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DEVELOPING A FRAMEWORK TOWARDS EFFECTIVE QUALITY CONTROL MANAGEMENT PRACTICE ON BUILDING CONSTRUCTION PROJECTS IN NIGERIA - A CASE STUDY OF LAGOS

by

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ABSTRACT

Across the world, quality issues on construction projects have been challenging, especially in developing countries with increased demand for buildings due to emerging economies and growing populations. In Nigeria, especially Lagos, poor quality of work has led to the continuous collapse of buildings, with several lives claimed. The need to improve the quality performance of construction projects and curb the quality issues faced by construction industries in Lagos has called for effective quality control management practices. Therefore, this research aims to develop a framework for effective quality control management of building construction projects in Lagos, Nigeria, by investigating the current quality control practices, the challenges inhibiting effective quality control management, the influence of quality control managers as well as the critical success factors required for quality control management of building construction projects. The study employs a quantitative research method using a questionnaire as the research instrument. A total of one hundred and sixteen responses were obtained from construction professionals working in the construction industries within Lagos state, Nigeria. The professionals were randomly selected from each construction firm. The data collected were analysed through descriptive and exploratory factor analysis methods utilizing Statistical Package for the Social Sciences (SPSS) version 28. The findings revealed that the firms carry out quality control management practices but mostly adopt traditional quality control practices to control the quality of work being carried out. Also, the findings revealed that employing quality control managers will positively influence the quality control management of construction projects. They would ensure the implementation of quality plans and checklists, boost quality compliance, and increase the project's success. The study further identified quality control challenges and the success factors required for effective quality control management. Upon this, a graphical framework for effective quality control management was developed. The proposed framework in this study shall be helpful to construction stakeholders and organisations in efficiently controlling the quality of construction projects. The study, therefore, recommends applying digital quality control tools to building projects among construction professionals, as this will help put the industry ahead of others and reduce human error in production.

Keywords: Quality management, Quality assurance, Construction projects, Developing countries

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DECLARATION

I, **MARGARET DAMILOLA OYEWOLE**, certify that this dissertation's intellectual content is entirely the result of my effort, except for the references and bibliographies cited. This research work, in whole or in part, has never been submitted to any other university for review, publication, or any other purpose.

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DEDICATION

This work is primarily dedicated to Almighty God, the beginning and the end, who saw me through this master's degree journey. I also dedicate this dissertation to my husband, Past. Emmanuel Jayeola, and my son, Gideon Jayeola.

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My profound gratitude goes to Almighty God, the giver of wisdom, knowledge, and understanding, who saw me through this journey's end. I would have dropped out if it were me, but His grace sustained me.

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LIST OF PUBLICATIONS

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JOURNAL

M.D. Oyewole and M. C. Mewomo. Factors affecting effective quality control management of building construction projects in Lagos. Journal of Engineering, Design and Technology (in progress).

M.D. Oyewole and M. C. Mewomo. An empirical survey of quality control manager's influence on building construction projects. Journal of Engineering, Design and Technology (in progress).

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LIST OF ABBREVIATIONS

(BIM) Building Information Modelling

(QA) Quality Assurance

(QC) Quality Control

(QCP) Quality Control Practice

(TQM) Total Quality Management

(ISO) International Standard Organisation

(SON) Standard Organisation of Nigeria

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CHAPTER ONE

1.1 INTRODUCTION

This chapter discusses the background of the study on quality control management practices in building construction projects. It further introduces the problem statement, research questions, the research aim and objectives, the research methodology, the scope of the study, study motivation, ethical considerations, and the outline of chapters.

1.2 BACKGROUND OF STUDY

The production process in the construction sector is recognised to be complex, capital-intensive, and highly specialised. Other manufacturing industries rely on the construction industry's output to manufacture their goods and services (Boadu, Wang and Sunindijo, 2020). Also, the sector contributes significantly to a country's GDP, especially in developing countries (Oladinrin, Ogunsemi and Aje, 2012). In Nigeria, the construction sector employs up to 20% of the labour force and contributes no less than 16% to the nation's GDP (Amade, 2016).

However, regardless of the building industry's important role and contribution to a nation's development, achieving the expected quality required by its customer has been challenging. Odutola (2021) reported that in 2019, Nigeria recorded no less than 43 building collapses, of which Lagos state had the highest incident with seventeen cases. That is, approximately 39.53% of the total number of collapsed buildings in Lagos. Additionally, on 1st November 2021, in Ikoyi, Lagos, a structure that was planned to be the first of its kind in Nigeria and which was to have various apartments with facilities collapsed during construction, resulting in the loss of many lives (Gbonegun and Olorunlomeru, 2021).

Therefore, based on these ongoing building failures and collapses, several studies have been conducted to determine the leading causes and provide appropriate solutions. Salvi and Kerkar (2020) opined that the most significant issues affecting the development of construction projects and structures could be resolved by creating and implementing effective and continuous quality control at each level of production and by testing goods and structures using the most up-to-date tools and equipment. Also, Abdullahi et al. (2019) concluded that a solid dedication to quality and

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continual improvement by any construction company would result in a considerable improvement in quality performance and a rise in profit margins.

Quality control is a means of monitoring a project to ensure compliance with required quality standards and find ways to eliminate poor performance (Ashokkumar, 2014). Quality managers are employed to manage the task of supervision of construction projects to ensure the quality of the construction process. However, currently, the rate at which buildings collapse is still a concern in Nigeria's construction industry, specifically in Lagos. Mane and Patil (2015) further confirmed that inefficient quality management practices result in significant annual time and resource waste.

Therefore, based on this baseline information, it is necessary to inquire about the quality control practices on building construction projects in Lagos, the challenges they experience, the quality control managers' influence and the critical success factors required for effective quality control management in Nigerian construction projects.

1.3 PROBLEM STATEMENT

The ongoing collapse of buildings under construction and after construction in Nigeria is becoming more alarming, especially in Lagos, Nigeria. Approximately 461 structures collapsed in Nigeria between 1974 and July 2021, resulting in over 1,090 documented fatalities and several injuries (Gbonegun and Olorunlomeru, 2021). Additionally, Odeyemi, Giwa, and Abdulwahab (2019) assessed building collapses in Nigeria from 2009 to 2019 and found that the southwest of the country had the highest percentage of building collapses, accounting for a total of 60.71% of the 64.08% of lives lost. Apart from this, the complexity and uniqueness of the product, working conditions, and involvement of diverse subcontractors and suppliers make construction project management difficult. According to Awoyera et al. (2021) and Osuizugbo (2018), more of these project failures are a result of human factors such as improper use of some key professionals in the building industry, design of work by unqualified individuals and the use of unskilled persons for building construction.

Therefore, to solve quality issues faced by the Nigerian construction industry, much research has been done in the context of quality management, some of which are quality management systems at construction (Mane and Patil, 2015, Abdullahi et al., 2019, Lawrence et al., 2021) and quality

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control mechanism in building production management in Nigeria (Bustani, 2014), but few works of literature addressed quality control practices, especially from the perspective of the quality control manager's influence on building project performance in terms of the desired quality.

Quality control is the aspect of quality management that ensures that workers, materials, methods, plants, and equipment function at the expected standards and that the final product of the construction meets the required standard and specifications, including the client's needs. Therefore, this research aims to develop a framework for effective quality control management practices on building construction projects in Nigeria by looking into the current quality control management practices in Nigeria building construction projects, the influence of quality control managers on achieving an effective quality control management on building construction projects, the challenges and the critical success factors for effective quality control management.

1.4 RESEARCH AIMS AND OBJECTIVES

This research aims to develop a framework for effective quality control management practices of building construction projects in Nigeria's construction industries. Therefore, the following objectives were studied to achieve this aim:

1. To investigate the current quality control management practices on building construction projects in Lagos, Nigeria.
2. To investigate the influence of quality control managers on quality control management on building construction projects.
3. To examine the challenges of quality control management practices on building construction projects in Lagos, Nigeria.
4. To investigate the critical success factors for effective quality control management practices on building construction projects.

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1.5 RESEARCH QUESTIONS

The research objectives were examined by discussing and answering the following research questions:

1. What are the current quality control management practices on Nigerian construction building projects?
2. What is the influence of quality control managers on achieving effective quality control management on building construction projects?
3. What are the challenges of quality control management practices on building construction projects?
4. What are the critical success factors for effective quality control management practices on construction projects?

1.6 RESEARCH MOTIVATION

The persistent collapse of buildings in Lagos state, Nigeria, is a major concern in the construction industry and the country. Subsequently, these incidents have claimed many lives and properties, thereby affecting Lagos's economy. Therefore, there is a need for improvement in construction quality. On this note, this research addressed the quality control management practices of building construction projects in Lagos, Nigeria. The findings from this study will contribute to global knowledge of the challenges influencing quality control practices, the roles of quality managers, and the necessary competence required of them to ensure effective monitoring and control in construction projects. Also, information on ways to ensure effective quality control management will be provided to improve the quality control management practices on building construction projects. Finally, the research will present a framework for quality control management of building construction projects.

1.7 JUSTIFICATION OF THE STUDY

A construction project is referred to an organised process of constructing, renovating, and refurbishing a building or structure. The construction project is complex due to its reliance on organisations engaged at different levels, from the planning phase to the execution phase (Arora

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and Ogra, 2012). Besides this, project failure and collapse have become a threat to the safety and health of building occupants and the environment. Therefore, a system that will guarantee that work is undertaken correctly and per the contract specifications is essential for project quality management.

Quality control is the main activity and technique employed to satisfy quality requirements (Fox, 2013). It involves the control of every aspect; the control of what is done, how it is done, where it is done, who does it, and why it is done (Juran et al., 2005). A quality control system helps to facilitate the quality improvement of products and services, provides a continual assessment and necessary revisions required to satisfy the customers changing requirements, improves productivity and reduces cost in the long run (Mitra, 2016).

1.8 SCOPE OF STUDY

The study focused on quality control practices, the challenges, the success factors required for effective quality control management on building construction projects and the influence of quality managers in terms of their roles, competence and training. The research survey focused on the construction industries in Lagos state Nigeria. The data collection was through well-structured questionnaires administered to professionals working in the Lagos construction firms.

1.9 RESEARCH METHODOLOGY

Research methodology refers to the methods and procedures by which the research objectives are being achieved. They include the quantitative approach, qualitative, and mixed method approach. This study adopted a quantitative approach because of its suitability to survey a large population and provide results that are more readily analysed and interpreted (Goundar, 2012). The target population for the study were professionals working in construction firms in Lagos, Nigeria. This was achieved by getting their contacts from the Federation of Construction Industries (FOCI), Nigeria. The research employed a random sampling technique to select the construction professionals randomly from their respective firms. The data collection method was a well-structured questionnaire administered to the research participants online. Moreover, the secondary data used in the study were obtained from existing research articles, journals, books, websites, newspapers and magazines to gain more insight into the subject under study. Furthermore, the

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analysis of the collected data was done using a Statistical Package for Social Sciences (SPSS) computer software, wherein the mean item score (MIS), exploratory factor analysis (EFA), and internal consistency were calculated.

1.10 RESEARCH OUTCOME

The research findings include the quality control practices among Lagos firms, the challenges facing quality control management, the influence of quality control managers, the roles and competencies, the critical success factors for effective quality control management, and a framework for effective QC implementation on building construction projects. The result of the study will help construction firms, quality managers and countries better understand quality control practices and evaluate their current QC practices for improvement. The identified critical success factors for QC management will serve as guidelines for construction firms and professional bodies in implementing effective quality control of construction projects. This will increase the quality performance of construction projects, reduce cost, help them to compete effectively in the global market and give them an edge over other industries. In addition, the study's outcome will benefit researchers by increasing their knowledge of QC management practices, resulting in better quality performance of construction projects.

1.11 ETHICAL CONSIDERATION

The study ensured the voluntary participation of research participants. All data collected were treated anonymously and kept confidential. Ethical clearance was sought and received from the Institutional Ethics and Research Committee, and the research work was carried out in accordance with the university's ethical guidelines.

1.12 OVERVIEW OF THE CHAPTERS

The thesis is outlined in five chapters as follows:

Chapter One: Introduction

This chapter presents the study's background on managing quality control practices in Lagos, Nigeria. It further describes the problem statement, the research aims and objectives, the research

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questions, the justification of the study, the research motivation, the research methodology, and the ethical consideration of the study.

Chapter Two: Literature Review

This chapter presents the quality management concept. It reviews the construction industry's current quality control management practices in the context of the tools and techniques used, organisational commitment to quality management, and the industry's compliance with quality standards. The chapter further investigates the challenges facing quality control management practices and the influence of quality control managers on construction project quality in terms of their roles and competencies. The chapter also analyses the critical success factors for effective quality control management on construction projects.

Chapter Three: Methodology

This chapter explains the methodological approach and method adopted in the study to solve the research objectives. It also presents the sampling method and sample size, the study's targeted population, and the research's ethical considerations.

Chapter four: Data Collection and Analysis

This chapter presents the collected data, the analyses, and records from the processed data.

Chapter five: Discussion of Findings

This chapter reviews the data generated, provides in-depth information on the research findings and relates it to the existing literature.

Chapter Five: Conclusion and Recommendation

This chapter summarises the research's findings, discusses the contributions to knowledge, and provides recommendations for further study.

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1.13 Conceptual Framework of the Study

Figure 1.1 presents the conceptual framework of the research study. This was developed to serve as a guideline for the research process.

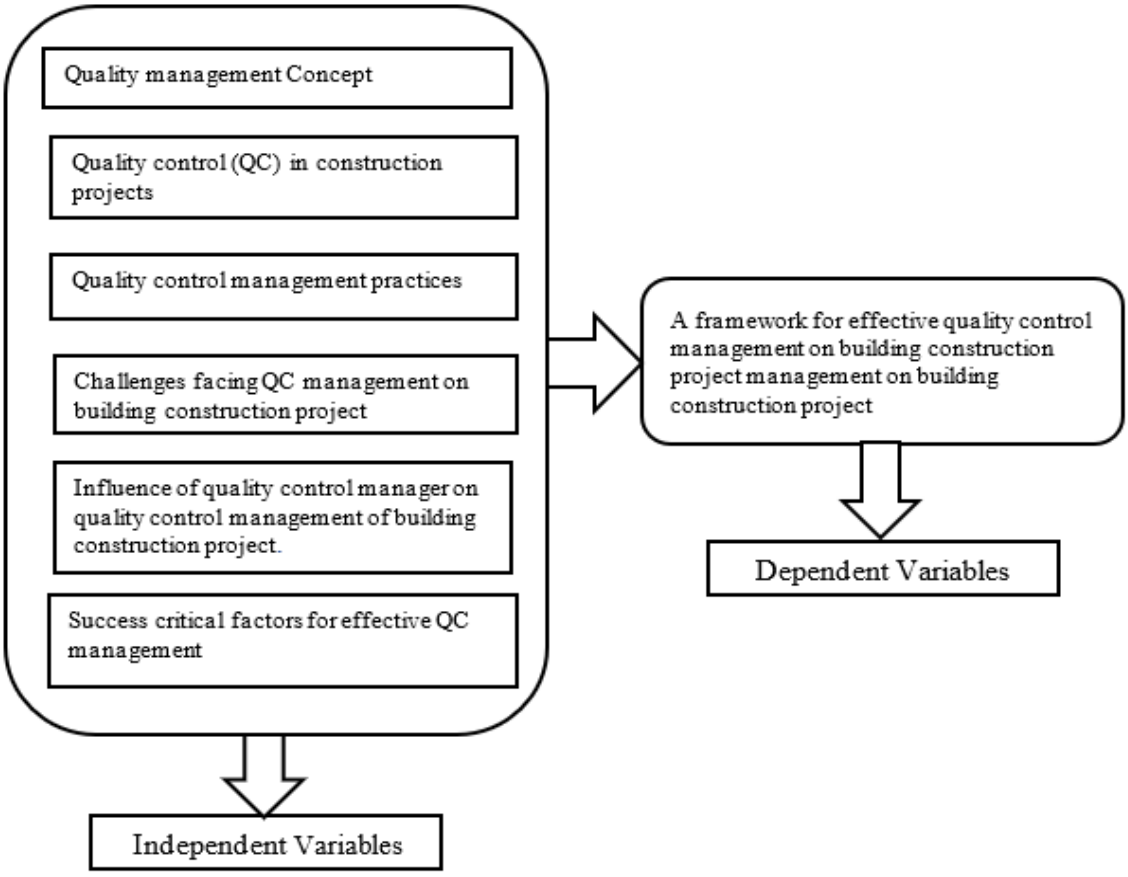

Figure 1. 1 Conceptual framework of the study

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CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

A construction project is one of the projects that is progressively being embarked upon by both government and private bodies in Nigeria. This is due to the high demand for housing and the need for infrastructural development in the country. However, the rate at which building collapses in Nigeria, especially in Lagos, is alarming and worrisome. This situation has been a great concern in the industry and the government as the incident has claimed many lives and properties. The Nigerian government has tried regulating construction projects by establishing codes and standards as well as regulatory agencies and bodies to govern construction works. Still, the issue of building collapse continues to rise. Various studies have been conducted in these contexts to investigate the causes of building collapses.

