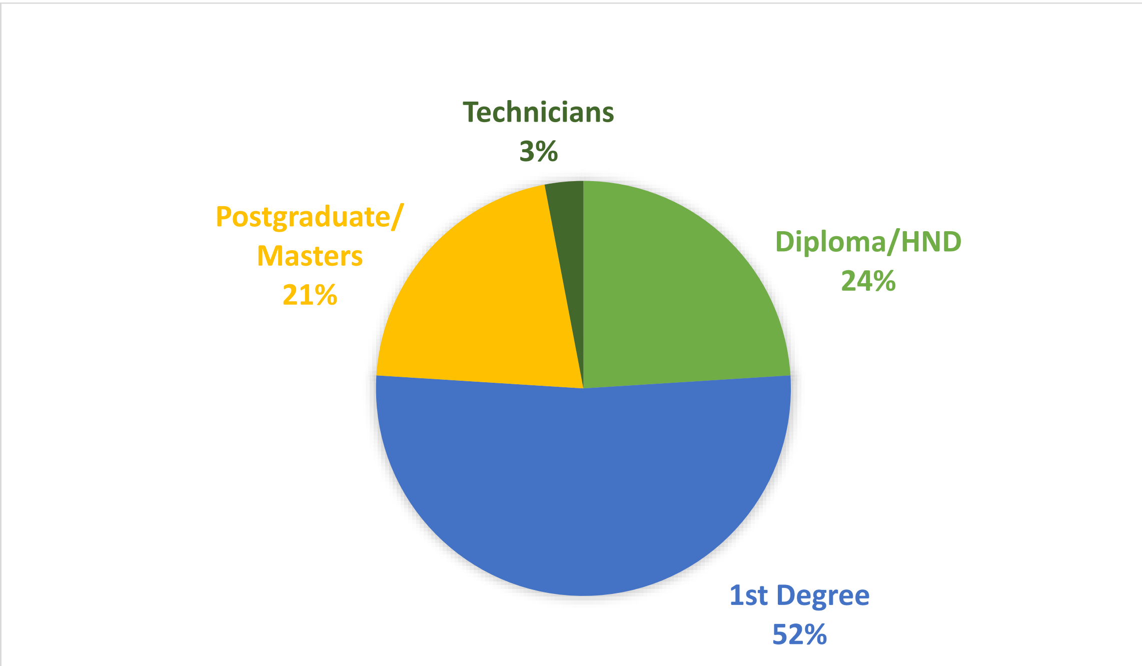

Figure 4.1 Respondents Level of Education

Figure 4.1 presents the statistical data on the various positions held by the respondents with the firms they work with. Out of all the respondents reached, the highest of 32% was the Site Engineers, Project and Construction mangers formed a total of 21% with the least being the Quality control and Quality Assurance personnel's who formed a total of 8%. This indicates that the role of quality control and assurance within the firms where associated to other experts within the institution. This results indicate the respondents where all partakers of construction related firms and targeted by the researcher.

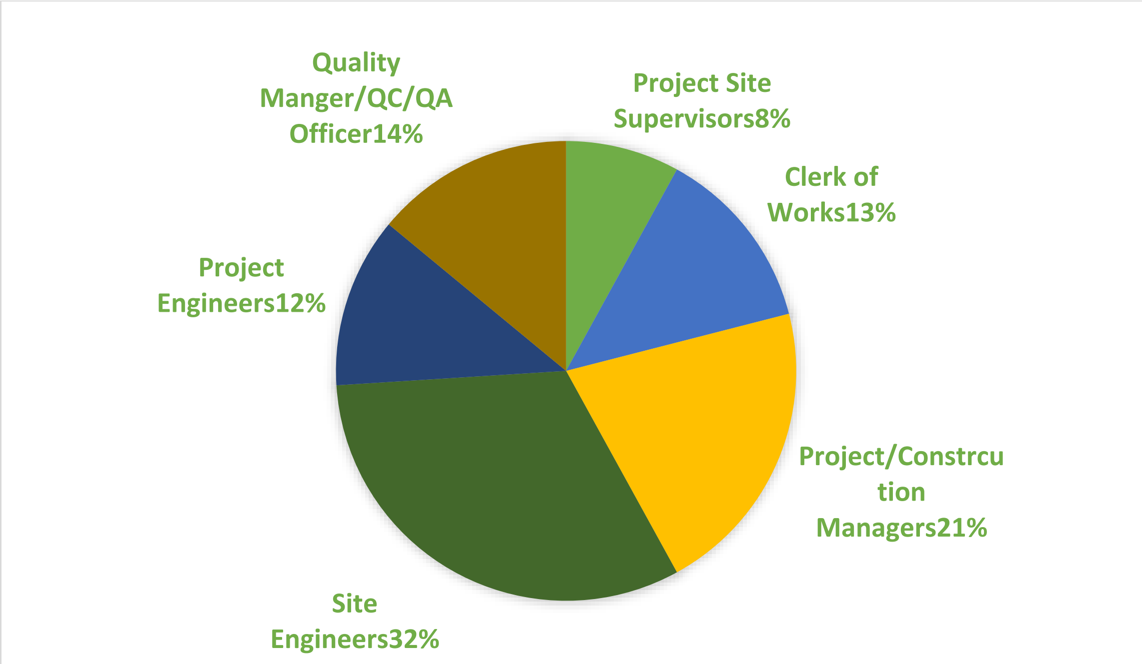

Figure 4.2 Job title or Position of respondent in Company

4.3 KNOWLEDGE OF FACTORS NECESSARY FOR DURABLE AND QUALITY CONCRETE WORKS

The factors necessary maintaining durability and quality of reinforced concrete where highlighted in literature, and it is vital that the perceptions of the respondents are determined in order to understand how they rate these factors in respect to the durability and quality of concrete. Five factors were listed as vital to the achievement of durability and quality in reinforced concrete. Respondents required to rank these factors in order of importance. The factors listed for ranking by respondents are as follows:

- Cement/Water Ratio
- Curing
- Cover of reinforcement
- Cement content
- Compaction

Figure 4.3 presents the percentages of respondents who ranked the factors in their order of importance. The results from the respondents indicate that a majority which represents 35% consider the cement content as a highly rated factor in the durability of reinforced concrete. 26% of the respondents raked the type of reinforcement as the second most important factor, followed by 23% who suggested that water to cement ratio is the third most important factor. While 10 % raked cover of reinforcement as the fourth factor that determines durability and quality of reinforced concrete whiles curing which recorded 6% became the fifth factor while none of the respondents considered compaction as the least important with 0%. These finding go contrary to literature in that water to cement ration is valued and the most important factor and cover to reinforcement is place as second most important factor. A similar study conducted in South Africa by Rwelamila (1996) raked Cement content a most important, which is similar to what this study recorded.

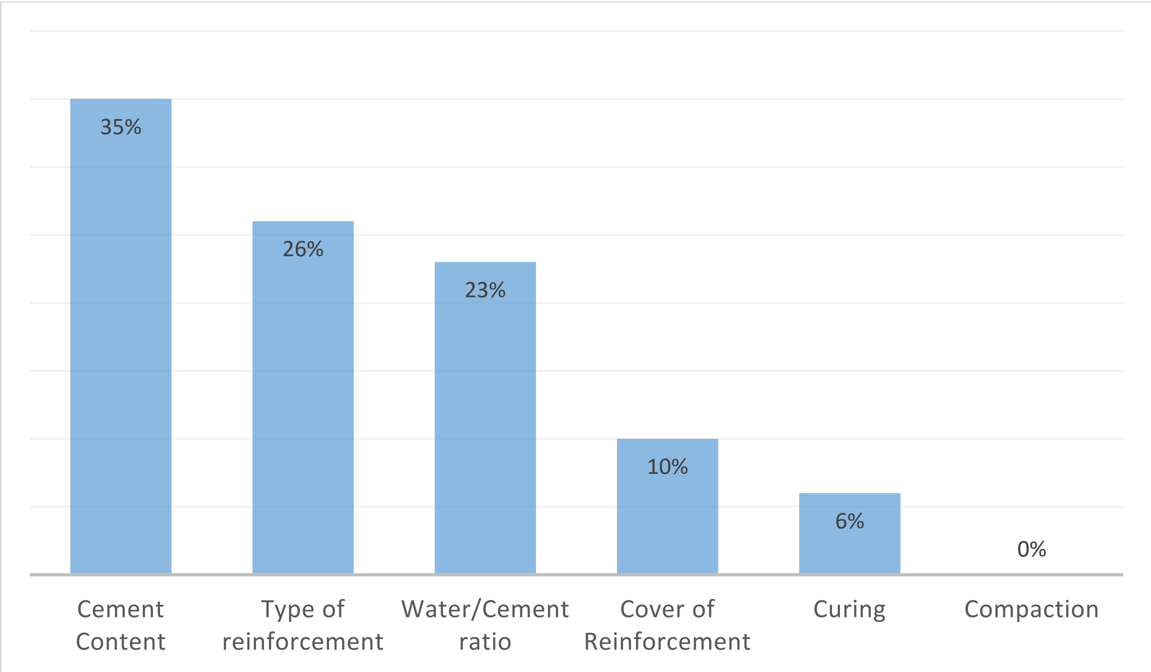

Figure 4.3 Ranking of Concrete Durability

With a means score ranking method, the data sought from respondents was analyzed and when there is a tie of a particular factor with another, the factor with the least standard deviation is ranked as the highest or most important factor. Cement content was ranked most important with a means score of 4.82 and a standard deviation of 1.428 as shown in Table 4.1, the type of reinforcement was ranked second most important with as mean score of 3.54 and a standard deviation of 1.403. Water to cement ratio was rank third most important with s standard deviation of 1.253 and a means score of 3.05.

Table 4.1 Mean Score Ranking of Concrete Durability Factors

	Mean	Std. Deviation	Rank
Cement content most important factor	3.82	1.428	1^{st}
Type of reinforcement most important factor	3.54	1.403	2^{nd}
Water/Cement Ratio most important factor	3.25	1.368	3^{rd}
Cover of Reinforcement most important factor	3.05	1.253	4^{th}
Curing is the most important factor	2.84	.893	5^{th}
Compaction is the most important factor	1.83	.986	6^{th}

Gerwick (1989) and Shayan and Quick (1992) assert that durability of concrete has been attributed to several factors but two of these factors which are ‘cement content’ and the quality and type of reinforcement’. This in in line with the research result as the highly rated factors by respondents are in line with what literature asserts.

4.4 QUALITY MANAGEMENT PRACTICES CURRENTLY ADOPTED BY RESPONDENTS FIRM

4.4.1 DEFINITION OF QUALITY REINFORCED CONCRETE

With the aid of literature, quality reinforced concrete is defined as the conformance to detailed specification by qualified professionals with knowledge in concrete manufacturing. Rwelamila (1996) in their study of quality in concrete alluded to the fact that conformance to specified requirements, the structural functionality and aesthetics are all factors that define reinforced concrete. This therefore makes the quality of reinforced concrete to be measure beyond its aesthetic or desirable features.

Table 4.2 outlines the results from respondents concerning the definition of quality of reinforced concrete as follows: Conformance to detailed quality specifications with a mean score of 4.68 and the lowest standard deviation of 0.735 was ranked highest as what best defines quality reinforced concrete, while Structural functionality was ranked second highest with a recorded mean score of 4.56 and a standard deviation of 0.704 which indicated a consistent result from respondents. This was followed by the least being aesthetics.

Table 4.2 Mean Score Ranking of Concrete Quality Definition

	N	Mean	Std. Deviation	Rank
Quality reinforced concrete defied by its conformance to detail quality specifications	56	4.68	0.735	1st
Structurally determinate and Structural Functionality	56	4.56	0.704	2nd
Aesthetically pleasing	56	3.21	1.341	3rd

Cornick (1991) and Loh (1981) in his study of concrete structures as cited by Rwelamila (1996) suggested that “conformance to detailed quality specification results in the other two components and Structural functionality and aesthetics. Juran and Gryna (1980) in their study of ‘quality and its fitness for use’ assert that, there is a wide range of elements that satisfy quality characteristics, they further explained that the parameters for defining quality mainly aim at the adherence to customer demands and design specification and the structural soundness of the product. Finally they assert that is ams be aesthetically pleasing to the customer (Juran and Gryna, 1980).

4.4.2 QUALITY CONTROL OF REINFORCED CONCRETE ON SITE

Respondents were required to select the appropriate quality control measures that where prevailing on their current industry practice and site. On a Likert scale they were to rank the how essential these factors are as existing on the sites they were operating on.

The responses by the respondents are analyzed below as follows in Table 4.3. Results from the respondents indicate that inspection during the execution of concrete works was highly prevalent as it recorded a mean score of 4.53 and a standard deviation of 0.783. This further affirms to what literature outlines that detailed inspections are undertaken during concrete operations and it advocates inspection wherever concrete works is to be undertaken (Ozyildirim, 2011; ACI 201.2R-01, 2008). This ensures quality and durability as well as consistency in procedure.