It was revealed that inadequate monitoring and supervision, use of quacks, faulty construction, and poor quality of materials and workmanship, to mention a few, are the key factors contributing to building failure in Lagos, Nigeria (Oseghale et al., 2015, Oyedele, 2018, Akande et al., 2016). Preethi and Manoharan (2017) suggest that through steady planning, supervision, and inspection, the quality of a project can be ensured, and waste eliminated, including schedule delays. Consequently, studies have been conducted on quality management practices on building construction projects in Lagos, but few addressed the QC management practices and the competency and skills required of quality control managers in Lagos, Nigeria. Hence, this study focuses on developing a framework for quality control management practices for construction projects.

Therefore, this chapter systematically reviewed extant and past literature such as journals, articles, books, theses and magazines to gain more knowledge on the study area. These include the quality control practices, the challenges facing quality control management, the influence of quality managers on quality management and the essential factors for efficient quality control management towards developing a framework for quality control management of building construction projects.

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2.2 BUILDING COLLAPSES TREND IN LAGOS NIGERIA

The primary purpose of constructing a building is to provide shelter, but currently, especially in Lagos, Nigeria, buildings have become a medium by which lives are lost. This is due to continued collapse and failure experienced during building construction and after construction. Imafidon and Ogbu (2020) argued that the cause of these failures arises from the design and construction, policy and quality management.

Scholars have carried out many studies to trace the collapse incidence in Lagos, Nigeria. A report by Ndubisi (2019) revealed that between 2007 and 2013, 135 cases occurred in Lagos, of which 50 incidents happened during the construction phase. Between 2013 and 2019, the total number of buildings that collapsed was 41, with 439 deaths recorded, 302 injured, and 106 individuals rescued (Ede et al., 2021). The result also revealed that Lagos Island has the highest rate of building collapse because of outdated and poorly maintained structures. According to Gbonegun and Olorunlomeru (2021), over 461 buildings collapsed in Nigeria between 1974 and July 2021, resulting in over 1,090 fatalities and numerous injuries. Of these cases, Lagos registered roughly 295 incidents across all states. The study by Okunola (2022) also affirmed that in 2019, Lagos had the highest number of building collapses, with 17 cases.

Therefore, from the trends of building collapse in Lagos, it can be concluded that building collapse has become a norm. Hence, the need for effective monitoring and control for better project performance in the state and Nigeria at large.

2.3 QUALITY MANAGEMENT CONCEPT

2.3.1 Definition of Quality

The description of quality varies from one person to another. According to the dictionary, quality is referred to as a "general standard of excellence." The International Standard Organisation (ISO) defines quality as a product or service's full features and properties that affect how well it can meet the stipulated needs (ISO, 2000). Similarly, the American Society for Quality defines quality as the full features and attributes of a product or service made according to the required standard to please customers both during use and at the point of purchase (ASQ, 2022). The meaning of

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quality, as defined by quality gurus, is presented in Table 2.1 below. Crosby (1982) described quality as conformance to product requirements. That is, evaluating a product's quality will be based on its conformance to the specified requirements. Joseph and Joseph (2010) stated that a product produced under no condition should be fit for its purpose as defined by the customer. This definition agrees with Feigenbaum's definition of quality: quality is all about meeting the use for which the customer intends to use the product.

Table 2. 1 A summary of quality definitions

Author	Quality definition
Joseph and Joseph (2010)	Fitness for use
Crosby (1982)	Product conformance to requirements
Feigenbaum (1983)	Meeting the expectations of customers

2.3.2 Quality Management

According to Tang et al. (2005), quality management is referred to as all functions of general management, particularly top management leadership, that set quality policy objectives and obligations for all members of the organisation. Quality management entails the operational activities and set of functions carried out by an organisation's management and staff to ensure that the product produced complies with quality (Romanova, 2016). Total quality management (TQM) is an organisation's tradition of focusing on customer satisfaction by embracing continuous improvement (Priya et al., 2017). TQM method focuses on quality and relies on member participation to achieve long-term success through benefits to all organisation and society members.

The quality management process involves Quality Planning (QP), Quality Assurance (QA) and Quality Control (QC) (Abdullahi et al., 2019).

1. **Quality Planning:** This is carried out at the early stage of production (Liepiņa et al., 2014). Quality planning involves specifying the requirement and standards to be met, the steps,

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and the related resources required to achieve such specified standards. Planning should also incorporate provisions for evaluating project quality performance and must be specific and measurable (Juran et al., 2005). Effective quality planning demands an organisation to plan for the construction work and resources through the provision of the work program, project quality plan, cost program, material, labour and plant schedule, construction method statement, and inspection and test plans (Mane and Patil, 2015).

2. **Quality Assurance:** This covers all the scheduled and systematic activities required to give enough certainty that a structure, system, or component will adhere to the project's specifications and perform as intended (Tang et al., 2005). Quality assurance is maintained from project conception and provides the basis for quality control planning and implementation (O'Brien, 2013). Quality assurance actions and plans are essential for an effective QC system as it outlines what is to be performed by the quality control system in an orderly and timely manner.
3. **Quality Control:** This is referred to as a set of specific procedures which include coordinating, developing, checking, reviewing, and scheduling the work involved in the quality assurance process (Arditi and Gunaydin, 1997). It is also a process by which all factors involved in production are checked and reviewed for compliance.

Quality assurance (QA) and quality control (QC) are interrelated but are different in function. QA is the planned actions and processes required to achieve the desired quality. A QA system specifies the expected quality that an organisation's product should meet, while QC seeks to implement QA plans. Quality control is essential for those involved in production for operations regulations, while QA is essential to those who need to know and be assured about the state of production (Joseph and Joseph, 2010).

2.3.3 The History of Quality Control

Quality control is not a recent invention, monitoring the production of goods and services has been a culture from the olden days. Up to the nineteenth century, quality was controlled by the persons or small groups responsible for product production, known as an operator control. From 1900 to 1920, foremen and supervisors were responsible for quality control in their domain (Bowman et al., 1991). A foreman is a trained worker usually in control of the workers responsible

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to produce a particular operation or section of work. Between 1920 and 1940, inspectors were assigned to inspect work proceeds periodically, compare the work with the set standards, and identify non-conformances for correction. This was due to the higher production rate, the complexity of work and the increase in the number of these supervisors.

In 1924, a quality control chart to monitor the process against the specified control limit was developed by Walter Shewhart, a father of statistical quality control when it was observed that 100% supervision is inevitable (Peters, 1987). The adoption of statistical QC came into existence and was gradually accepted in England and the United States. In 1946, the American Society for quality control was founded, a body comprising quality experts to ensure quality, now known as the American Society for Quality. By 1950, statistical quality control had become accepted in Japan. W. Edwards Deming and J.M Juran, the quality control gurus who visited Japan brought about awareness in Japan. W. Edwards Deming informed them about the importance of statistical QC, and J.M Juran emphasized top management's role in quality implementation. They embraced this, and Japan began to have an edge over other countries in terms of quality (Mitra, 2016). Consequently, the notion of managers' involvement based on measurements began and was implemented in the united states between the 1942-1945 war efforts (Bowman et al., 1991).

The transition in quality has shifted to total quality management, yet quality control is still an essential requirement in the quality improvement process.

2.4 QUALITY CONTROL IN CONSTRUCTION PROJECTS

Quality control is a management practice used in building operations to achieve the appropriate level of performance and cost (Salvi and Kerkar, 2020). Besides monitoring, quality control entails identifying and correcting the root causes of quality issues to meet client needs. According to Liepiņa et al. (2014), QC is a systematic process in which the errors identified give information about the product, the process of production and the necessity for improvement. The contractor executes the work in the construction industry and is also responsible for quality control. Quality control seeks to ensure that projects are completed per specifications, complaints from customers are minimised, customer confidence is assured, the quality of work produced is improved and project costs are reduced (Odiba, 2018).

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Quality control is necessary at every stage of a project's life cycle, the design, building, upkeep, and operating phases. Among the primary control elements are evaluations of soil properties, drawings and designs, structural safety and durability, quality of materials, quality of workmanship, specifications, material tests and equipment inspection.

1. Planning and design stage

This is the construction stage where all the professional hands are on the desk to evaluate the technical option available for the project feasibility and the time to prepare their inputs. The inputs include architectural drawings, structural designs, and mechanical and electrical designs. The quality control of the designs involves checking the designs for errors and omissions to ensure that the design meets the required standards. In addition, these designs' buildability and constructability analyses are carried out to prevent clashes. However, some modern tools, such as BIM, a collaborative tool, are being adopted to cross-check design and detect discrepancies in real time. Similarly, all tender and contract documents are checked for quality and the company's ability to achieve quality work is appraised.

2. Construction stage

Quality control in the construction phase of a project ensures that all specifications, as stated in the designs, are being complied with and that the appropriate material, human resources, tools and machines are used during the construction process. Quality control in construction involves the control of all the factors involved in the construction process to eliminate non-conformances and errors. These factors include material, humans, plants and equipment, working methods and the environment.

3. Maintenance and operation stage

Quality control of the post-construction phase of a project ensures that the structure serves the purpose for which it was constructed without causing any harm to the user. The usage must comply with the design purpose and be continually inspected for maintenance to retain the structure state and functionality. Thus, ensuring the user's comfort and safety.

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Figure 2.1 illustrates the quality control chart showing the characteristics of a well-planned quality control program in the construction industry: a) a quality standard developed from a current database created through feedback gotten from previous projects, b) quality management implemented in all the construction phases through the project management delivery system, c) Early identification and correction of defects through the quality management of the phases d) Feedback report to eliminate repetition of the identified defects (Arditi and Gunaydin, 1997)

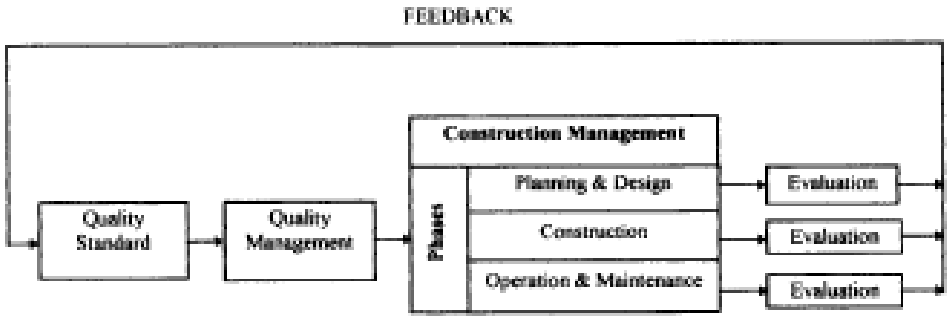

Figure 2. 1 Total quality control chart

Source: (Arditi and Gunaydin, 1997)

2.4.1 Quality Specifications and Standards

The necessity of quality structures in society has raised the need for improvements in construction standards, and the effective way to achieve this is through collaborative and dedicative effort by all stakeholders in the industry using the appropriate regulations as the key guide and document for quality management (Fadason et al., 2017). Specifications are part of the contract documents, which consist of a series of written requirements for materials, equipment, construction systems, standards, and workmanship, usually prepared in a standard format (Sultan Al Aryani, 2011). Specification and standards are the legal and enforceable written language of a contract that serves as a baseline for construction work. Nigeria has established standards and codes governing construction projects in terms of design, materials, and testing. Unclear specifications and work methods result in errors and mistakes, which contribute to poor-quality production. These errors and mistakes result in project delays and an increased cost of production. Therefore, for QC to be

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effective, the specifications for construction work must be well-stated so that there will be a proper understanding of what to be done by the project participants.

Furthermore, various standards exist to regulate construction quality management in practice. These standards vary from country to country, but the core of the standards remains the same. Most countries establish technical standards and requirements, which provide detailed descriptions of the minimum standards a product or material must meet to ensure consumers' health, safety and environmental protection.

To assure quality, safety, and competence in the Nigerian building industry, the federal government of Nigeria enacted the National Building Code, which defined minimum criteria for building pre-design, design, construction, and post-construction phases. This code was created as a response to the current state of Nigerian cities and the environment, which includes the following: poor planning of towns and cities, ongoing building collapses, a lack of referenced design standards for professionals, the use of non-professionals and quacks, the use of untested products and materials and poor maintenance practices (Code, 2006). Emeka (2020b) studied the level of knowledge of government regulatory regulations on quality assurance of construction projects in the southeastern states of Nigeria. The findings showed that the level of knowledge is extremely high. The study concluded that the solution to executing quality building projects is by creating more awareness levels on government regulatory policy.

Adenuga (2012) studied the compliance of quality standards in the construction of infrastructural services in Lagos state, Nigeria. The result revealed that contractors and their organisations failed to apply quality control methods during project execution and only 12.8% of the respondents had their organisation complied with their quality standards. They concluded that the level of compliance of contractors and their organisations to quality standards significantly affects the performance of infrastructural services. They further suggest that there should be a constant evaluation of contractors and their organisations by professional bodies and government agencies to determine their level of compliance. Also, organisations should be ranked based on their level of compliance with quality standards. Neyestani and Juanzon (2017) explored the effect of the ISO 9001 standard on the quality cost of projects in the Philippines-certified ISO 9001 large construction companies. The result revealed that ISO 9001 increases the quality control costs,

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prevention and appraisal costs at a 1% significance level while ISO 9001 decreases failure costs at 5% significance level. The study further concludes that ISO 9001 is an essential quality management tool that should be employed by construction firms as it will help to reduce project expenses and quality costs.

Some of the standards used to drive quality in construction include the following:

1. American Society for Testing and Materials (ASTM) standards: These are widely used standards created for testing and materials to ensure quality in different industries in which the construction industry is not an exemption. These include standard specifications, the practice guide and standard testing methods for construction materials.
2. BS standards: A British standard popularly used for practice guides in engineering works.
3. ISO standards: These are established by national standards bodies which provide a series of standards that deal with product design, production, delivery, service and testing. The series include ISO 9000, 9001, 9002, 9003 and 9004. These standards are directed toward improving a firm's production processes (Arditi and Gunaydin, 1997).

2.4.2 Quality Control of Materials and Components

Building materials are either naturally occurring or manufactured. Materials commonly used in construction include concrete, aggregate, cement, steel, tiles and bricks. The adequate inspection of these material properties is essential for achieving a durable and high-quality structure (Savitha, 2012).

Quality control of raw materials, finished product, semi-finished product and components on-site, ensures that materials supplied conform to the specified specification through testing. All materials to be used in the construction process are tested and approved by the client's contractor or quality engineer representative to ascertain the quality. Any deviation or change in the specified quality and specification is reported and eliminated. A sample from the materials is tested, which serves as a representative of the material.

The main contents of quality control of materials are material procurement, material testing, storage and usage (Wei, 2012).

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1. Material procurement: Control of material procurement requires checking the quality of the supplied material and other elements to be included in the works. If the criterion is not met, they should be rejected and replaced even though supplied by the employer.

2. Material testing: Quality standards and quality control testing criteria are specified in the construction contract, and the QC testing facility must be confirmed by the authorised source (institutions, consultants, competent testing house /firm). Materials test is carried out to verify the compliance of materials with project specifications. The contractor will select representative samples of the substances referred to as the indicated source substances and take them to the laboratory for testing. Following that, the testing laboratory reports all test results to determine whether the substance meets the acceptance standards (Lakshmi, 2015). Examples are field tests on cement, brick, sand, aggregate, reinforcement, plaster strength and concrete strength tests (Siddiqui, 2016). Also, random samples and statistical methods are frequently used as the basis for accepting or rejecting completed work. The rejection of a batch is based on non-conformance with the relevant design specification (Amani, 2017).

3. Storage and usage: Materials must be preserved from any type of deterioration by being stored in a condition that is suitable for their various qualities. The materials must also be labelled with the manufacturer's name, batch number of storage, the position where it will be utilised, delivery date, model, certificate number, test report number, and buyer and keeper information (Wei, 2012).

2.4.3 Quality Control of Workmanship

The workforce is a critical factor in achieving quality in production. Quality control of workmanship involves managing an organisation's total quality as well as each individual's knowledge, skill, physical and mental health, quality perception, conduct, and understanding of organisational regulation and professional and ethical standards (Wai and Cho, 2013). That is, construction QC management ensures that competent workers conduct work in terms of education, training, skills, and experience. QC management of workers further includes employee training

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about the job and work standards, workers supervision, the establishment of employee motivation programs such as zero defect, participation in quality control and awards for outstanding workers.

2.4.4 Quality Control of Plants and Equipment

Construction advancements have increased the use of plants and equipment to make work faster and easier and achieve a uniform and controlled quality. However, the state of the machines affects the quality of work executed. For adequate functioning of the machines, periodical testing programs for machinery must be conducted, accurate calibration of devices inspection and testing of systems before use and the use of the right tool or equipment for the right job.

2.4.5 Quality Control of the Construction Process

The control of the construction process covers the control of all factors required in the process of production. This includes a) the control of materials, b) control of work sequence or construction methods, c) inspection of the work process, d) identification, documentation and correction of non-conformances, e) use of competent workers with provision for training and motivations, f) test and maintenance of plants and equipment, g) quality information such as inspection reports, production reports and waste reports.

2.4.6 Quality Control of Construction Environment

Safety and productivity are interrelated. Safety measures implemented in construction project affects productivity. QC of the working environment involves setting the site layout of materials, components, store, site office, road and all other preliminaries needed on site to ensure the safe and smooth running of the construction process. Quality control ensures that all health and safety measures and tools are provided on-site to prevent accidents.

2.5 QUALITY CONTROL PRACTICES ON BUILDING CONSTRUCTION PROJECTS

QC practices are how an organisation plans, organises and implements quality control of works. It can also be referred to as an organisation's culture in achieving effective quality control of work to meet customer requirements. The QC process includes adequate planning, training, giving clear decisions and instructions, regular supervision, reviewing finished operations right away for

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accuracy and completeness, and documenting all assumptions, recommendations, and conclusions (Salvi and Kerkar, 2020, Bustani, 2014).

Studies have been carried out on the strategies adopted by organisations in controlling work for better productivity and performance. A study by Oludare and Olugboyega (2016) on quality management practices in Lagos revealed that supervision of workers, client checklists, job site quality plans, skill enhancement and training is a common quality practice on construction sites in Lagos state while proper procurement system and the use of ISO 9000:2015 standards are rare. Additionally, Oludare and Olugboyega (2016) propose that construction sites should adhere to the following: a specialised subcontractor system, appropriate material storage, a specially developed system, and third-party certification.

Nyakala, Pretorius, and Vermeulen (2019) identified eight quality assurance practices that can minimise the causes of poor performance of projects executed by construction SMEs in Nigeria. These include employee involvement, project management and control methods, project construction design, organisational structures, quality standards and measurements, financial management, process implementation and process improvement. Shah et al. (2012), Bustani and Oyemogum (2014) suggest that a well-experienced professional, both the contractor and the consultant staff and semi-skilled labourers should be trained on concreting work, should be provided to ensure quality control of concrete and that a manual on concrete production should be separately prepared and used as a guide for concrete work on construction sites.

2.5.1 Quality Control Plan

A QC plan is a document prepared by an organisation that states the way the quality control procedures will be achieved right from project inception through to the post-construction stage. QC plan helps define what to do, who will do it, how to do it and when to do it. According to Salvi and Kerkar (2020), the QC plan of a project comprises information on the planned techniques to be used in accomplishing quality control for all work products, including organisation, quality assurance records, quality control reviews, the suggested method of documentation of comments and coordinating answers. Sanni and Windapo (2008) argued that the availability of a QC plan on

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construction sites does not guarantee the delivery of a high-quality project by contractors but rather quality control plan implementation.

2.5.2 Quality Control Training

This is a process of ensuring the control officers, the control department and all the project participants are aware of the basic requirements to achieve quality and have a proper understanding of the quality control system and the operation of the field laboratories. The implementation of quality control training is to update workers' knowledge, including the management, on the work standards and specifications, testing methods and frequency, and tests acceptance criteria. Effective quality control management recognises the need for training for all tasks and activities that may have an impact on quality. QC training can be carried out through regular workshops, job training discussions, third-party trainers, Online/eLearning sites, and exchange activities of quality assurance for adequate knowledge on quality control management and staff quality consciousness.

2.5.3 Quality Control Tools

According to Abdullahi et al. (2019), the primary quality control methods involve statistical quality control and inspection. They include Pareto charts, cause-effect diagrams, flow charts, check sheets, histograms, control charts and scatter diagrams. According to Adinyira et al. (2014), quality tools are beneficial for increasing productivity, preventing errors effectively, and providing information about the process's capacity to satisfy customers.

Stojcetovic et al. (2013) studied the major quality tools which can be used in a project. The study classified the tools used in project management into four categories: tools for collecting and understanding (check sheets, graphs, histograms, Pareto charts, scatter diagrams), tools for understanding processes (run charts and control charts), tools for analyzing processes (cause and effect diagrams) and tools for solving problems (brainstorming, and force field analysis). Mane and Patil (2015) investigated the quality management system in construction projects. The result revealed that the most quality control used is a checklist, while the quality control measure used on site is the quality of workmanship.

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Adinyira et al. (2014) explored the major quality control tools precast concrete producers use in Ghana. The study revealed that flow charts, check sheets, and histograms are the most used tools by these organisations. They concluded that quality control tools are not effectively used by the producers of precast concrete products in Ghana.

Aichouni (2012) also opined that by using basic quality tools, and Statistical Process Control (SPC) tools, such as control charts, construction organisations can monitor, control and improve their processes to achieve breakthrough improvements and business results. These quality control tools are described below.

1. Cause and effect diagram: A tool that shows the relationship between a result and its possible causes.
2. Pareto chart: A tool that groups things according to how much they contribute, allowing the user to see which few things have the maximum impact.
3. Histogram: These are bar charts showing the distribution pattern of observations grouped in convenient class intervals and arranged in order of magnitude. Histograms are useful in studying patterns of distribution and in concluding the process based on the pattern.
4. Scatter diagram: A tool used to study the relationship between two variables. It consists of plotting a series of points representing several observations on a graph in which one variable is on the X-axis, and the other variable is on the Y-axis.
5. Control chart: A control chart makes possible the diagnosis and correction of many production troubles and brings substantial improvements in the quality of the products and reduction of spoilage and rework. It tells us when to leave a process alone as well as when to take action to correct the error.
6. Flow charts: These are graphical representations of the sequential steps of a process. The ability to diagnose and address a variety of production issues with a flowchart enables significant enhancements to product quality and waste reduction (Aichouni, 2012).
7. Check sheets: These are used to measure faults by type, location, and cause, assess the form of a process probability distribution, and keep track of the completion of phases in a multistep method (Magar and Shinde, 2014). Some examples of check sheets are daily maintenance check sheets, attendance records and production logbooks.

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2.5.4 Applications of Digital/Automation Quality Control Tools and Techniques on Building Construction Projects

The quality control procedures and processes now used on construction sites are time-consuming and inadequate because they only give data for certain times and locations to reflect the work in progress. This restricts the quality manager's ability to quickly identify and handle faults (Wang et al., 2015). An accurate, comprehensive, and regular assessment of the as-built conditions at construction sites is necessary for an effective quality control management system. It also calls for the identification of critical patio-temporal and material quality-related deviations of work in place and the determination of whether these deviations qualify as defects during a construction project (Akinci et al., 2006).

To quickly spot flaws on construction sites, researchers have begun to investigate the use of technology devices for quality control and inspection on construction sites. Romero, D.et al. (2019) declare that automation of QA and QC practices will promote better quality improvement, save time and enable higher quality, cheaper costs, shorter lead times, and support industries in operating successfully and thriving in fiercely competitive conditions. Hence, the need for the incorporation of advanced computing technologies in addressing quality issues.

Gordon and Akinci (2005) investigated the application of Laser Detection and Ranging (LADAR) and embedded sensing technologies to support inspection and quality control processes on construction sites. Results from the use of the technologies on the case study sites indicated that the technologies demonstrated a wide range of speed and power for data collecting, demonstrating their value for effective quality management. Arora and Ogra (2012) compared the traditional methods of quality surveys and mobile Geographical Information System (GIS) applications. The findings revealed that GIS application by quality managers and surveyors helped to eliminate paperwork, facilitates the storing and analysis of quality information, saves time and money on information collection and processing, and coordinates project management systems efficiently.

The study by Lou et al. (2017) revealed that BIM makes quality inspection data and documents available electronically, reduces the time required for inspection and completion, and guarantees comparative analysis of high-quality data and effective quality control. Also, the experimental

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survey by Wang (2008) proposed the use of Radio Frequency Identification (RFID) revealed accurate and real-time monitoring of the progress and quality inspection of the concrete specimens in the testing laboratory. In addition, Dudgikar et al. (2012) developed enterprise resource planning software for the application of quality control on building projects based on construction resources - 5M's (material, man, machine and equipment, money and methods). The module was developed to aid quality control of a building and as well communicate and document quality parameters.

2.5.5 Quality Control Inspections

To achieve quality control, inspection is carried out throughout the stages of work on-site to identify defects in each item of work and to provide possible corrections (Siddiqui, 2016). Inspection is the process of examining raw materials or finished goods at various stages of production or development. It is carried out following a few predetermined parameters and seeks to identify whether the object is defective (Priyadharsan and Raja, 2020). Creating and overseeing the activities within the quality assurance program during the construction phase are the responsibility of either the designer or the construction management organisation in charge based on the type of contract (Arditi and Gunaydin, 1997). Inspections can be carried out at any level and involve tasks like measuring, evaluating, and testing to see if the outcomes meet the standards. The acceptance or rejection of items inspected is based on the item's conformance to required standards and specifications.

In summary, table 2.2 below itemized the quality control practices on building construction projects.

Table 2. 2 A summary of quality control practices on building construction projects

CODE	Quality control practices (QCP)
QCP 1	Inspection and testing of executed works
QCP3	Construction process adopted
QCP2	Material selection and usage
QCP17	Quality control of material
QCP5	Use of checklist
QCP11	Quality of workmanship in all construction activities

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CODE	Quality control practices (QCP)
QCP4	Use of code of conduct
QCP6	Report of non-conformity of quality standards
QCP16	The practice of sound housekeeping
QCP14	Observation of regular schedule
QCP8	Evaluation and correction of deviations in quality
QCP10	Quality control plan
QCP5	Record of changes
QCP9	Coordination with the project purchase department
QCP13	Maintaining the sequence of construction
QCP18	Quality control training
QCP 15	Keeping spare parts/materials for laboratory equipment
QCP12	Quality Control Laboratory at the construction site

Sources: (Salvi and Kerkar, 2020), (Bustani, 2014), (Oludare and Olugboyega, 2016), (Nyakala et al., 2019), (Shah et al., 2012), (Lawrence et al., 2021), (Baguma, 2021) and (Sanni and Windapo, 2008).

2.6 CHALLENGES FACING QUALITY CONTROL MANAGEMENT OF BUILDING CONSTRUCTION PROJECT

Quality control is a compulsory process due to contract obligations that contractors employ to make sure their completed work adheres to the standards and needs of the designers and other project stakeholders (Ellis, 2010). However, achieving this has been a challenge in the construction industry in Lagos, Nigeria.

Reviewing the literature on factors affecting effective quality control management, Lawrence et al. (2021) identified that inadequate funds, high cost of testing materials, delay in the delivery of materials, and stakeholder influence are the challenges that majorly influence quality control in construction projects. Arowolo et al. (2019) propose that the greediness of contractors, corruption, insufficient regulatory framework, quackery, lack of punishment for violators and inadequate fiscal allocation as the most critical challenges. The study additionally recommends the following: having authorized agencies enforce quality control, holding building designers, contractors,

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consultants, and approving agencies accountable for flaws and violations of building regulations on construction projects, emphasizing training and retraining of professionals and artisans in the construction industries, and providing sufficient financial resources to support more reputable testing laboratories. Getu and Quezon (2021) established that supervisors' lack of knowledge and experience, poor quality of design, Project location, the impact of weather conditions, a lack of appropriate decision-making, equipment and material costs, and scarcity of construction materials supply are the most factors that affect supervision of construction project.

The study by Kimeria et al. (2019) on the effect of project management practices on quality control of building construction revealed that regulatory framework, project planning and competency of the project team affect construction quality control. They concluded that a project team with appropriate skills is more likely to ensure project success through the application of effective quality control, which will ultimately minimise or avoid flaws and the ensuing collapse of structures. Osegbo et al. (2021) found that lack of standard quality management system implementation, lack of project meetings with clients, unmotivated workers, lack of quality departments, and lack of material test impact quality management. Bustani (2014) opines that the main elements affecting the control of the building construction process are workmanship, testing of work and measurement, education and training, and employee management and relationship.

The study by Shammas-Toma et al. (1998) on 25 construction projects where QA and several procedures were in place. The study found that poor communication and coordination between the parties to the project was an obstacle. Table 2.3 presents the challenges facing QC management on building construction projects as identified from the reviewed literature.

Table 2. 3 A summary of quality control management challenges in building construction projects

CODES	Variables
CHA1	Inadequate funds/budgetary allocation
CHA2	High cost of testing materials
CHA3	Delay in delivering materials
CHA4	Poor conduct of review meeting
CHA5	No good stores on the site

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CODES	Variables
CHA6	Lack of training/education of construction workers
CHA7	Poor site safety measures
CHA8	Inadequate on-time supervision
CHA9	Lack of quality control inspection program
CHA10	Insufficient quality control plan
CHA11	Unrealistic project time
CHA12	Bribery and corruption
CHA13	Lack of effective quality policy implementation
CHA14	Inadequate technical knowledge
CHA15	Poor communication among the design and construction team
CHA16	Cost of correcting non-conformance by the contractor
CHA17	Non-provision for documentation of non-conformance
CHA18	Inclement weather conditions
CHA19	Supervisors lack of skills and experience
CHA20	Faulty equipment for testing
CHA21	The high cost of materials and equipment
CHA22	The high number of a semiskilled and untrained labor
CHA23	Poor understanding and coordination between stakeholders
CHA24	Lack of supplier evaluation
CHA25	Lack of modern information system
CHA26	Poor laboratory for material testing

Sources: (Bustani and Oyemogum, 2014, Lawrence et al., 2021, Ellis, 2010, Osegbo et al., 2021, Getu and Quezon, 2021, Arowolo et al., 2019, Kimeria et al., 2019)

2.7 THE INFLUENCE OF QUALITY CONTROL MANAGER ON QUALITY CONTROL MANAGEMENT OF BUILDING CONSTRUCTION PROJECT

Construction quality control comprises routine inspections of the facilities and work areas to ensure that they adhere to the contract's requirements for uniformity. QC is carried out by a team of QC engineers or teams with specialised training. Many construction companies have a quality control department or, at the very least, a quality control officer who directs quality control. The primary goal is to inspect the items before they are delivered to the client so that any that do not adhere to the requirements and specifications are eliminated or fixed (Oyedele, 2018). Also,

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because of the complexity of construction work, most firms employ quality personnel to oversee the works on site and to ensure strict compliance with project specifications and standards.