Table 4.3 Concrete Quality Control on Site

	N	Mean	Std. Deviation	Rank
Inspection during the concrete operation	56	4.53	.783	1st
Slump test is undertaken	56	4.21	.894	2nd
Results of slump test recorded	56	4.18	.906	3rd
The use of a checklist	56	4.16	1.034	4th
Production of Cubes for test analysis	56	4.10	.943	5th
Strength test performed with cube test	56	3.96	.926	6th
Recoding of strength tests results	56	3.93	1.138	7th

Undertaking a slum test recorded a second highest mean score of 4.21 and a standard deviation of 0.894. This signifies that most respondents undertake this activity on their projects as a means to access the quality of concrete.

The use of strength test and recording of strength test results recorded less mean scores of 3.96 and 3.93 respectively as outlined in Table 4.4 even though higher score where recorded than average.

Ying (2010) in his study of Quality Control in Construction projects, outlined processes in ensuring quality in concrete works on site. Some of which are: Material procurement, Material testing, placing and storage of material, and analysis of results over time (Ying, 2010). These conditions align with the results from literature which further gives proof of why respondents rank material test for consistency and the recording of material for analysis high during their activities for checking quality of concrete on site.

4.4.3 QUALITY OF SUPERVISION OF REINFORCE CONCRETE WORKS

The quality of supervision on site is dependent on some factors: The experience of the person supervising and the detailed working drawings provided with its specifications. Respondents ranked the quality of supervision on site as being directly related to the level of experience of the supervisor higher than the detailed specifications and drawings. Although these factors work hand in hand, it is vital that the practical experience is prioritized to enhance the quality of work execution. The results recorded a higher mean score of 4.58 and a standard deviation of 0.803 for the experience of the supervisor which emphasizes why this factor is very important to the quality of reinforced concreted works, whiles the specifications and drawings recorded a mean score of 4.43 which represents the second rank which is of a high values of importance.

Table 4.4 Mean Score on Quality of Supervisor of Works

	N	Mean	Std. Deviation
Experience of the supervisor	56	4.58	.803
Specification and drawings	56	4.43	1.035

4.4.4 FORMAL QUALITY MANAGEMENT

Questions where posed to respondents to access their formal quality management systems in their organisations. The questions asked are: "Does your company have a formal Quality Management system in accordance to its operations?" and "Is your company ISO 9000 certified?" figure 4.4 indicates that 39% of the respondents agree to have a formal quality management system within their organisations. A majority forming 46% indicate they are neutral, which indicates that most firms do not have formal management systems dedicated to quality. A minority of 15% of the respondents disagree to having formal management systems.

It can therefore be concluded that there is a low level of formal systems within most of the firms.

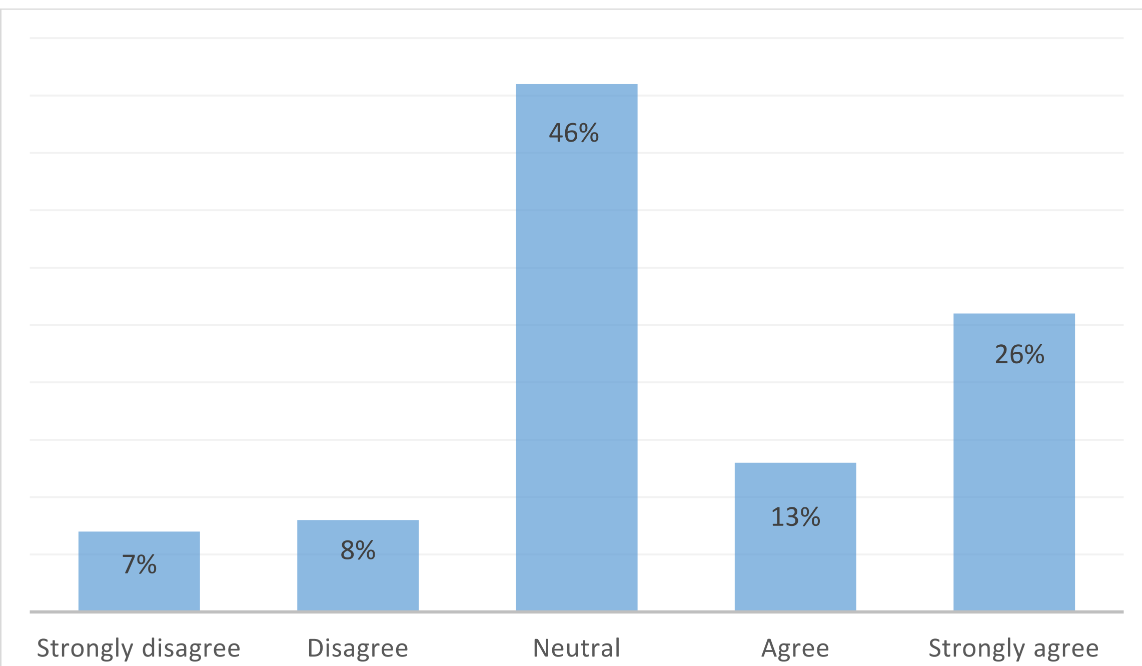

Figure 4.4 Response on the Formal Quality Management System

Data on Global certification of quality manage practices was required from these firms. For these reason respondents were asked about their ISO certification. 30% of respondents agree to ISO certification as shown in Figure 4.5. While 47% of the respondents where indifferent about ISO certification and their neutral stand was notable with a higher percentage.