Abdullahi et al. (2019) opine that contracting companies must establish quality departments that will plan, control, and monitor quality both on and off-site if any reasonable quality improvements reflect in the Nigerian construction industry. The QC manager supervises all on-site field inspection and material quality control testing adherence to the required quality standards and specifications. However, there is a need to investigate the roles of quality control managers and the competency needs required by them in quality issues faced by the Nigerian construction industry.

2.7.1 Roles of Quality Control Managers on Construction Projects

The group of quality control inspectors establishes the appropriate standards and practices for quality control. Additionally, they examine the goods to make sure the quality requirements are met and update the procedure that needs revision. The findings of Gremyr et al. (2021) on Swedish quality managers identified four specific roles of the quality department firefighters, orchestrators, auditors and process improvers. Similarly, Elg et al. (2011) argued that the quality department's duty is seen as organising improvement efforts, providing support, and serving as a resource for information on particular tools. However, it also encompasses more practical duties like enhancing product quality and speaking for the interests of the consumer within the company. The best practice for quality managers entails connecting the notion of quality improvements to the company strategy (Palmer, 2006).

QC roles are itemised below:

1. A thorough awareness of customer needs and communication with them to implement quality control procedures.
2. Monitoring of technicians and other workers to ensure that allocated tasks are carried outaccording to quality standards.
3. Supervises the product creation process to spot non-conformances and qualitypolicies violation.
4. The setting of quality criteria for workers' safety during the operational process.

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5. Creating and monitoring the requirements for raw materials from the suppliers and their qualitycompliance.
6. Keeping proper records and conducting statistical analysis.
7. Engaging in meetings, getting client feedback, submitting documented reports, and helping external quality auditors.
8. Reviewing the final product, comparing it with the initial requirements, and rejecting or approving the final product complying with quality standards.
9. Creation of production improvement techniques to guarantee high-quality products.
10. Devise techniques for maximizing resources and minimising waste during the production phase.
11. Ensure compliance with production standards.

(Gremyr et al. 2021) and (Rojas, 2013)

2.7.2 Competency of Quality Control Managers on Construction Projects

Construction projects' complexity, clients' dynamic nature and the growing need for better and more effective project delivery have put construction managers under pressure, thereby causing a lot of management challenges that needed a greater level of management acumen, abilities, skills, and strategies to overcome (Okoye et al., 2015). Competence is the set of demonstrable traits and skills that enhance a job's effectiveness and performance. It includes all the related knowledge, skills, abilities, and attributes that form a person's job. According to Arditi et al. (2013), knowledge, skills, cognitive patterns, attitudes, social roles, and elements of self-esteem or self-efficacy are some of these performance factors.

Several researchers have looked at the competencies of some professionals in the construction industry, but few explored the competency of quality control managers. The study by Matranga (2021) identified 11 essential skills that any member of a quality team should possess: understanding variations by measurement devices, the efficient use of data analysis tools**,** problem-solving, analytical and research skills, effective communication with other suppliers and other departments**,** leadership**,** the desire to learn new methods and techniques, ability to multitask, teamwork, good interpersonal skills, sound judgment and decision making**.**

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Lee et al. (2011) established a competency model for a construction firm's project team and project control team. The following qualities were identified as necessary for the project execution construction team: decision-making, professionalism, delegating roles and responsibilities, working cooperatively with other organisations, practical application ability, construction experience, quality safety and environment management, cost management, process management, record management, public complaint management, and persuasion skill. While reasoning, morality, cooperation with other organisations, construction experience, planning skills, cost control, contract management, and negotiation skills were the competencies developed for carrying out project control team affairs services. Among these competencies, logical reasoning, morality, interpersonal skills, planning prowess, and cost management necessitated a high level of expertise.

A study by Rojas (2013) identified 12 key competencies required of field supervisors and project managers for successful supervision: humility, character, leadership, consistency, commitment, curiosity, communication skills, people skills, effectiveness, knowledge, experience, and willingness. This competence was classified into four categories: managerial competence, conceptual competence, competence-in use and contextual competence.

Figure 2.2 displays a house of competency containing the characteristics that should define a model quality manager.

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Figure 2. 2 Quality Manager's house of competency

Source: (Ingason and Jónsdóttir, 2017)

2.8 SUCCESS CRITICAL FACTORS FOR EFFECTIVE QUALITY CONTROL MANAGEMENT

Dealing with issues relating to construction quality management and compliance with standards at various levels is one of the components of successful project management (Arora and Ogra, 2012). Oke et al. (2017) concluded that the factors for improving performance quality are the use of a highly experienced technical team, the use of adequate construction methodology, appropriate material procurement, timely supply of materials, and frequent progress meeting.

Bustani (2014) suggests that a crucial step in achieving the intended quality control objectives is by employing a qualified registered professional to oversee the quality control procedures for construction projects. They also suggest training construction staff on appropriate quality control methods that should be employed throughout the building production process. The study by Adinyira et al. (2014) recommends that a clear policy regarding quality control, frequent inspections and audits, regular meetings between key stakeholders, workers training and education, especially the lead on the use of the seven basic quality control tools, will improve quality control in the industry. Also, Aichouni (2012) concluded that critical success factors for construction industry organisations to keep operating and achieve customer satisfaction and

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organisational excellence include systematic implementation of the quality tools in production processes, planned and documented procedures for training employees from senior management to technical staff, and a strong commitment from leadership to continuous improvement.

Nyakala et al. (2019) examined the influence of fifteen quality assurance factors when applied in the road small and medium-sized road construction projects. The study result showed that the appointment of consultants to supervise and evaluate construction quality control of work was rated the most influential quality assurance practice within road SMEs. Tengan and Aigbavboa (2021) found that stakeholder participation, fiscal allocation, leadership, communication, and monitoring and evaluation information systems are required for effective monitoring and evaluation. A study carried out by Khan et al. (2008) on the QA and QC of the Taunsa Barrage project in Pakistan revealed that the QC was implemented through project assurance requirements, monitoring and inspection, measuring testing equipment, tests and testing results, non-conformance reports and actions, quality records, and internal quality audits.

Stephens (1979) suggests the following factors for implementing effective QC at national levels: the development of a QC program, the establishment of an integrated way of standardisation, the establishment of a national certification program for the certification of products produced by companies, the establishment of training programs covering QC methodology and QC management, QC promotion through awareness and by educating people, client and workers on the need to involve in quality movement in a country.

Oludare and Olugboyega (2016) argued that the expertise of project managers affects the quality of projects. When inexperienced supervisors who lack quality control knowledge supervise workers on a project, the project may be of poor quality. In addition, Lawrence et al. (2021) revealed that appropriate procurement procedures, third-party certification, material testing, and the presence of a quality assurance team are required to ensure the integrity of building construction projects.

Below are the critical success factors for effective quality control management of building projects.

1. The strong commitment of leadership to quality control.
2. Well-defined policies and objectives by the senior management for efficient use of resources.

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3. Customer focus.
4. Monitoring and evaluation of construction quality control by government agencies.
5. Monitoring and evaluation of construction quality by a third-party consultancy.
6. Education and training.
7. Employees employed with the necessary skills.
8. Adequate quality control planning.
9. Testing and measurement of work done.
10. Quality control cost.
11. Quality teamwork.
12. Availability of funds.
13. Quality documentation.
14. Continuous quality improvement.

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CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter discusses the method deployed in solving the research problems. The research approach design, study area, sampling, and data collection methods were addressed. The technique used for data analysis, as well as the ethical consideration and limitations of the study, were also defined in this section.

3.2 STUDY RATIONALE

The construction industry has been faced with quality issues in terms of project performance, especially in Nigeria. The rate at which buildings collapse in Lagos is alarming and has caused concern in the industry for effective quality control. On this note, this study proposed a quality control framework for effective quality control management on building construction projects in Lagos. The study investigated the current quality control practices, the challenges, roles, and competencies of quality control managers, and the critical success factors required for quality control management to be effective. Therefore, the findings from this study contribute to the body of knowledge on quality control management of construction projects and are likewise essential to the construction industry for better project performance in terms of quality.

3.3 RESEARCH DESIGN AND APPROACH

The quantitative research approach was adopted for this research as it permits the collection of information from many respondents and allows the accuracy of the result. Aside from this, it is suitable for research studies that involve making depth inquiries about a phenomenon and generalisation of results (Adedoyin, 2020). This is the objective of this study: to investigate the quality control practices, challenges, and success factors for effective QC management of construction projects in Lagos. Hence, the development of a framework for effective quality control management. Data collection for this study was through a structured questionnaire. This was considered the most appropriate tool to reach the survey population within a limited time and

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from a distance.

3.4 THE AREA OF STUDY

The research was conducted among construction professionals in registered small, medium and large-size construction firms in Lagos, Nigeria. Lagos is known to be the financial centre andthe economic hub of Nigeria. It is in the southwest part of Nigeria. Lagos is one of the world's fastest-growing cities, with a population of over 10 million. The remarkable population growth resulted in an ever-increasing demand for houses and business premises, which made the city attract numerous construction activities toward infrastructural development. However, the rate at which building collapses during and after construction in Lagos is now alarming. A report on building collapse and failure statistics by Gbonegun and Olorunlomeru (2021) revealed that over four hundred and sixty-one buildings have collapsed in Nigeria, of which Lagos recorded about 295. This scenario has raised much concern as regards the safety of people and property in the state and the country. On this note, this study has chosen Lagos as the area of the study to investigate the quality control practices on building construction projects in Lagos, Nigeria, identify the challenges, and provide factors for effective quality control management for better quality performance of the construction industry.

Figure 3. 1 Map of Lagos

Source: Oyebode (2013)

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3.5 TARGETED POPULATION

The first step in determining a sample is to identify the targeted population (Symeou and Lamprianou, 2008). The target population for the questionnaire distribution in this study is the building construction project professionals within small to large, registered construction firms in Lagos, Nigeria. They include architects, builders, quantity surveyors, engineers, and project manager working as site managers, project managers, managing directors, QA/QC managers, works inspectors and facility managers in their respective firms. The population is chosen to obtain diverse views on QC management within construction firms in Lagos, Nigeria.

3.6 SAMPLING TECHNIQUE

A sample is a smaller portion of the research selected by the researcher from the entire study population being investigated (Symeou and Lamprianou, 2008), while the selection of some individuals to represent the large group from which they were selected is referred to as sampling. The sampling technique is of two types: probability and non-probability. Probability sampling involves a random process of selection. In contrast, the non-probability method is based on the investigator's decision which might involve sampling biases (Acharya et al., 2013). In this study, a probability sampling method was used as it gives individual elements in the targeted population an even chance and a non-zero chance of being selected (Arber, 2001). Thus, the type of random sampling used was cluster random sampling. The cluster random sampling method is a method of selection in which clusters of participants representing the population are identified and included in the sample (Alvi, 2016). Hence, this method was used to randomly select the construction professionals and quality control managers in each registered construction firms in Lagos.

3.7 SAMPLE SIZE

The study sample size includes construction professionals who are responsible for project implementation in registered construction firms in Lagos. As obtained by the Federation of construction industry Nigeria (FOCI), a total of forty-five firms were reported to be actively running in Lagos.

Within the 45 active registered firms, the professionals who are responsible for project

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implementation in their respective organisations having the following positions, managing director, project manager, site manager, QA/QC manager, facility manager, and works inspector, were surveyed. These sets of people were chosen to obtain adequate information about their organisation's quality control management. Three respondents were drawn from the population of each firm to obtain diverse information on the quality control practices in their firm and to avoid a biased report. Therefore, a sample size of 135 participants forms the population of professionals working in registered companies in Lagos. From each sampled firm, three responses were collected, and this yielded a total of one hundred and sixteen valid responses from the field survey. This indicates a return rate of 85%, which is considered acceptable and valid.

3.8 METHOD OF DATA COLLECTION

The research adopted both primary and secondary sources of data collection. The primary data collection used was a survey questionnaire. The use of a structured questionnaire was considered the most appropriate tool because of its ability to reach the population of the study with limited time and from a distance and for easy data analysis. In contrast, the secondary source of data collection was the extensive review of the literature to gain more insight into the subject under study. The concept of quality control, the challenges, and the existing critical success factors used by several studies to investigate the implementation of quality control management from different industries in various countries were reviewed. In addition, the collection of relevant academic publications related to this study's aim was obtained through scientific databases, Scopus, Web of Science, and Google Scholar. Table 3.1 below summarizes the method used for the data collection on the research objectives.

Table 3. 1 Data collection method

Objectives	Information required	Sources	Data collection method
To investigate the current QC management practices on Nigeria construction building projects.	The current QC management practices on building construction projects in Lagos	-Literature review	-Secondary sources (literature databases)

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Objectives	Information required	Sources	Data collection method
		-Field survey (Questionnaire)	-Primary data sources
To examine the challenges of QC management practices in building construction projects	Challenges inhibiting effective quality control management of building construction projects	-Field survey (Questionnaire)	-Primary data sources
To investigate the influence of QC manager on quality control management on building construction project	The roles and competency and education required of QC managers for adequate quality control management	-Field survey (Questionnaire)	-Primary data sources
To investigate the critical success factors for effective QC management practices on building construction projects.	The strategies by which quality control management can be achieved on construction projects	-Field survey (Questionnaire)	-Primary data sources

3.9 DATA COLLECTION INSTRUMENT

A questionnaire and a systematic literature review were used as data collection tools or instruments in this study. A questionnaire is a list of questions drafted to obtain the respondents' opinions on a survey. It ensures the easy collection of a large amount of data at one time by the researcher to and eliminates any face-to-face pressure on the research participants in answering research questions. The questionnaire for this study was designed based on variables extracted from the literature. The questions were developed based on a closed-ended format.

The survey questionnaire was subdivided into five sections. The first section obtained the

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bibliographic information of the respondents. These include the highest educational qualification, profession, years of professional experience, organisation type, organisation size, and position in the firm. Section B identified the current quality control practices on building construction projects in Lagos. Section C addressed the quality control challenges, Section D identified the quality control manager roles, competency, and education requirements, and section E identified the critical success factors for effective quality control management. (See attached questionnaire – Appendix A)

A total of 116 responses were received, with an 85% response rate. There was no personal contact with the research participants as the questionnaires were administered and collectedelectronically online via Google forms. The research participants' details were obtained from a database list provided by the FOCI in Nigeria of the currently active companies. The period used for administering the questionnaire was two months July-September.

3.9.1 The procedure for administering the questionnaire and obtaining informed consent

The questionnaire was prepared, administered, and collected online using Google forms. The questionnaire was designed in a way that the participants do not have access to the questionnaire without confirming that they have been duly informed about the research and that their participation is voluntary in the research. Participants' anonymity and confidentiality were ensured as the researcher avoided questions such as names, identity numbers, and physical addresses.

3.9.2 Assurance of confidentiality and anonymity

The data collected were treated anonymously. The survey findings were used for research purposes only. There were no risks, current or anticipated, to any research participant in this study. The researcher was responsible for protecting the participants as an ethical commitment that considers the participant's rights.

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3.10 DATA ANALYSIS

The data obtained from the questionnaires were analysed using Statistical Package for Social Sciences (SPSS) version 28.0. A total of 116 responses were analysed. Descriptive and inferential methods of data analysis were employed. The descriptive method of analysis was used to describe and summarise the data collected, while the inferential was used to generalise the findings from the collected data (Sullivan-Bolyai and Bova, 2014). The respondents' backgrounds were measured using the frequency distribution technique, and the mean item score and standard deviation were used to estimate the variables' empirical relative weights. Lastly, the exploratory factor analysis was used to summarise and reduce the variables for easy analysis and interpretation of the results, and to produce the significance of variables and their groupings.

Furthermore, a rating scale used by Oke and Aghimien (2018) was adopted in this study for data analysis interpretation. A scale of 0-20% was rated as very low, 21-40% was rated as low, 41-60% was rated as average, 61-80% was rated as high, and above 80% was rated as very high.

3.10.1 Mean Score (MS)

A five-point Likert scale was used to rate the quality control practices, the QC challenges, QC manager competencies, and the critical success factors for effective QC management on building construction projects. The five points of the Likert scale were converted into MS for each of the factors presented in the research questions. The principles were in relation to the respondents' scores for selected criteria. The MS of the index factor is the summation of the actual rating of the participants based on the five-point scale. The MS can be expressed in the mathematical formula below.

Where: $MS = \frac{1n1 + 2n2 + 3n3 + 4n4 + 5n5}{\Sigma N}$ ……. (1)

n1 = number of respondents for Never or Not important or Not Significant or Strongly Disagree or Not Familia

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n2 = Participants number for Rarely or Less Significant or Not Important or Disagree or Less Familiar

n3 = Participants number for Average or Moderately Significant or Moderately Important or Neutral

n4 = Participants number for often or Significant or Important or Agree or Familiar

n5 = Participants number for Always or Very Significant or Very Important or Strongly Agree or Very Familiar

N = Total of the respondent's numbers

MS values were ranked from the highest to the lowest based on the factors identified in each question. After mathematical computations on a Statistical Package for the Social Science Version 28 (SPSS V28), the variables are then ranked in descending order based on their mean score.

3.10.2 Standard Deviation (SD)

Ranking of the variables was through the standard deviation with the same mean item scores. The standard deviation is expressed below mathematically.

$$\mathbf{SD} = \sqrt{\Sigma (x - \bar{x})^2 / N - 1}$$

Σ − Summation symbol

x − Value in the sample

$\bar{x}$ − Mean of the values

N − Simple sizes

``

3.10.3 Relative Important Index Analysis

Relative important index analysis was selected to rank the variables according to their importance as rated by the respondents. This method of analysis has been used by other scholars in ranking variables, such as Oni et al. (2019), and Lawrence et al. (2021).

The RII formula is stated below:

$$RII = \frac{\Sigma W}{A \times N}$$

Where:

W= the point assigned by the respondent to each factor on a scale of 1-5.

A=highest Point, for example, 5

N=Sampled population (N=116)

Table 3.2 below presents the rating scale adopted in this study for data interpretation.

Table 3. 2 RII rating scale

RII < 0.599= Insignificant
RII ≥ 0.73= Critical
RII>0.599< 0.73=significant

Source: Lawrence et al. (2021)

3.10.4 Exploratory Factor Analysis EFA

The essence of factor analysis is to summarize data for easy comprehension of their relationships and patterns (Yong and Pearce, 2013). Factor analysis was used to regroup the identified factors in the study into a smaller set of variables and to explore inter-relationships between the items. There are four steps of factor analysis: assessment of the data suitability, extraction of factors,

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factor rotation, and interpretation of factor loadings. Kaiser Meyer Olkin (KMO) tests were conducted to measure the adequacy of the data for factor analysis. KMO was used to measure the suitability of a sampling, whilst Bartlett's test was conducted to measure the strength of the relationship between the variables. The factor analysis is considered suitable when Bartlett's test of sphericity is less than 0.05, and KMO is over 0.6 index (Hooper, 2012).

3.11 VALIDITY AND RELIABILITY TEST

The degree to which a measure is error-free and consistent in its output is referred to as its reliability. The internal consistency of the questionnaire results and the reliability of the quantitative data were evaluated in this research using Cronbach's Alpha test. All measuring scales were checked to see if they measured the same construct reliability using Cronbach's Alpha test. A Cronbach's rating between 0 and 1 denotes greater reliability (Pallant, 2020). Table 3.3 shows the results of the questionnaire reliability test using Cronbach's Alpha falls between ranges from which postulate that the reliability test is acceptable.

Table 3. 3 Cronbach's Alpha Test

Category	Cronbach Alpha
The Current QC management practices	0.976
The influence of quality control managers	0.976
Challenges facing quality control management	0.958
Critical success factors for effective quality control management	0.942

The validity test measures the extent to which the research instrument captures the purpose for which it was designed (Leedy and Ormrod, 2005). Validity can be carried out through content validity, construct validity and criterion validity. However, this study employed content validity through a pilot test.

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3.12 PILOT TEST

The research questionnaire was sent to academia and practising professional experts in the study domain to measure its correctness and ability to meet the purpose for which it was designed. The feedback received from them was addressed, and after effecting the recommended changes, the questionnaire was sent back to the professionals for review (That is, the pilot survey was carried out two times). Subsequently, the comments from the experts were positive and permission to proceed with the research was granted.

3.13 RESEARCH ETHICS

The study ensured that all ethical considerations were observed. The anonymity and confidentiality of research respondents were ensured. The collection of data did not involve the collection of the private details of the respondents. Likewise, the responses cannot be traced to any participant. Furthermore, participation was optional, and there were no repercussions for individuals who chose to withdraw at any moment. Moreover, the consent of research participants was sought by designing the questionnaire so that the participants do not have access to the questionnaire without confirming that they have been duly informed about the research and that their participation is voluntary. Finally, the data collected from the survey was only used for the study.

3.14 LIMITATION OF THE STUDY

Only the construction project participants in construction firms, project managers, builders, engineers, architects, and quantity surveyors in Lagos state Nigeria were included in this research survey. Other related professionals who arenot responsible for construction and management were excluded.

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CHAPTER FOUR

DATA ANALYSIS AND INTERPRETATION

4.1 INTRODUCTION

The results of the data analysis were presented in this chapter. The data analysed were obtained from the survey questionnaire administered to construction firms in Lagos, Nigeria.

The analysis is divided into five sections as used in the questionnaire. Section A addressed the demographic data of the research participants. Section B explored the quality control practices of construction firms in Lagos. Section C analysed the challenges affecting quality control management on building construction projects. Furthermore, section D presents the results of quality control managers' influence on quality control management of building construction projects. Finally, Section E explores the critical success factors for effective quality control management.

4.2 SECTION A: RESPONDENTS' BACKGROUND INFORMATION

The background information of the respondents who took part in the research survey is shown in this section. This information includes gender, educational qualification, profession, designation, professional experience, organisation size, and organisation status.

4.2.1 Gender of Research Participants

Figure 4.1 below shows the gender breakdown of the study participants. 85.3% of the respondents were male, while 14.7% were female.

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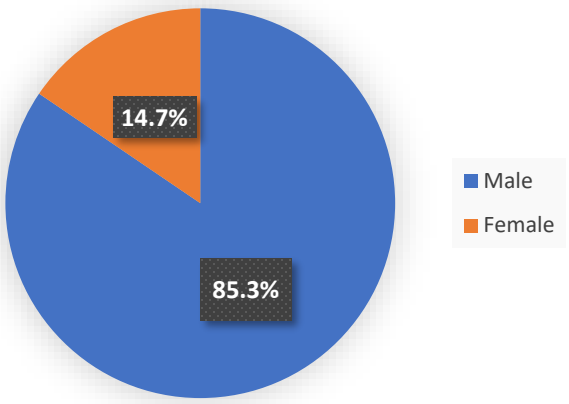

Figure 4. 1 Gender of research participants

4.2.2 Respondents' Highest Educational Qualification

Figure 4.2 below shows the respondents' highest level of education. The result showed that out of the 116 survey participants. 4.3% of the population held a national diploma (ND), 26.7% a higher national diploma (HND), 4.3% a post-graduate diploma (PGD), 42.2% a bachelor's degree (B.Tech/BSc), 21.6% a master's degree (MSc), and 0.9% a Doctor of Philosophy (PhD). Consequently, it can be shown that most respondents have a degree.

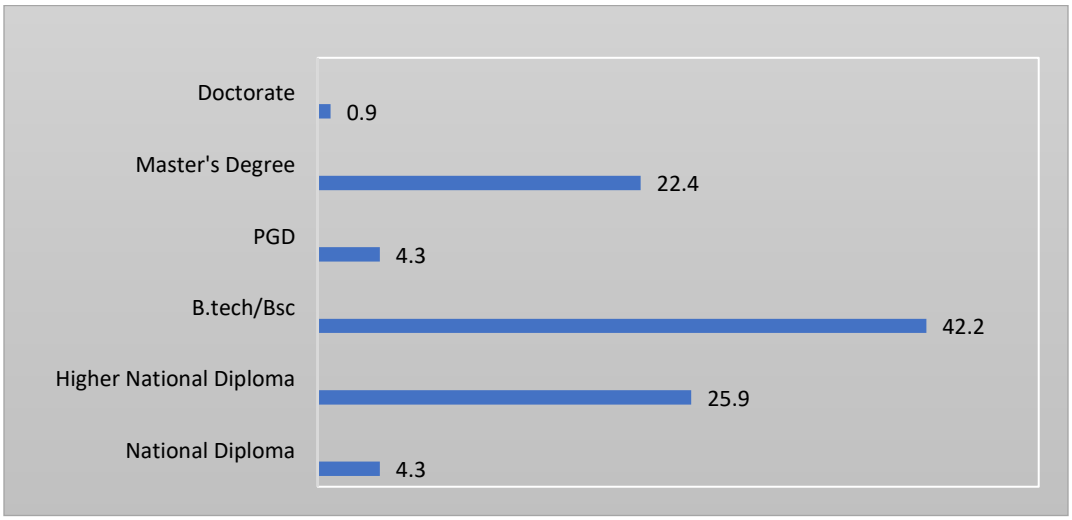

Figure 4. 2 Respondents' highest educational qualification

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4.2.3 Respondents' Profession

Figure 4.3 below shows the profession of the research participants. The findings revealed that 42.2% of the respondents were engineers, 25.9% were builders, 11.2% were quantity surveyors, 10.3% were project managers, and 10.3% were architects.

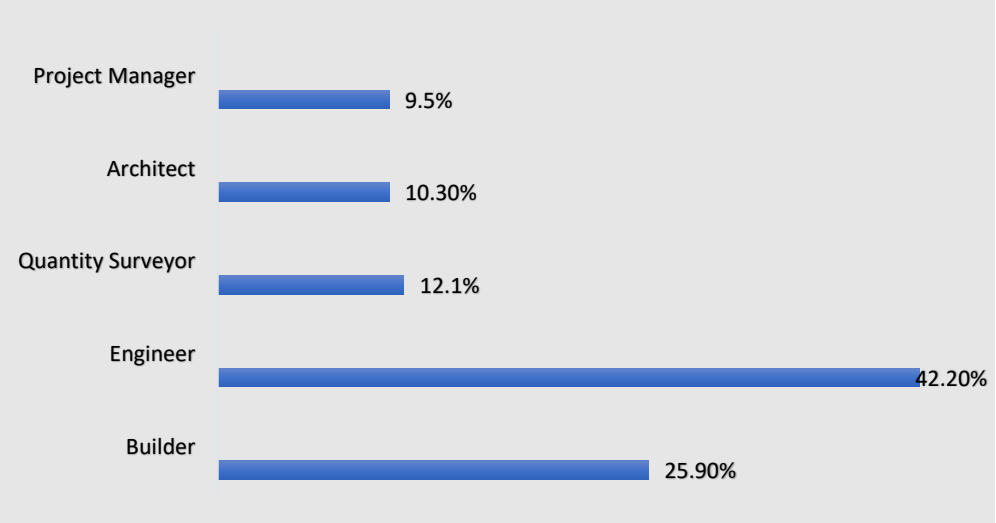

Figure 4. 3 Respondents' Profession

4.2.4 Respondents' Position

Figure 4.4 below represents the position of the respondents in their respective firms. The designation showed that 34.5% were site managers, 25.9% were project managers, 13.8% were managing directors, 11.2% were QA or QC managers, 10.3% were works inspectors and 4.3% were facility managers.

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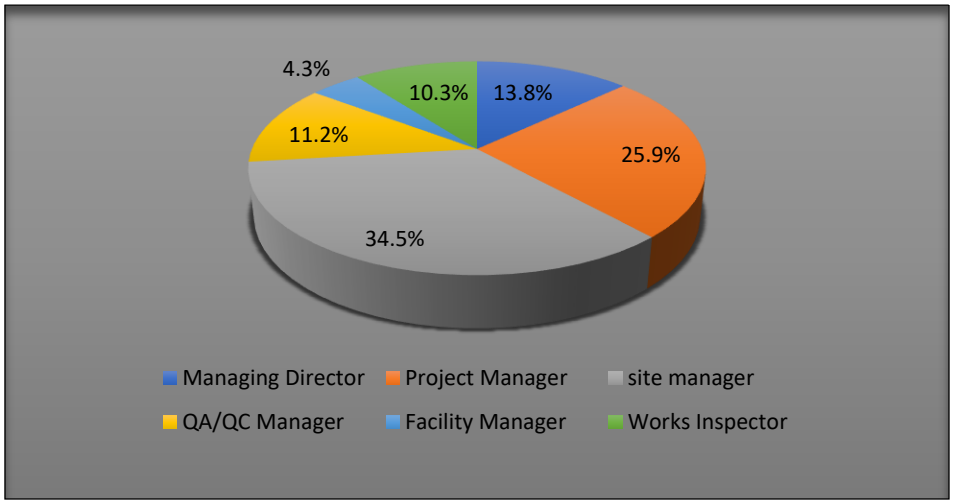

Figure 4. 4 Respondents' position

4.2.5 Respondents' OrganisationType

The types of organisations to which the respondents belong are shown in Table 4.1 below. 69.8% of the study's participants are employed by a contractor's organisation, 15.5% by a consulting firm, 12.1% by a subcontractor, and 2.6% by the government.

Table 4. 1 Respondents' organisation type

S/N	Type of organization	Number	Percentage (%)
1	Contractor	81	69.8
2	Sub-Contractor	18	15.5
3	Consultant	14	12.1
4	Government agency	3	2.6

4.2.6 Respondents' Professional Experience

Figure 4.5 below shows the respondents working experience. The findings showed that 44% of the participants have professional experience ranging from 0-5years, followed by 32.8% for

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experience within 6-10years range, 10.3% had experience ranging from 11-15%, 8.6% possess professional experience ranging between 16-20 years, and 4.3% had experience ranging from twenty years and above.

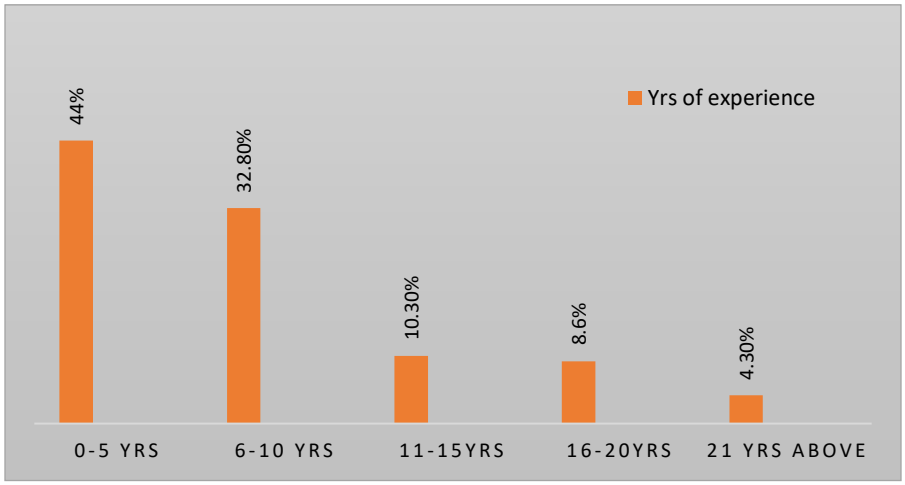

Figure 4. 5 Respondents' professional experience

4.2.7 Respondents' Organisation Size

Figure 4.6 below presents the organisation size of the respondents. 57.8% of the respondents work in a small firm (10-50 employees), 27.6% work in a medium firm (50-99 employees) and 14.7% are from a large firm (100 above employees).