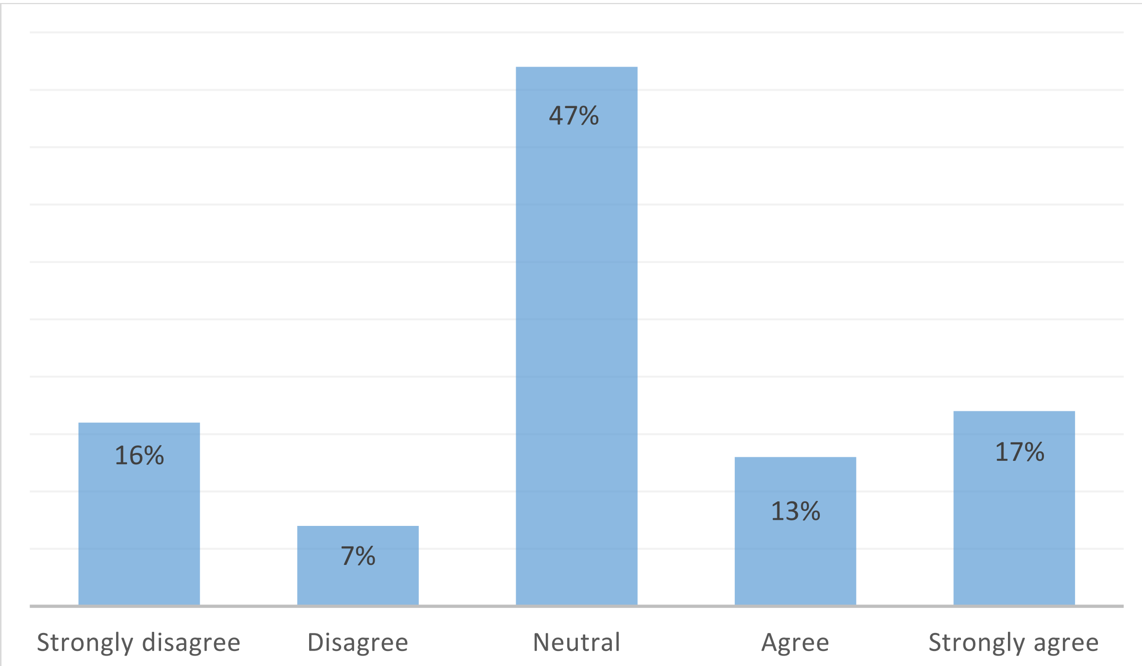

Figure 4.5 Response for ISO Certification

Neyestani (2016) undertook a study on the impact of ISO 9001 Certification, and observed that more than half of large scale construction firms in the Philippines where indifferent about ISO certification and a much more large number where practicing without ISO certification, this goes hand in hand with our research results were 47% of the population sampled where indifferent with ISO certification.

4.4.5 QUALITY MANAGEMENT TOOLS AND STRATEGIES

With the aid of literature a list of quality management tools where developed and given to respondents to rank using a Likert scale, if these tools where adopted in their firms. These tools comprised of:

- Quality Planning
- Quality Control
- Quality Assurance
- Total Quality management
- Quality Improvement
- Quality management systems

The results from the respondents indicate that quality improvement was prioritized as important with a means score of 3.87 and a standard deviation less that one. That was seceded by Quality planning with a means score of 3.84 and Quality control with a means score of 3.80, while Quality assurance recoded a means score of 3.76 with Total Quality management and Quality management systems recorded a means score of 3.74 and 3.7 respectively. These results are outlined in Table 4.5 below.

Table 4.5 Response on the Quality Management tools and strategies

	N	Mean	Std. Deviation	Rank
Quality Improvement	56	3.87	0.946	1st
Quality Planning	56	3.84	0.832	2nd
Quality Control	56	3.80	0.804	3rd
Quality Assurance	56	3.76	0.756	4th
Total Quality Management	56	3.74	0.903	5th
Quality management systems	56	3.70	0.954	6th

Project Management Institute (2013) divides quality management into three division; Quality management, Quality Assurance and Quality Control, and further explains that all other quality management tools and techniques are embedded within these three divisions and they all seek to achieve these three tools and techniques. This is evident in the results tabulated in Table 4.5 above where these three element are rank 2nd, 3rd and 4th respectively.

4.5 QUALITY CONTROL AND QUALITY ASSURANCE

4.5.1 SUMMARY OF QUALITY ASSURANCE AND CONTROL MEASURES ADOPTED BY FIRMS

The finding from the research measure quality control and quality assurance practices which indicate that systematic documentation and assessment of procedure for handling, storing and preserving reinforced concrete constituents had a mean score of 3.87, with a standard deviation of 0.125 which indicates a higher consistency in the respondent's selections of responses. These results are further outlined in Table 4.6 below:

Table 4.6 Mean Score on Quality Control and Quality Assurance

	Mean		Std. Deviation
	Statistic	Std. Error	Statistic
The Quality management techniques include the development of quality policy, objectives, responsibilities and their implementation within the quality system	4.20	.126	.783
Control measures put in place to ensure that timely inspection and testing equipment's are capable of the necessary functions and accuracy	3.94	.136	.894
The company has the systematic accessing procedures to aid in the efficient quality recording documentation.	3.87	.130	.937
There is a documented procedure for handing, placing, storing and preserving reinforced concrete constituents and finishes	3.87	.125	.875
Codes, standards and other relevant documents are available at the site and accessible to you	3.75	.122	.876
Documented procedure for reviewing the disposition of non-conforming products exists in the company	3.68	.126	.903
there is documented procedure for implementing corrective and preventative actions in you organization	3.66	.146	1.062
Routine internal auditing of the systems by independent personnel to assess effectiveness of the quality systems is performed by your company	3.43	.136	.973

The results further indicates that a majority of the firms do not have ISO certification, and therefore this resulted in several elements of formal quality management practice being affected. Neyestani, (2016) in a study on the impact of ISO 9001 Certification, and observed that more than half of large scale construction firms in the Philippines where indifferent about ISO certification and a much more large number where practicing without ISO certification, this goes hand in hand with our research results were 47% of the population sampled where indifferent with ISO certification.

4.6 EFFECTIVE QUALITY MANAGEMENT FACTORS

Respondents were asked to indicate their level of effective quality management by their firms by rating their firm's management and other factors that affect quality directly or indirectly.

4.6.1 MANAGEMENT AND LEADERSHIP'S COMMITMENT TO MANAGEMENT OF QUALITY

This part of the analysis focuses on the practical measures being suggested to improve quality by leaders and management in the operations of reinforced concrete.

Table 4.7 Means scores on the Leadership and management commitment to quality

	Mean	Std. Deviation	Rank
Objectives for quality set by top management and show commitment to quality	3.53	.705	1st
Top management defines the responsibility of personnel who manage, perform and verify work that affect quality	3.21	.671	2nd
Existence of a formal communication system notifying all personnel about the quality responsibilities expected of every individual	3.18	.630	3rd
Adequate provision of resources for performance or work to produce quality oriented results	3.16	.664	4th
Management actively and passively leading and directing quality management programs assuming their roles and responsibility for evaluating and improving quality management systems at predefined intervals	3.10	.623	5th
Employees feel top management provides full support to process and project quality improvement	2.96	.763	6th

The results as outline in table 4.8 above shows that 'top management set objectives for quality and is committed to quality' has a mean score of 3.53 and is ranked first, 'top management have the responsibility of managing personnel to undertake and perform quality related activities' ranked second with a mean score of 3.21, 'the existence of a formal communication system notifying all personnel about the quality responsibilities expected of every individual' ranked third but with a mean score of 3.18. Other factors that involved managements support and roles in ensuring continuous quality management recorded lower mean scores, such as 'Employees feel top management provide full support to process and project quality improvement' recording the lowest mean score of 2.96. Literature outlines five principles of Total Quality Management by (Dahlgaard *et al*. 2007) and "management commitment (leadership)' is the major factor in the effective quality management in all activities which ties into the research results as observed From the above table. It can be observed that practical measures to improve and control quality is very paramount for good project performance and should not be downplayed.