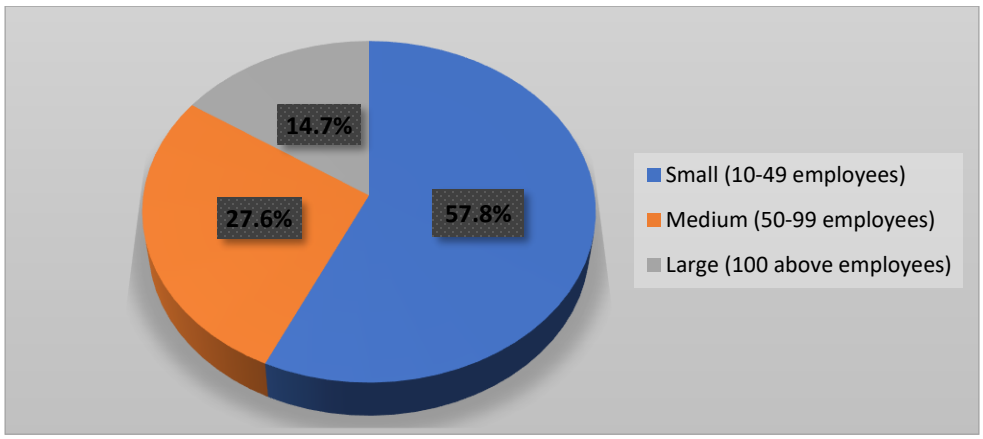

Figure 4. 6 Respondents' organisation size

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4.2.8 Respondents' Organisation Origin

The origin of the organisation sampled is presented in figure 4.7 below. 84% of respondents' firms are indigenous firms (locally owned) while 16.4% are non-indigenous firms.

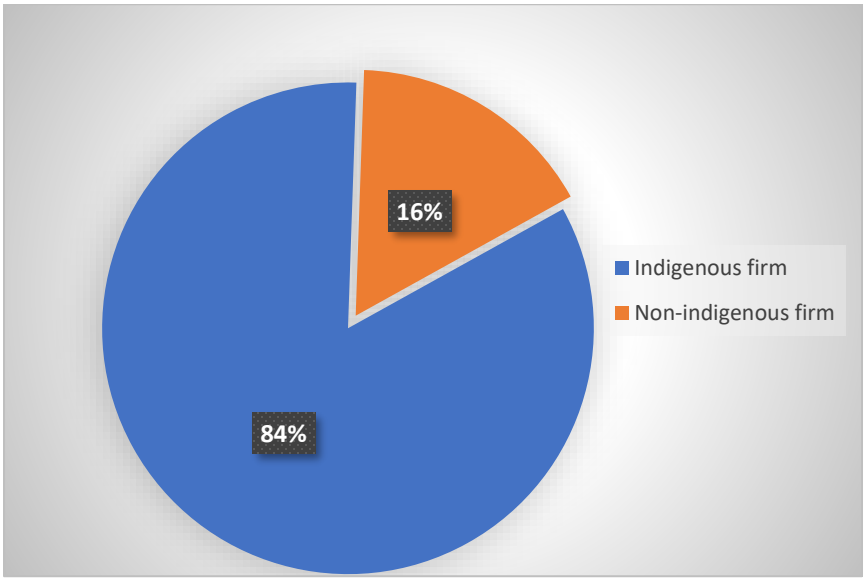

Figure 4. 7 Respondents' organisation status

4.3 SECTION B: CURRENT QUALITY CONTROL PRACTICES ON BUILDING CONSTRUCTION PROJECTS IN LAGOS, NIGERIA.

This section investigates the current quality control practices among construction firms in Lagos, Nigeria, using the descriptive method of analysis.

4.3.1 Descriptive Analysis: Respondents' Awareness Level of Quality Control Management

The knowledge of the respondents on quality control management was investigated by asking them to rate their awareness level on QC management using a 5-point Likert scale of 'Not at all (NA) – Very high (VH)'. Table 4.2 presents the awareness level of the respondents on quality control management as responded by them. 1.7% of the respondents were unaware of quality control management, 21.6% were averagely aware, 41.4% were highly aware, and 35.3% have a very high

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level of awareness of quality control management. Table 4.3 shows the correlation analysis between the respondents' educational experience and their level of awareness. There was a significant correlation between the variables at a 0.05 significant level.

Table 4. 2 Respondents' level of awareness on quality control management

	Frequency	Percent	Mean	SD
Not at all	-		4.10	.795
Low	2	1.7		
Average	25	21.6		
High	48	41.4		
Very High	41	35.3		

Table 4. 3 CORRELATIONS – Educational qualification and level of awareness

		Educational Qualification	Level of awareness on quality control
Educational Qualification	Pearson Correlation	1	.205*
	Sig. (2-tailed)		.028
	N	116	116
Level of awareness on quality control	Pearson Correlation	.205*	1
	Sig. (2-tailed)	.028	
	N	116	116

4.3.2 Descriptive Analysis: Respondents' Organisation's Attention to Quality Control Management

A five-point Likert scale with the options Not at all (NA) and Very high (VH) was used to ask the respondents how supportive or committed their respective organisations were to QC management. Table 4.4 presents the respondents' company’s attention to quality control management. 4.3% of the respondents responded that their firm attention to QC management is low, 30.2% averagely

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attend to QC management, 26.7% are highly committed to QC management and 38.8% have very high commitment to QC management.

Table 4. 4 Respondents' organisation's attention to quality control management

	Frequency	Percent	Mean	SD
Not at all	-	-	4.00	.933
Low	5	4.3		
Average	35	30.2		
High	31	26.7		
Very High	45	38.8		

4.3.3 Familiarity of Respondents with Quality Standards

The survey participants were asked to rate their familiarity with the standards used to drive quality on a 5-point Likert scale of Not familiar – Very familiar. The result shown in table 4.5 below revealed that the British standard (BS) has the highest rank ((MIS=4.22, SD=1.014, R=1), (MIS=3.23, SD=1.404, R=2). International standard organisation (ISO) (MIS=3.85, SD=1.366, R=3). National Building Code (2006) (MIS=3.84, SD=1.278, R=3). American Society for Testing and Materials Standard (ASTM) (MIS=3.52, SD=1.282, R=4) and The American National Standards Institute (ANSI) (MIS=3.20, SD=1.253, R=5).

Table 4. 5 Familiarity of respondents with quality standards

Cronbach Alpha=.953								
Quality standards	Not at all	Low	Average	High	V. High	Mean	SD	R
British Standard (BS)	2(1.7%)	8(6.9%)	13(11.2%)	32(27.6%)	61(52.6)	4.22	1.014	1
International standard organisation (ISO 9000 series)	12(10.3%)	11(9.5%)	12(10.3%)	28(24.1%)	53(45.7)	3.85	1.366	2
National Building Code 2006	9(7.8%)	10(8.6%)	21(18.1%)	27(23.3%)	49(42.2)	3.84	1.278	3

``

Cronbach Alpha=.953								
Quality standards	Not at all	Low	Average	High	V. High	Mean	SD	R
American Society for Testing and Materials (ASTM) standard	13(11.2%)	10(8.6%)	28(24.1%)	34(29.3%)	31(26.7%)	3.52	1.282	4
The American National Standards Institute (ANSI)	15(12.9%)	18(15.5%)	30(25.9%)	35(30.2%)	18(15.5%)	3.20	1.253	5

4.3.4 Respondents' Organisation Quality Certification

Figure 4.8 presents the percentage of the respondent firms that have obtained ISO 9000 and Standard Organisation of Nigeria (SON) quality certification. The result revealed that 56.0% of the respondents' firms had obtained ISO standardisation (ISO 9000) while 44% did not. Also, 78.4% of the respondents' firms have obtained SON certification, while 21.6% did not.

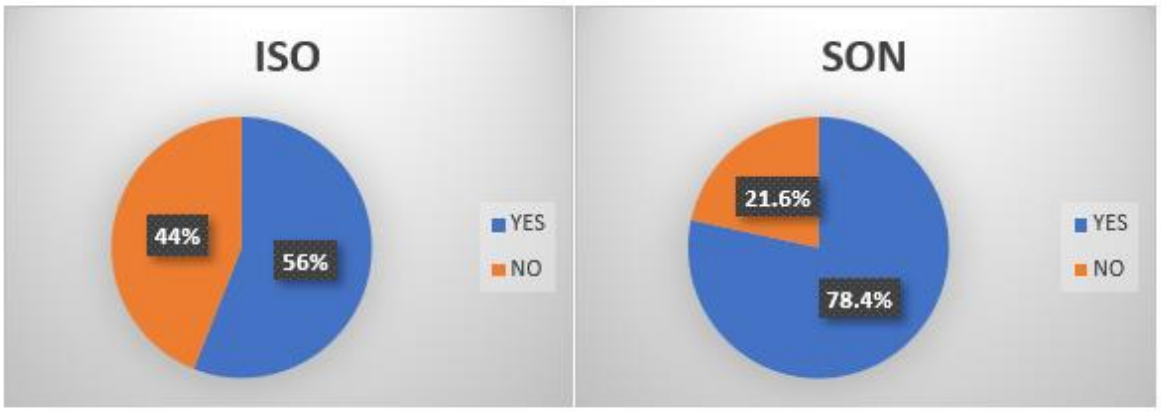

Figure 4. 8 Respondents' organisation quality certification

* *International Standard Organisation (ISO)*

* *Standard Organisation of Nigeria (SON)*

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4.3.5 Descriptive Analysis Respondents' Familiarity with Quality Control Tools

Respondents were asked to rate their knowledge of quality control tools on a five-point Likert scale, from Very Familiar (VF) to Not Familiar (NF). The respondents' familiarity with the seven quality control instruments is shown in Table 4.6. From the findings, the histogram was rated as first (MIS=3.40 SD= 1.257). The flow chart was rated as the second (MIS=3.35 SD=1.144). The control chart was rated as third (MIS=3.22 SD=1.156). The cause-and-effect diagrams rated fourth (MIS=3.35 SD=1.144)., Check sheets rated fifth (MIS=3.12 SD=1.181). scatter diagrams rated sixth (MIS=3.11 SD=1.277) and Pareto charts ranked the least (MIS=2.70 SD=1.203).

Table 4. 6 Respondents' Familiarity with quality control tools

	Not	Less			Very			Rank
QC Tools	Familiar	Familiar	Neutral	Familiar	familiar	Mean	SD	
Histogram	13(11.2%)	15(12.9%)	24(20.7%)	41(35.3%)	23(19.8%)	3.40	1.257	1
Flow charts	9(7.8%)	16(13.8%)	35(30.2%)	37(31.9%)	19(16.4%)	3.35	1.144	2
Control charts	13(11.2%)	14(12.1%)	38(32.8%)	37(31.9%)	14(12.1%)	3.22	1.156	3
Cause and effect diagrams	16(13.8%)	16(13.8%)	30(25.9%)	38(32.8%)	16(13.8%)	3.19	1.244	4
Check sheets	15(12.9%)	14(12.1%)	44(37.9%)	28(24.1%)	15(12.9%)	3.12	1.181	5
Scatter diagrams	17(14.7%)	20(17.2%)	29(25.0%)	33(28.4%)	17(14.7%)	3.11	1.277	6
Pareto charts	25(21.6%)	25(21.6%)	32(27.6%)	28(24.1%)	6(5.2%)	2.70	1.203	7

SD = Standard deviation

4.3.6 Descriptive Analysis - Respondents' Awareness Level of Digital Quality Control Tools

The respondents' awareness level of digital quality control tools for quality management was examined. This was achieved by asking them to rank their level of awareness using a 5-point Likert scale of Not at all (NA) – Very high (VH). Table 4.7 revealed the awareness level of the respondents on digital QC tools. The result revealed that 8.6% of the respondents are not aware of digital quality control tools, 10.3% have low awareness, 27.6% are averagely aware, 34.5% are highly aware, and 19% have the highest level of awareness.

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Table 4. 7 Respondents awareness level of digital quality control tools

	Frequency	Percent	Mean	SD
Not at all	10	8.6	4.00	.933
Low	12	10.3		
Average	32	27.6		
High	40	34.5		
Very High	22	19.0		
Total	116	100		

4.3.7 Respondents' Usage Level of Digital Tools for Quality Control Management

To determine the usage level of digital QC tools for quality control management on building construction projects in Lagos, the respondents were asked to rate their application of digital QC tools on a 5-point Likert scale of Not at all (NA) – Very high (VH). The respondents' level of usage of digital QC tools by the respondents is shown in table 4.8. The first five most used tools for QC are cameras ranked first (MIS=3.78, SD=1.35). BIM ranked second (MIS=3.71, SD=1.111). GIS ranked third (MIS=3.47, SD=1.361). LADAR ranked fourth (MIS=3.31, SD=1.429). laser scanner ranked fifth (MIS=3.28, SD=1.399) while the five least used tools identified were: RFID ranked tenth (MIS=2.85, SD=1.287). Personal Digital Assistant ranked ninth (MIS=3.00, SD=1.383 Ranked). Drones/Unmanned Aircraft Systems/Vehicles ranked eighth (MIS=3.04, SD=1.398). Mobile Computing Technology ranked seventh (MIS=3.22, SD=1.415). Sensor ranked sixth (MIS=3.23, SD=1.404). The laser scanner ranked fifth (MIS=3.28. SD=1.399).

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Table 4. 8 Respondents' usage level of digital tools for quality control management

Cronbach Alpha=.953								
Digital Qc Tools	Not at all	Low	Average	High	V. High	Mean	SD	Rank
Cameras	14(12.1%)	7(6%)	6(13.8%)	32(27.6%)	47(40.5%)	3.78	1.357	1
Building Information Modelling (BIM)	6(5.2%)	8(6.9%)	33(28.4%)	36(31%)	33(28.4%)	3.71	1.111	2
Geographical Information System (GIS)	14(12.1%)	17(14.7 %)	19(16.4%)	33(28.4%)	33(28.4%)	3.47	1.361	3
Laser detection and ranging system (LADAR)	19(16.4%)	14(12.1 %)	29(25%)	20(17.2%)	34(29.3%)	3.31	1.429	4
Laser scanner	21(18.1%)	11(9.5%)	26(22.4%)	31(26.7%)	27(23.3%)	3.28	1.399	5
Sensor	20(17.2%)	14(12.1 %)	30(25.9%)	23(19.8%)	29(25%)	3.23	1.404	6
Mobile Computing Technology	22(19%)	14(12.1 %)	21(18.1%)	34(29.3%)	25(21.6%)	3.22	1.415	7
Drones/ Unmanned Aircraft Systems/Vehicles (UAS/UAV)	26(22.4%)	11(9.5%)	32(27.6%)	26(22.4%)	21(18.1%)	3.04	1.398	8
Personal Digital Assistant (PDA)	25(21.6%)	16(13.8 %)	28(24.1%)	28(24.1%)	19(16.4%)	3.00	1.383	9
Radio Frequency Identification (RFID)	23(19.8%)	23(19.8 %)	31(26.7%)	26(22.4%)	13(11.2%)	2.85	1.287	10

4.3.8 Respondents' Organisation's Quality Control Management Practices

Table 4.9 presents the respondents' firm rating on their involvement in QC practices on building projects using the using 5-point Likert scale: 1= To no extent; 2= to a small extent; 3= to moderate extent; 4= to a large extent; 5= to a very large extent. According to Field (2005), the variable or factor with the lowest standard deviation is placed first and given the highest weight when two or more variables have the same mean. Therefore, the variables with the same mean were ranked based on the standard deviation value. From table 4.9, the top five QC practices practiced by the firms are inspection and testing of executed works (MIS=4.23, SD=.888, R=1). Construction process adopted (MIS=4.18, SD=.956, R=2). Material selection and usage (MIS=4.11, SD=.930, R=3). Quality control of material (MIS=4.02, SD=.995, R=4). Use of checklist (MIS=4.01, SD=1.168, R=5). Furthermore, the five least ranked QC practices are quality control laboratory at the construction site (MIS=3.45, SD=1.328, R=17). Keeping of spare parts/materials for laboratory

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equipment (MIS=3.58, SD=1.238, R=16). Maintaining the sequence of construction (MIS=3.78, SD=1.056, R=15). Coordination with the project purchase department (MIS=3.79, SD=1.059, R=14). Record of changes (MIS=3.80, SD=1.136, R=13). The five least ranked QC practices are quality control laboratory at the construction site (MIS=3.45, SD=1.328, R=18). Keeping spare parts/materials for laboratory equipment (MIS=3.58, SD=1.238, R=17). Quality control training (MIS=3.70, SD=1.049, R=16) Maintaining the sequence of construction (MIS=3.78, SD=1.056, R=15). Coordination with the project purchase department (MIS=3.79, SD=1.059, R=14).