4.6.2 TRAINING

Respondents were asked questions concerning their firm's quality training systems. This was to inquire if there was a system that aided in the constant upgrade of staff and how important it was in achieving higher quality based results in their institutions and how it relates to the growth of the institution. From table 4.9 below shows how respondents rate their training related factors in their firms. A means score of 3.36 was recorded from the 'identification and provision of the required training needed for all staff ', while 'regular training organized for staff' recorded a means score of 3.34 which is the second highest, and the third being 'employees introduced to the principles and tools for total quality management at the project commencement' with a means score of 3.19.

Table 4.8 Mean Score Ranking on Training

	Mean	Std. Deviation	Rank
Identification and provision of requisite training for all staff including the basics of total quality management	3.36	.735	1st
Regular training organized for staff	3.34	.624	2nd
Employees introduced to the principles and tools for total quality management at the project commencement.	3.19	.603	3rd

This result indicates that a higher number of respondents place high value on training which is in correlation to one of the five key principle in total quality management as stated by (Dahlgaard *et al*., 2007). The results further emphasize that importance of enhancing quality and the continuous upgrade of spersonnel to meet the growing changes in quality and its approaches. It therefore vital that institutions take necessary steps to ensure their staff are kept updated on changing quality management strategies and tools.

4.6.3 SUPPLIER INVOLVEMENT IN QUALITY MANAGEMENT

In managing quality, another tool that can aid in the efficient management of quality is the involvement of quality. Respondents were asked of their views on the use of suppliers to check quality. Table 4.10 below shows the results of how respondents rate the involvement of suppliers in quality management. With a mean score of 3.92 'providing clear and concise specifications to suppliers' ranked first as the highest in making sure suppliers can be involved in quality management, 'dealing with the suppliers who have quality assurance programs' ranked second most important with a means core of 3.84, while the least of them was 'satisfying internal and external customers or suppliers' with a means score of 2.74 and a standard deviation of 0.893.

Table 4.9 Results on the Supplier Involvement on Quality management

	Mean	Std. Deviation	Rank
Providing clear and concise specifications to suppliers	3.92	1.428	1st
Dealing with the suppliers who have quality assurance program	3.84	1.403	2nd
Rely on few dependable supplier who are committed to quality	3.85	1.368	3rd
Establishing closer and long term relationship with suppliers	3.78	1.253	4th
Satisfying internal and external customers/suppliers	2.74	.893	5th

The result further emphasis that it is best to involve suppliers in the quality management processes in order that materials used in the execution of work can be cleared as fit for their purpose. This increase the quality of the works and also reduces quality control and assurance to the work execution stage.

4.6.4 QUALITY CODES AND STANDARDS

This part analyses the impact of the codes and standards in influencing quality management practices and the quality of reinforce concrete structures. Literature emphasizes the use of codes and standards in order to attain the quality and maintain safety for public use (Oberlender, 2000).

Table 4.10 Mean Scores on the Codes and Standard on Quality

	Mean	Std. Deviation	Rank
There must be early identification of codes and standards	4.31	.672	1st
Project team members must have thorough knowledge of the codes and standards during the design stage	4.22	.503	2nd
Codes and standards have an effect on the quality of the final product	4.20	.856	3rd
Codes and standards primarily protect the public health and safety	4.18	.740	4th

Pyzdek (2003) assert that quality codes and standards are the means by which quality systems are measure, and it is vital that these codes and standards are identified at an early stage to aid in the monitoring on the organizations quality systems. Table 4.11 above shows the results that 'there must be early identification of codes and standards' pertaining to quality of reinforced concrete, which ranked the highest means score of 4.31, 'project team members having a detailed knowledge of the codes and standards during design stage' ranked second with a means score of 4.22 which is in line with Chun, (1999) who asserts that standards and a detailed knowledge about these codes at the early stages of design and constructions can aid in right decision making to minimized risk for error and reworks. . The least score were recorded for 'code and standards have an effect on the quality of the final product' and 'codes and standards primarily protect the public health and safety' with means score of 4.20 and 4.18 respectively.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

The research aims at exploring the quality management practices in project management for reinforced Concrete Structures in the construction industry.

The research questions were;

1. What are the existing quality standards pertaining to the construction industry?
2. How can the barriers that impede quality control and quality assurance be overcome?
3. How can quality management in project management aid in improving quality control and quality assurance in the construction of reinforced concrete structures?
4. What are the efficient quality management strategies for reinforced concrete structures?

These research questions formed the basis of guiding the researcher in achieving the purpose of the study. The questions will be discussed in detail with regards to their research findings.

5.2 SUMMARY OF FINDINGS

The summary of finding of the research as shown by the study are presented below:

- OBJECTIVE ONE of the research was to identify the quality factors related to the production of reinforced concrete structures in construction industry. In identifying the quality factors, with the aid of literature these factors were water, cement ratio and reinforcement cover, among others. Other success factors such as the structural functionality where deemed highly significant in determine the quality of reinforced concrete. Objective one was achieved by these factors.

- OBJECTIVE TWO focused on examining the barriers that impede quality control and assurance in construction projects. Respondents were asked to assess the factors and practices on site that aid in enforcing quality on site while executing reinforced concrete works. Factors and process such as undertaking a slump test, analysis of cube test where used to check quality on their construction sites. All these tests were recorded and documented for analysis and for future documentation. These tests and analysis aided the firms in their constant quest to improve quality in accordance to the code and standards for best practice.
- OBJECTIVE THREE assessed how quality management in project management can improve quality control and assurance in reinforced concrete structures. Throughout the research there were a majority of positive responses pertaining to quality management and how their firms work to achieve quality results.

  Majority of the participants in the research relied on the level of experience of supervisors as a means to check quality on projects and also there was low level of reliance on the specification and drawings as compared to the level of experience of supervisors on the project.

  The results further indicated that a huge number of respondents did not possess any form of formal quality management system or held any ISO certification, but they relied of their multiple work experience and exposure to maintain quality on their projects.

  In order to control quality during work execution for reinforced concrete works, it was recorded that carry out through inspections before concrete works was a key practice for most organizations, and this was followed by a slump test to check the concrete quality specifications if they met the job specifications regarding quality. This was followed by the production of test cubes for various quality related test and analysis. However, all results were recorded on ta checklist for comparative analysis and checks, although the use of the checklist was a relatively low, which does not conform to good quality management practices. A system that relies on a good checklist for its documentation in order to make sure there is high conformance to quality is well place to produce quality and mange quality diligently.

The research further discovered that the work of quality managers and quality control professionals was outsourced to professionals and project participants with practical experience and not necessary to quality managers and specialists due to low recruitment of quality managers.

5.3 CONCLUSION

Based on the findings the following conclusion can be drawn;

- The study revealed that the majority of construction teams appreciate quality in totality, but did not fully appreciate the constituting factors that are associated with the production of quality reinforced concrete. Majority of the respondent considered only cement content and quality of reinforcement as the major factor in achieving quality reinforced concrete.
- Respondents generally accepted that quality of reinforce concrete is defined based on the structural functionality and soundness of concrete structures rather than the adherence to quality defined specifications and requirements.
- The use of quality control and quality assurance techniques were on the barest minimal. The use of the cube test and analysis form the use of checklists to keep and analyze records form test carried out were recorded among the least used practices.

- The research revealed the minimal use of formal quality management systems whereas there was a relatively low use of ISO certified personnel and operations, but the research discovered the use of quality management techniques in the execution of their reinforced concrete operations.

5.4 RECOMMENDATIONS

The study recorded some shortcoming that will need to be outlined and improved upon to help in the quality management and production of reinforced concrete structures. The recommendations are as follows:

- The strict implementation of the formal quality management systems within all construction firms.
- Construction team members must consist of quality control and quality assurance experts who are ISO certified.
- The strict adherence to construction specifications and working details as outlined by architects and engineers.
- The use of experience personnel on with execution of reinforce concrete works and the use of a checklist to guide the execution of works on site.
- The use of basic quality concrete quality management principles during the execution of concrete works and the training of personnel routinely to keep them updated on the new trends and practices.
- The display of commitment by top management and leadership in the adherence to quality in the execution of concrete works. All team participants must be seen to display all skills necessary in achieving quality and not left to unskilled labour or personnel.

- The use of a slump test must be encouraged and a detailed documentation must be made to check the consistency of concrete delivered to site. Undertaking of cube test to check the quality results of the strength of concrete as recommended for the project.

5.5 FUTURE RESEARCH

With the growing population in the country, there is constant pressure on the development of infrastructure and this calls for the need on further research into the production quality infrastructure being quality reinforce concrete structures and the quality management of reinforced concrete works. The pressure on infrastructure gives rise to poor quality due to the financial compromise. Poor quality management will in turn affect the durability and quality of concrete structure. Areas for father research with respect to the growing demand are:

- Quality Management and Quality Certification.
- Quality Management in Concrete Standards for Road Contractors.
- Quality Management in Road constructions.

5.6 LIMITATIONS OF STUDY

The study was restricted to D1K1 and D2K2 contractors who were organized and work with large scale construction and the use of qualified personnel for their projects. The results where base on this category of contractors only and generalized.

REFERENCES

ACI 121R-08, 2008. *Guide for Concrete Construction Quality Systems in Conformance with ISO 9001*, MI

ACI 201.2R-01, 2008. *Guide to Durable Concrete*, Available at: http://ccl.worldcat.org.ccl.idm.oclc.org/oclc/244388069.

ACI Committee E-701, 1999. *Aggregates for Concrete*, USA.

Ahadzie, D.K., 2007. *A Model for Predicting the Performance of Project Managers in Mass House Building Projects*. University of Wolverhampton.

Al-Ani R. and Al- Adhmawi I. F. (2011). Implementation of Quality Management Concepts in Managing Engineering Project Site. A Case Study of Total Quality Management in a Manufacturing and Construction Firm, Jordand Journal of Civil Engineering, Vol. 5, No. 1; 89-106.

Amoa- Mensah, K. (2002) The Strategy of Fast Track Housing Delivery: The Ashongman Success story, Paper presented at the Building and Road Research Institute, Research Week Seminar, November, pp 1-7

Arora, N. L. & Gupta, B. R, (2003) "Building Construction"

Ashford, J.L., 1989. *The Management of Quality in Construction*, london: Taylor & Francis e Library, 2003

Atkinson, G. (2005). Construction Quality and Quality Standards, The European Perspective, London: E & FN SPON

Ayandibu O. G. (2010). Quality Management and Socio-Economic Objectives in the Construction of the Guatrain. University of the Witwatersrand, Johannesburg. Pp 153

Battikha, M. G. (2002a) ‘Quality management practices in highway construction’, Emerald, , pp. 532-550

Bryman, A. and Duncan, C. (1990). *Quantitative Data Analysis for Social Scientists*. London and New York: Routledge, Chapman and Hall.

Chase, G.W. (1998). Improving Construction Methods: A Story about Quality. Journal of Management in Engineering, 14(3), 30–33

Chin-keng, T. & Hanuzah, A.-R., 2011. Study of Quality Management in Construction Projects. *Chinese Business Review*, 10(7), pp.542–552.

Chung, H.., 1999. *Understanding Quality Assurance in Construction, A Practical Guide to ISO 9000*, New York: Taylor & Francis e-Library, 2002

Cohen, L., Manion, L. & Morrison, K., 2007. *Research Methods in Education* 6th ed., New York: Taylor & F Francis Group.

Collins, J., and Hussey, R. (2003). Business research. Basingstoke NH: Palgrave, Macmillan.

Deming, W.E. 1982. Quality Production and Competitive Position, Massachusetts Institute of Technology, Center for Advanced Engineering Study, USA.

Dias, S. And Saraiva, P. M., 'Use Basic Quality Tools To Manage Your Processes', Quality Progress; Aug 2004, Vol. 37 Issue 8, Pp47-53.

Feigenbaum, A.V. 1983. Total Quality Control. McGraw-Hill Book Company. New York. 3rd ed

Richard F. Fellows, Anita M. M. Liu. (2018). *Construction Management and Economics* 36:11, pages 623-634.

Fellows, R.F. & Liu, a M.M., 2008. *Research Methods for Construction* 3rd ed., oxford: Blackwell Publishing.

First International Conference of Construction In Developing Countries (ICCIDC-1), 4-5 August, pp. 109-120

Fisher, C., 2010. *Researchin and writing a dissertation* 3rd ed., London: Prentice Hallpearson Educational Ltd.

Formosoa C.T , Revelob V.H. 1999. Improving the materials supply system in small-sized building firms NORIE—Federal University of Rio Grande do Sul, Porto Alegre, Brazil Fundacion Ecuatoriana de Ingenieria, Quito, Ecuador

Ghana Statistical Service, 2012. *2010 Population and Housing Census*, Accra.

Granado, J.., 2015. Ghana's Advance to Middle-income Status Requires Firm Policies. *IMFSurvey Magazine: Countries & Regions.* Available at: http://www.imf.org/external/pubs/ft/survey/so/2013/car061213a.htm [Accessed August 15, 2018].

Granado, J.., 2015. Ghana's Advance to Middle-income Status Requires Firm Policies.