Table 4. 9 Respondents' organisation quality control practices

	Quality control practices	Mean	SD	Rank
QCP 1	Inspection and testing of executed works	4.23	.888	1
QCP3	Construction process adopted	4.18	.956	2
QCP2	Material selection and usage	4.11	.930	3
QCP17	Quality control of material	4.02	.995	4
QCP5	Use of checklist	4.01	1.168	5
QCP11	Quality of workmanship in all construction activities	4.00	1.038	6
QCP4	Use of code of conduct	4.00	1.079	7
QCP6	Report of non-conformity of quality standards	3.89	1.207	8
QCP16	The practice of sound housekeeping	3.84	1.060	9
QCP14	Observation of regular schedule	3.84	1.084	10
QCP8	Evaluation and Correction of deviations in quality	3.84	1.111	11
QCP10	Quality control plan	3.84	1.164	12
QCP5	Record of changes	3.80	1.136	13
QCP9	Coordination with the project purchase department	3.79	1.059	14
QCP13	Maintaining the sequence of construction	3.78	1.056	15
QCP18	Quality control training	3.70	1.049	16
QCP 15	Keeping spare parts/materials for laboratory equipment	3.58	1.238	17
QCP12	Quality Control Laboratory at the construction site	3.45	1.328	18

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4.4 SECTION C: INFLUENCE OF QUALITY CONTROL(QC) MANAGER ON EFFECTIVE QUALITY CONTROL MANAGEMENT ON BUILDING CONSTRUCTION PROJECTS

The analysis in this section investigates the influence of QC managers, their roles, and the competency required of them for effective quality control management of building construction projects.

4.4.1 Percentage of Quality Control Manager

Table 4.10 below displays the percentage of the respondents' firms that has a quality control manager. The findings result revealed that 69.8% of the respondents claimed to have a QC manager in their firms, while 30.2% had no QC manager.

Table 4. 10 Percentage of quality control manager

Construct	Response	Frequency	Percentage
Do you have a quality manager in your	Yes	81	69.8%
firm?	No	35	30.2%

4.4.2 Descriptive Analysis: Quality Control Manager Influence on Achieving Effective Quality Control Management

The respondents were asked to rate their agreement on the influence of QC managers on effective QC management of building construction projects using a 5-point Likert scale of Strongly disagree (SD) – Strongly Agree (SA). From the result in table 4.11, 72.4% of the respondents, with a mean score of 4.59 and a standard deviation of .769, strongly agreed that every construction site should have a quality control manager responsible for implementing quality Plans and checklists while 0.95 strongly disagree. Also, 63.8% strongly agree that hiring a quality control manager to commit to the project will ensure quality compliance, while 2.6% strongly disagree. 65.55% of the respondents strongly agreed that assigning the responsibility of quality control management on-site to a quality control manager results in an increased level of success while 0.9% strongly disagreed.

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Furthermore, a report was generated as shown in table 4.12 below to show the level of agreement by each respondent based on their profession. Regarding construct one - every construction site should have a quality control manager responsible for implementing quality plans and checklists, the project managers had the highest mean item score of 4.82 and a standard deviation of .603, followed by the builders with a mean item score of 4.73 and a standard deviation of .521. Architects with a mean item score of 4.67 and a standard deviation of .492. Engineers with a mean item score of 4.55 and a standard deviation of .891 and lastly the quantity surveyors with a mean item score of 4.21 and a standard deviation of .975.

Construct two - hiring a quality control manager to commit to a project will ensure quality compliance, the project managers had the highest mean item score of 5.00 and a standard deviation of .603 and the builders had a mean item score of 4.70 and a standard deviation of .596. Architects had a mean item score of 4.33 and a standard deviation of .778. The engineers had a mean item score of 4.29 and a standard deviation of 1.061 and the quantity surveyor had a mean item score of 4.21 and a standard deviation of .975.

Construct three - assigning the responsibility of quality control management on site to a quality control manager results in an increased level of success, the project managers had the highest mean item score of 4.82 and a standard deviation of .405, and the engineers had a mean item score of 4.59 and standard deviation of .788, the quantity surveyor had a mean item score of 4.57 and a standard deviation of .514, the builders had a mean item score of 4.57 and a standard deviation of .679, the architects had a mean item score of 4.25 and a standard deviation of .754.

Table 4. 11 Quality control managers influence on achieving effective quality control management

Quality Control Manager Influence	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	
Every construction site should have a Quality Control Manager responsible for implementing Quality Plans and Checklists	1(0.9%)	2(1.7%)	8(6.9%)	21(18.1%)	92%

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Quality Control Manager Influence	Strongly Disagree	Disagree	Neutral	Agree	
Hiring a quality control manager to commit to the project will ensure quality compliance	3(2.6%)	1(0.9%)	10(8.6%)	28(24.1%)	89%
Assigning responsibility for quality control management on-site to a quality control manager causes an increased level of success	1(0.9%)	1(0.9%)	5(4.3%)	33(28.4%)	91%

Table 4. 12 The professionals' perception regarding the influence of QC managers on the quality control management of construction projects

Profession		Every construction site should have a QC Manager responsible for implementing Quality Plans and Checklists	Hiring a QC manager to commit to the project will ensure quality compliance	Assigning responsibility for quality control management on-site to a QC manager results in an increased level of success
Architect	Mean	4.67	4.33	4.25
	N	12	12	12
	SD	.492	.778	.754
Builder	MIS	4.73	4.70	4.57
	N	30	30	30
	SD	.521	.596	.679
Engineer	Mean	4.55	4.29	4.59
	N	49	49	49
	SD	.891	1.061	.788
Project	Mean	4.82	5.00	4.82
manager	N	11	11	11
	SD	.603	.000	.405
Quantity	Mean	4.21	4.21	4.57
Surveyor	N	14	14	14
	SD	.975	.975	.514
Total	Mean	4.59	4.46	4.57
	N	116	116	116
	SD	.769	.888	.701

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4.4.3 Descriptive-Respondents Rating on Quality Control Manager Roles Required for Effective Quality Control Management

By using a 5-point Likert scale of Strongly disagree (SD) – Strongly Agree (SA). Respondents were asked to rate the QC manager roles required for effective QC management on building construction projects. From table 4.13, the result revealed that QCR 1 was ranked first (MIS= 4.53, SD=.715), QCR 2 ranked second (MIS=4.52, SD=.728), QCR3 ranked tenth (MIS=4.41, SD=.823) and QCR 9 ranked least (MIS=4.41, SD=.865).

Furthermore, to compare the level of agreement of individual respondents against their profession, a Kruskal-Wallis H-test was run using a significant level of 0.05% (95% confidence level). Table 4.14 shows that the level of significant factor (P value) for each QC manager role is greater than the significant level; 0.05%<Pvalue indicates that there is no significant difference among the professionals. Hence, the acceptance of all the hypotheses.

Table 4. 13 Respondents' rating on quality control manager roles required for effective quality control management

Code	QC Roles	MIS	SD	Rank
QCR 1	Ensuring compliance with national and international standards of production processes	4.53	.715	1
QCR 2	Supervises Construction processes to identify defects and deviations in the quality policies.	4.52	.728	2
QCR 5	Monitors the compliance of suppliers to quality	4.51	.808	3
QCR 6	Engages in meetings, gets feedback from clients, submits documented reports, and helps the external auditors	4.50	.740	4
QCR 10	Develops ways to improve the production process techniques to ensure high-quality outputs	4.47	.796	5
QCR 11	Devise ways to come up with new techniques to reduce waste during the production phase and maximize resources	4.46	.785	6
QCR 7	Sets quality standards as regards the safety of workers during the production process	4.45	.858	7

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Code	QC Roles	MIS	SD	Rank
QCR 8	keeping accurate documentation and statistical analysis	4.43	.783	8
QCR 4	Monitors technicians and other members to ensure that they perform their assigned duty following quality standards	4.41	.823	9
QCR 3	Have an in-depth understanding of customer requirements and communicate with them to have adequate quality control processes.	4.41	.845	10
QCR 9	Reviews the final product, compares it with the initial requirements, and rejects or approves the final product complying with quality standards	4.41	.865	11

Table 4. 14 Hypothesis test for agreement on QC manager's roles by construction professionals

Null Hypothesis	Test	Sig.	Decision
The distribution of QCR 1. Ensuring compliance with national and international standards of production processes is the same across categories of Profession.	Independent-Samples Kruskal-Wallis Test	.350	Retain the null hypothesis.
The distribution of QCR 2. Supervises Construction processes to identify defects and deviations in the quality policies is the same across categories of Profession.	Independent-Samples Kruskal-Wallis Test	.804	Retain the null hypothesis.
The distribution of QCR 3. Have an in-depth understanding of customer requirements and communicating with them to have adequate quality control processes is the same across categories of Professions.	Independent-Samples Kruskal-Wallis Test	.246	Retain the null hypothesis.

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Null Hypothesis	Test	Sig.	Decision
The distribution of QCR 4. Monitors technicians and other members to ensure that they perform their assigned duty following quality standards are the same across categories of Profession.	Independent-Samples Kruskal-Wallis Test	.403	Retain the null hypothesis.
The distribution of QCR 5. Monitors the compliance of suppliers to quality is the same across categories of Profession.	Independent-Samples Kruskal-Wallis Test	.276	Retain the null hypothesis.
The distribution of QCR 6. Engages in meetings, gets feedback from clients, submits documented reports, and helps the external auditors is the same across categories of Profession.	Independent-Samples Kruskal-Wallis Test	.407	Retain the null hypothesis.
The distribution of QCR 7. Sets quality standards as regards the safety of workers during the production process is the same across categories of Profession.	Independent-Samples Kruskal-Wallis Test	.350	Retain the null hypothesis.
The distribution of QCR 8. keeping accurate documentation and statistical analysis is the same across categories of Profession.	Independent-Samples Kruskal-Wallis Test	.606	Retain the null hypothesis.
The distribution of QCR 9. Reviews the final product, compares it with the initial requirements and rejects or approves the final product complying with quality standards is the same across categories of Profession.	Independent-Samples Kruskal-Wallis Test	.112	Retain the null hypothesis.

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Null Hypothesis	Test	Sig.	Decision
The distribution of QCR 10. Develops ways to improve the production process techniques to ensure high-quality outputs are the same across categories of Profession.	Independent-Samples Kruskal-Wallis Test	.183	Retain the null hypothesis.
The distribution of QCR 11. Devise ways to come up with new techniques to reduce waste during the production phase and maximize resources is the same across categories of Profession.	Independent-Samples Kruskal-Wallis Test	.657	Retain the null hypothesis.

*The significance level is .050.

4.4.4 Quality Control Managers' Competency

The respondents were asked to rate the important competencies required for quality control management on building construction projects in Lagos, Nigeria, using a five Likert scale: 1=Not important; 2=Less important; 3= moderately important; 4= Important; 5=Very important. From table 4.15, The first five ranked QC competencies were knowledge of building codes and standards ranked first with a mean score of 4.33 and a standard deviation of .902, commitment and willingness to learn new methods and systems ranked second with a mean score of 4.28 and a standard deviation of .940, character ranked third with a mean score of 4.27 and a standard deviation of .888, teamwork ranked fourth with a mean score of 4.27 and a standard deviation of .898, sound judgment and decision making ranked fifth with a mean score of 4.27 and a standard deviation of .908. Furthermore, the least ranked competency was effective supervisory skills, ranked tenth with a mean score of 4.07 and a standard deviation of 1.069. Leadership and development skills ranked ninth with a mean score of 4.15 and a standard deviation of .998. Good working knowledge and QA/QC implementation ranked eighth with a mean score of 4.25 and a standard deviation of .986. Construction experience ranked seventh with a mean score of 4.25 and a standard deviation of .922 and knowledge of material tests and equipment ranked sixth with a mean score of 4.27 and a standard deviation of .972.

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Table 4. 15 Quality control manager competency

S/No	QC competency	Mean	SD	Rank
QCC4	Knowledge of building codes and standards	4.33	.902	1
QCC 9	Commitment and willingness to learn new methods and systems	4.28	.940	2
QCC 7	Character	4.27	.888	3
QCC 6	Teamwork	4.27	.898	4
QCC 8	Sound judgement and decision making	4.27	.908	5
QCC 10	Knowledge of material tests and equipment	4.27	.972	6
QCC 5	Construction experience	4.25	.922	7
QCC 3	Good working knowledge and QAQC implementation	4.25	.986	8
QCC 2	Leadership and Development skills	4.15	.998	9
QCC 1	Effective supervisory skills	4.07	1.069	10

4.5 SECTION D- CHALLENGES FACING QUALITY CONTROL MANAGEMENT ON BUILDING CONSTRUCTION PROJECTS IN LAGOS NIGERIA

This section is obtained from part of the questionnaire, which described the challenges facing quality control management on building construction projects in Lagos, Nigeria. A total of 27 challenges were identified as derived from reviewed literature and subjected to descriptive and factor analysis. The factor analysis was carried out to regroup the identified challenges in the study into a smaller set of variables and to explore inter-relationships between them.

4.5.1 Descriptive Analysis Result - Quality Control Challenges

By using a five-point Likert scale of Strongly disagree (SD) – Strongly Agree (SA). respondents were asked to rate the challenges facing QC management on building construction projects. The descriptive result in table 4.16 revealed that bribery and corruption were ranked first (MIS= 4.57, SD=.701). Lack of effective quality policy implementation ranked second (MIS=4.48, SD=.740). Inadequate technical knowledge ranked third (MIS=4.47, SD=.739). Inadequate funds and budgetary allocation ranked fourth (MIS=4.45, SD=.838). Lack of quality control inspection program ranked fifth (MIS=4.40, SD=.779). Insufficient quality control plan ranked sixth

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(MIS=4.38, SD=.742). Unrealistic project time ranked seventh (MIS=4.36, SD=.879). Lack of training/education of construction workers ranked eighth (MIS=4.34, SD=.874). Supervisors' lack of skills and experience ranked ninth (MIS=4.30, SD=.867). Inadequate on-time supervision ranked tenth (MIS=4.29, SD=.914). Lack of modern information system ranked eleventh (MIS=4.28, SD=.832). The cost of correcting non-conformance by the contractor ranked twelfth (MIS=4.28, SD=.850). Poor communication among the design and construction team ranked thirteenth (MIS=4.27, SD=.917). Non-provision for documentation of non-conformance ranked fourteenth (MIS=4.26, SD=.905). Faulty equipment for testing ranked fifteenth (MIS=4.24, SD=1.004). Poor testing procedures ranked sixteenth (MIS=4.21, SD=.890). High number of semiskilled and untrained labour ranked seventeenth (MIS=4.17, SD=.916). Poor understanding and coordination between stakeholders ranked eighteenth (MIS=4.16=, SD=.941). The high cost of materials and equipment ranked nineteenth (MIS=4.16, SD=.941). Lack of supplier evaluation ranked twentieth (MIS=4.16, SD=.956). Poor laboratory for material testing ranked tent (MIS=4.15, SD=.944). Poor conduct of review meeting (MIS=4.10, SD=.999). High cost of testing materials (MIS=4.10, SD=1.050). Delay in delivering materials (MIS=3.99, SD=1.146). Inclement weather conditions (MIS=3.96, SD=1.058). No good stores on the site (MIS=3.93, SD=1.053).