Griffith, A. (1990), Quality Assurance in Building, London: Macmillan

Harris, F., McCaffer, R. & Edum-Fotwe, F., 2013. *Morden Construction Management* 7th ed., London: Blackwell Publishing.

Hendrickson, T. F., Matthews, D. A., Love, R. A., Patick, A. K., Meador, J. W., Ferre, R. A., et al. (1999) J. Med. Chem. 39, 5072–5082

Hoonakker, P.L.T., Carayon, P. & Smith, M.J., 2006. Quality and Safety Management in Construction. Total Quality Management, 17 (9), 1-42.. Total Quality Management. 17. 1-42.

Hoonakker, P, Carayon, P, Loushine, T. (2010) 'Barriers and Benefits of Quality Management in the Construction Industry: An Empirical Study',Total Quality Management, Vol. 21, No. 9, September, pp. 953-969

Hussey, J. and Hussey, R. (1997) Business Research. A Practical Guide for Undergraduate and Postgraduate Students, Palgrave. Basingstoke

IMFSurvey Magazine: Countries & Regions. Available at: http://www.imf.org/external/pubs/ft/survey/so/2013/car061213a.htm [Accessed July 23, 2019].

ISO 9000, 2005. *INTERNATIONAL STANDARD ISO Fundamentals and vocabulary* 3rd ed., Geneva: ISO.

Israel, G.D., 2009. Determining Sample Size. , (April 2009), pp.1–5.

Juran, J.M. & Godfrey, B.A., 1999. *Juran's Quality Handbook* 5th ed. R. E. Hoogstoel & E. G. Schilling, eds., New York: McGraw-Hill.

Juran, J.M. & Gryna, F.M.J., 1980. *Quality Planning and Analysis* 2nd ed., New York: McGraw Hill.

Kaufmann, T., Wiltschko, T. (2006) D 2.4, Quality Management Concept, Eeuroroads

Khan, A.H, Azhar, A, Mahmood, A. (2008), 'Quality Assurance and Control in the Construction of Infrastructure Services in Developing Countries – A Case Study of Pakistan',

Kish, L., 1965. *Survey Sampling*, New York: John Wiley & Sons, Inc.

Kuprenas. J.A. & Kenny, M.D. (1998). Total Quality Management Implantations and Results: Progress Update. Practice Periodical on Structural Design and Construction. 3(1):34-39

Kumar, R., 2011. *Research Methodology; a step-by-step guide for beginners* 3rd ed., New Delhi: SAGE publications.

Lahndt Leslie (1999) TQM Tools for the Construction Industry, Engineering Management Journal, 11:2, 23-27, DOI: 10.1080/10429247.1999.11415024

Love, P.E.D., Mandal, P., & Li, H. (1999). Determining the Causal Structure of Rework Influences in Construction. Construction Management and Economics, 17, 505–517

Lomborg, B., 2001. *the skeptical environmentalist: measuring the real state of the world*,

Macdonald, S. & Headlam, N., 2006. *Research Methods Handbook: Introductory guide to research methods for social research*, Manchester: CLES. Available at: www.cles.org.uk.

McKnight, 2004: A Brief History of Concrete. The History of Concrete – InterNACHI http://www.nachi.org/history-of-concrete.htm#ixzz32QPPFZXz

Mckim, R.A., & Kiani, H. (1995). Applying Total Quality Management to the North American Construction. Cost Engineering, 37(3), 24–28.

Meyer, C., 2002. Concrete for the New Century. *Association of New York City Concrete Producers*.

Mostafa. M. M. 2015. International Journal of Scientific & Engineering Research, Volume 6, Issue 8, August-2015.

Naoum, S.., 1998. *Dissertation Research and Writing for Construction Students*, oxford: Elsevier Butterworth-Heinemann.

Neuman, W.L., 2014. *Social Research Methods: Qualitative and Quantitative Approaches* 7th ed., England: Prentice Hall-pearson Educational Ltd.

Neyestani, B. (2016). “Impact of ISO 9001 Certification on the Projects' Success of Large-Scale (AAA) Construction Firms in the Philippines,” International Research Journal of Management, IT and Social Sciences, 3(11), pp. 35–45. http://dx.doi.org/10.21744/irjmis.v3i11.305

Ofori-kuragu, J.K., Baiden, B.K. & Badu, E., 2016. Key Performance Indicators for Project Success in Ghanaian Contractors. *International Journal of Construction Engineering and Management*, 5(1), pp.1–10

Oppenheim A.V., Suárez L.E. 1996. Applications of wavelet transforms to damage detection in frame structures, Engineering Structures, Volume 26, Issue 1, 2004, Pages 39-49, ISSN 0141-0296, https://doi.org/10.1016/j.engstruct.2003.08.009.

Osei-Asibey, D (15-Nov-2005) 'Implementation of Total Quality Management (TQM) for District Assemblies' Common Fund (DACF) Projects at Atwima District Assembly Precontract Stage'. Available from: http://hdl.handle.net/123456789/1825 (Accessed 10th July, 2019)

Project Management Institute, 2013. *A Guide to the Project Management Body of Knowledge* 5th ed. I. Project Management Institute, ed., Atlanta.

Pyzdek, T., 2003. *Quality Engineering Handbook* 2nd ed. P. A. Keller, ed., New York: Marcel Dekker, Inc.

Pyzdek, T. & Keller, P., 2013. *The Handbook for Quality Management* 2nd ed., New York: McGraw Hill

Quality Assurance in the Construction Industry. StudyMode.com, (2008,) Available: Http: //www.studymode.com/essays/Quality-Assurance-Construction-Industry-129387.html (Accessed on 2nd August, 2019)

Reuben McKnight, 2004: A Brief History of Concrete. The History of Concrete – InterNACHI http://www.nachi.org/history-of-concrete.htm#ixzz32QPPFZXz

Rumane, A.R., 2011. *Quality Management in Construction Projects*, London: Taylor & Francis.

Rwelamila, P.D., 1996. Durability of Building Materials and Components. In S. Christer, ed. *Durability of Building Materials and Components, Building Pathology and Rehabilitation 3*. Stockholm, p. 1031.

Sabah, C.B.S. (2011) Performance of District Assembly Consultants on Common Fund Projects Based on ISO 9000 Quality Management Systems, Kumasi: KNUST

Saunders, M., Lewis, P. & Thornhill, A., 2009. *Research Metods for Business students* 5th ed., Englaand: Prentice Hall-pearson Educational Ltd

Satterfield, Z. (2005), 'Quality Control in Construction Projects', Tech Brief, National Environmental Services Center

Saunders, M., Lewis, P. & Thornhill, A., 2009. *Research Metods for Business students* 5th ed., Englaand: Prentice Hall-pearson Educational Ltd.

Schriener, Judy (1195). "Total Quality Management struggles into low orbit" ENR, 234(19), 24-28

Seeley, I. H. (1987) "Building Technology" London Macmillan Press,

Tan, C.K. & Abdul Rahman, H., 2005. Preliminary Research Into Overcoming Implementation Problems Of Quality Management In Construction Projects. In *Proceeding of the 4th Micra Conference*. Kuala Lumpur.

Tasker, J.., 1985. Concrete disease - diagnosis and cure. *Structural Survey*, 3(1), pp.6–11. Available at: http://dx.doi.org/10.1108/eb006200.

Titman, P., 2003. Quality and Standards. In J. Newman & B. S. Choo, eds. *Advanced Concrete Technology: Testing and Quality*. New York: Elsevier ButterworthHeinemann, p. 8/3 8/30.

United States Army Corps. 2004. United States Army Corps of Engineers Water Resources Planning: A New Opportunity for Service. National Academics Press, 500 Fifth Street, N. W. Lockbox 285, Washington, DC 20055; (800) 624-6242 (Internet. http://www.nap.edu.)

Walton, M., 1986. *The Deming Management Method*, New York.: Pedigree.

Zairi, M. 1991. Total Quality Management for Engineers. Cambridge: Woodhead.

APPENDIX A

QUESTIONNAIRE

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI – GHANA

COLLEGE OF ART AND BUILT ENVIRONMENT

DEPARTMENT OF CONSTRUCTION TECHNOLOGY

QUESTIONNAIRE ON THE EFFECTIVENESS OF QUALITY MANAGEMENT PRACTICES IN PROJECT MANAGEMENT IN THE CONSTRUCTION OF REINFORCED CONCRETE STRUCTURES IN GHANA.

INFORMATION SHEET

This survey is part of a Master Project Management thesis research, investigating Effectiveness of Quality Management Practices in Project Management in the Construction of Reinforced Concrete Structures in Ghana. Relying on your broad practical experience, only your valued expert response is requested. The questionnaire will take approximately 15 minutes.

Confidentiality will not be compromised, thus personal information will not be disclosed in any publication.

The highest level of genuineness will go a long way to assist in curbing the matter at hand.

Thank you for your time.

For any enquiries, please contact:
SIAYOR, Bright Delali,
KNUST.
Mob. +233(0)509125591
Email: bright.delali@yahoo.com

Supervisor:
Dr. Kofi Agyekum
KNUST.
Email: agyekum.kofi1@gamil.com
Mob. +233(0)246761879

SECTION A – PERSONAL DATA

Name of Institution: ………………………………………………………………

Level of Education: HND/Diploma First Degree Postgraduate Technician

Position in your institution: ……………………………………………………....

Years of Experience in industry practice:

Does your institution have a quality control Department? YES/NO

What is the Human resource capacity in that department, (staff number)? …………………….

SECTION B

1. **Quality management practices in Reinforced Concrete Works**

No.	**Factors affecting the durability of reinforced concrete**	**Rank**
1.	Cement content	
2.	Type of reinforcement	
3.	Cover to reinforcement	
4.	Water/cement ratio	
5.	Compaction	
6.	Curing	
7.	If other (please specify)	

2. **Quality Reinforce Concrete**

On a Scale Of : 1= Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree		**1**	**2**	**3**	**4**	**5**
Quality of reinforced concrete defined as:						
1.	Conformance to specified requirements					
2.	Aesthetic features					
3.	Structural functionality					
How is the quality of concrete works controlled at the site						
1.	The use of a checklist					
2.	Inspection during the concrete operation					
3.	Cube teste analysis					
4.	Strength test performed with cube test					
5.	Recoding of strength tests results					
6.	Slump test is undertaken					
7.	Results of slump test recorded					
Quality of supervision in dependent on						
1.	Experience of the supervisor					
2.	Specification and drawings					
Formal Quality Standards						
1.	Does your company have a formal Quality Management system in accordance to its operations?					
2.	Is your company ISO 9000 certified					
Quality management strategies and tools						
1.	Quality Planning					
2.	Quality Control					

3.	Quality assurance					
4.	Total Quality Management					
5.	Quality Improvement					
6.	Quality management systems					
Quality Control /Quality Assurance						
1.	Quality management techniques include the determination of quality policy, objectives, responsibilities and the implementing them within the quality system					
2.	Codes, standards and other relevant documents are available at the site and accessible to you					
3.	Control measures are in place for ensuring that the inspection and test equipment is capable of the necessary function and accuracy					
4.	Documented procedure for reviewing the disposition of non-conforming products exists in the company					
5.	there is documented procedure for implementing corrective and preventative actions in you organization					
6.	There is a documented procedure for handing, placing, storing and preserving reinforced concrete constituents and finishes					
7.	The company has the systematic filling and accessing procedures to enable efficient quality record retrieving					
8.	Periodic internal auditing of the system by independent personnel to ensure effectiveness of the quality system is performed by your company					
9.	If any other (please specify)					

SECTION C

Effective Quality Management Factors

Below are a number of quality characteristics which can have an impact on quality management in your firm.

On a Scale Of : 1= Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree		1	2	3	4	5
Commitment by Management and leadership						
1.	Top management sets objectives for quality and is committed to quality					
2.	Top management defines the responsibility of personnel who manage, perform and verify work that affect quality					
3.	Existence of a communication system notifying all staff about the quality responsibilities of every individual					
4.	Adequate provision of resources for performance or work to produce quality oriented results					
5.	Management actively and passively leading and directing quality management programs assuming their roles and responsibility for evaluating and improving quality management systems at predefined intervals					
6.	Employees feel top management provides full support to process and project quality improvement					
7.	If any other (please specify)					
Training						
1.	Identification and provision of requisite training for all staff including the basics of total quality management					
2.	Regular training organized for staff					
3.	Employees introduced to the principles and tools for total quality management at the project commencement.					
4.	If any other (please specify)					
Supplier involvement						
1.	Rely on few dependable supplier who are committed to quality					

2.	Establishing closer and long term relationship with suppliers					
3.	Providing clear and concise specifications to suppliers					
4.	Dealing with the suppliers who have quality assurance program					
5.	Satisfying internal and external customers/suppliers					
6.	If any other (please specify)					
Quality of codes and standards						
1.	There must be early identification of codes and standards					
2.	Codes and standards primarily protect the public health and safety					
3.	Project team members must have thorough knowledge of the codes and standards during the design stage					
4.	Codes and standards have an effect on the quality of the final product					
5.	If others (please specify)					

EFFECTIVENESS OF QUALITY MANAGEMENT PRACTICES IN PROJECT MANAGEMENT IN THE CONSTRUCTION OF REINFORCED CONCRETE STRUCTURES IN GHANA.

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