Table 4. 16 Quality control challenges on building construction projects in Lagos

	Challenges	Mean	SD
CHA13	Bribery and corruption	4.57	.701
CHA14	Lack of effective quality policy implementation	4.48	.740
CHA15	Inadequate technical knowledge	4.47	.739
CHA1	Inadequate funds/ budgetary allocation	4.45	.838
CHA10	Lack of quality control inspection programme	4.40	.779
CHA11	Insufficient quality control plan	4.38	.742
CHA12	Unrealistic project time	4.36	.879
CHA7	Lack of training/education of construction workers	4.34	.874
CHA20	Supervisors' lack of skills and experience	4.30	.867
CHA9	Inadequate on-time supervision	4.29	.914
CHA8	Poor site safety measures	4.28	.940
CHA26	Lack of modern information system	4.28	.832

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	Challenges	Mean	SD
CHA17	Cost of correcting non-conformance by the contractor	4.28	.850
CHA16	Poor communication among the design and construction team	4.27	.917
CHA18	Non-provision for documentation of non-conformance	4.26	.905
CHA21	Faulty equipment for testing	4.24	1.044
CHA3	Poor testing procedures	4.21	.890
CHA23	A high number of semiskilled and untrained labour	4.17	.916
CHA24	Poor understanding and coordination between stakeholders	4.16	.941
CHA22	High cost of materials and equipment	4.16	.941
CHA25	Lack of supplier evaluation	4.16	.956
CHA27	Poor laboratory for material testing	4.15	.944
CHA5	Poor conduct of review meeting	4.10	.999
CHA2	High cost of testing materials	4.10	1.050
CHA4	Delay in delivering materials	3.99	1.146
CHA19	Inclement weather conditions	3.96	1.058
CHA6	No good stores on the site	3.93	1.053

4.5.2 Factor Analysis Results- Quality Control Challenges

The factors affecting QC management of building construction projects in Lagos, Nigeria, were subjected to principal component analysis (PCA) using SPSS version 28 software. The results are presented in table 4.17 and figure 3 below. However, before carrying out the PCA, the suitability of the data for factor analysis was evaluated. Kaiser-Meyer-Olkin (KMO) was used to determine the suitability of sampling, whilst Bartlett's test measured the strength of the variables. As shown in Table 4.17 below, The KMO is 0.911, which is higher than the recommended minimum value of 0.6 and the value for Bartlett's Test of Sphericity was 0.000, which is less than 0.05. Thus, indicating that the conditions for the use of factor analysis are met. The twenty-seven variables with their codes are presented in table 4.18 below.

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Table 4. 17 Definition of variables

CODES	Variables
CHA1	Inadequate funds/ budgetary allocation
CHA2	High cost of testing materials
CHA3	Delay in delivering materials
CHA4	Poor conduct of review meeting
CHA5	No good stores on the site
CHA6	Lack of training/education of construction workers
CHA7	Poor site safety measures
CHA8	Inadequate on-time supervision
CHA9	Lack of quality control inspection programme
CHA10	Insufficient quality control plan
CHA11	Unrealistic project time
CHA12	Bribery and corruption
CHA13	Lack of effective quality policy implementation
CHA14	Inadequate technical knowledge
CHA15	Poor communication among the design and construction team
CHA16	Cost of correcting non-conformance by the contractor
CHA17	Non-provision for documentation of non-conformance
CHA18	Inclement weather conditions
CHA19	Supervisors lack of skills and experience
CHA20	Faulty equipment for testing
CHA21	The high cost of materials and equipment
CHA22	The high number of a semiskilled and untrained labor
CHA23	Poor understanding and coordination between stakeholders
CHA24	Lack of supplier evaluation
CHA25	Lack of modern information system
CHA26	Poor laboratory for material testing

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Table 4. 18 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.911
Bartlett's Test of Sphericity	Approx. Chi-Square	2173.288
	Df	325
	Sig.	<.001

4.5.3 Communalities Table

Table 4.19 presents the commonalities of the challenges facing quality control management on building construction projects. Principal Component Analysis (PCA) was adopted as an extraction method. The results showed that all the twenty-six factors have values above 0.5 as a minimum value for the acceptability of the results conducted.

Table 4. 19 Communalities table

Factors	Initial	Extraction
1. Inadequate funds/ budgetary allocation	1.000	.563
2. High cost of testing materials	1.000	.601
3. Delay in delivering materials	1.000	.660
4. Poor conduct of review meeting	1.000	.626
5. No good stores on the site	1.000	.647
6. Lack of training/education of construction workers	1.000	.558
7. Poor site safety measures	1.000	.624
8. Inadequate on-time supervision	1.000	.673
9. Absence of a quality control inspection program	1.000	.721
10. Insufficient quality control plan	1.000	.737
11. Unrealistic project time	1.000	.579
12. Bribery and corruption	1.000	.587

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Factors	Initial	Extraction
13. Lack of effective quality policy implementation	1.000	.756
14. Inadequate technical knowledge	1.000	.704
15. Poor communication among the design and construction team	1.000	.642
16. Cost of correcting non-conformance by the contractor	1.000	.641
17. Non-provision for documentation of non-conformance	1.000	.666
18. Inclement weather conditions	1.000	.655
19. Supervisors lack of skills and experience	1.000	.596
20. Faulty equipment for testing	1.000	.717
21. The high cost of materials and equipment	1.000	.678
22. High number of semi-skilled and untrained labor	1.000	.676
23. Poor understanding and coordination between stakeholders	1.000	.746
24. Lack of supplier evaluation	1.000	.637
25. Lack of modern information system	1.000	.728
26. Poor laboratory for material testing	1.000	.726

Extraction Method: Principal Component Analysis.

4.5.4 Total Variance Explained

Table 4.20 shows the challenges facing QC management on building construction projects in Lagos, Nigeria, with their respective eigenvalues. The factors have eigenvalues that were not less than one, and the rotation sum of square loading is between 11.338 and 21.837 (Table 4.20). Four components were extracted to represent the underlying factors: 12.564, 1.853, 1.462, and 1.265, with 48.324%, 7.126%, 5.624%, and 4.865% of their variance, respectively. This means that the

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first group had a 48.32% contribution, the second group had a 7.126% contribution, the third group had a 5.624% contribution, and the fourth group had a 4.865% contribution. The four groups have a total cumulative variance of 65.939%.

Table 4. 20 Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	**12.564**	48.324	48.324	12.564	**48.324**	48.324	5.678	21.837	21.837
2	**1.853**	7.126	55.450	1.853	**7.126**	55.450	4.396	16.907	38.744
3	**1.462**	5.624	61.074	1.462	**5.624**	61.074	4.123	15.856	54.601
4	**1.265**	4.865	65.939	1.265	**4.865**	65.939	2.948	11.338	65.939
5	.982	3.776	69.715						
6	.875	3.366	73.082						
7	.776	2.985	76.067						
8	.673	2.589	78.656						
9	.640	2.460	81.116						
10	.549	2.112	83.228						
11	.490	1.885	85.113						
12	.443	1.703	86.816						
13	.436	1.679	88.495						
14	.383	1.472	89.967						
15	.379	1.456	91.423						
16	.323	1.243	92.666						
17	.296	1.137	93.803						
18	.259	.997	94.801						
19	.239	.919	95.720						
20	.209	.804	96.524						
21	.203	.781	97.305						
22	.181	.698	98.003						
23	.166	.638	98.641						
24	.135	.520	99.161						
25	.115	.441	99.602						
26	.103	.398	100.000						

Extraction Method: Principal Component Analysis.

Value in bold represents the four components retained.

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4.5.5 Scree Plot

Figure 4.9 shows the scree plot for the challenges facing QC management on building construction projects in Lagos, Nigeria, with their eigenvalues. The four groups located on the steep slope were retained. The steep slope represents the factors with an eigenvalue greater or equal to 1 (≥1). while the gradually decreasing components present the factors with an eigenvalue less than 1. the Varimax rotation was carried out to interpret the four groups as displayed in the table 4.21 and 4.22.

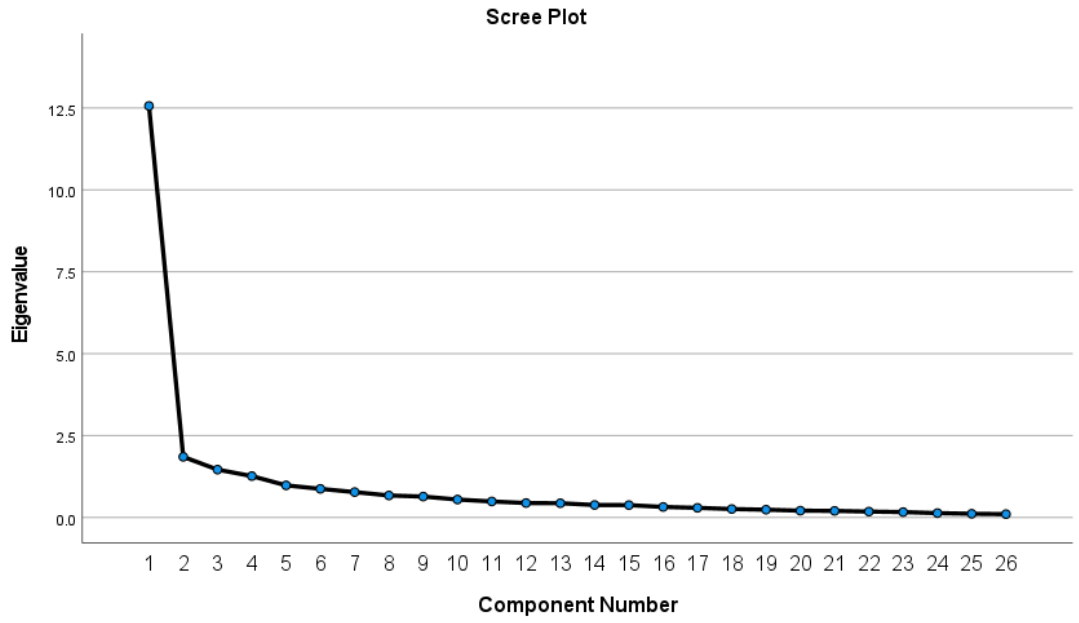

Figure 4. 9 Scree plot for quality control challenges

Table 4. 21 Rotated component matrix

	Component			
	1	2	3	4
1. Inadequate funds/ budgetary allocation	-.026	.027	**.714**	.228
2. High cost of testing materials	.385	.260	**.620**	.029
3. Delay in delivering materials	.400	.223	**.660**	.120
4. Poor conduct of review meeting	.285	.206	**.682**	.192
5. No good stores on the site	.306	.363	**.640**	-.111

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	Component			
	1	2	3	4
6. Lack of training/education of construction workers	.171	**.596**	.361	.209
7. Poor site safety measures	**.663**	.186	.271	.275
8. Inadequate on-time supervision	**.708**	.130	.239	.312
9. Lack of quality control inspection programme	**.692**	.022	.162	.464
10. Insufficient quality control plan	.349	.204	.163	**.740**
11. Unrealistic project time	**.570**	.429	.172	.198
12. Bribery and corruption	.126	.221	.085	**.718**
13. Lack of effective quality policy implementation	.204	.199	.120	**.813**
14. Inadequate technical knowledge	.161	**.748**	.237	.248
15. Poor communication among the design and construction team	.304	**.640**	.105	.360
16. Cost of correcting non-conformance by the contractor	.022	.482	**.524**	.365
17. Non-provision for documentation of non-conformance	**.612**	.405	.161	.319
18. Inclement weather conditions	.330	**.642**	.319	.181
19. Supervisors lack of skills and experience	.304	**.660**	.165	.203
20. Faulty equipment for testing	.581	**.536**	.304	-.009
21. The high cost of materials and equipment	.381	.338	**.645**	-.054
22. High number of a semi-skilled and untrained labour	**.597**	.536	.179	-.008
23 Poor understanding and coordination between stakeholders	**.680**	.485	.216	.045
24. Lack of supplier evaluation	.452	.184	**.562**	.286
25. Lack of modern information system	**.758**	.209	.287	.166
26. Poor laboratory for material testing	**.682**	.409	.267	.153

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalisation.

a. Rotation converged in 9 iterations.

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Table 4. 22 Pattern matrix

	Component			
	1	2	3	4
26. Lack of modern information system	0.758			
9. Inadequate on-time supervision	0.708			
10. Lack of quality control inspection programme	0.692			
27. Poor laboratory for material testing	0.682			
24. Poor understanding and coordination between stakeholders	0.680			
8. Poor site safety measures	0.663			
18. Non-provision for documentation of non-conformance	0.612			
23. High number of semi-skilled and untrained labour	0.597			
23. Faulty equipment for testing	0.581			
13. Unrealistic project time	0.570			
15. Inadequate technical knowledge		0.748		
20. Supervisors lack of skills and experience		0.660		
19. Inclement weather conditions		0.642		
16. Poor communication among the design and construction team		0.640		
7. Lack of training/education of construction workers		00.596		
1. Inadequate funds/ budgetary allocation			0.714	
5. Poor conduct of review meeting			0.682	
3. Delay in delivering materials			0.660	
22. The high cost of materials and equipment			0.645	
6. No good stores on the site			0.640	
2. High cost of testing materials			0.620	
25. Lack of supplier evaluation			0.562	

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	Component			
	1	2	3	4
17. Cost of correcting non-conformance by the contractor			0.524	
14. Lack of effective quality policy implementation				0.813
12. Insufficient quality control plan				0.740
13. Bribery and corruption				0.718

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalisation.

a. Rotation converged in 9 iterations.

4.5.6 Inferential Analysis - Component Analysis of the Four Groups of Challenges and their Factor Loadings

Table 4.23 presents the challenges loaded in each component alongside their unique name. Component one has ten items, and it's named management-related challenges. They include the lack of a modern information system (75.8%). Inadequate on-time supervision (70.8%). Lack of a quality control inspection program (69.2%). Poor laboratory for material testing (68.2%). Poor understanding and coordination between stakeholders (68.0%). Poor site safety measures (66.3%). Non-provision for documentation of non-conformance (61.2%). High number of semiskilled and untrained labour (59.7%). Faulty equipment for testing (58.1%) and unrealistic project time (57.0).

Component two has five components and is named knowledge-related challenges. They include inadequate technical knowledge (74.8%), supervisors' lack of skills and experience (66%), ,nclement weather conditions (64.2), poor communication among the design and construction teams (64%) and a lack of training/education of construction workers (59.6%)

Component three has eight items and is named cost-related challenges. They include inadequate funds and budgetary allocation (71.4%). The high cost of materials and equipment (64.5%). Poor conduct of review meetings (68.2%). Delay in delivering materials (66.2%). High cost of testing materials (64.5%) and no good stores on site (64%). A lack of supplier evaluation (56.2%) and cost of correcting non-conformance by the contractor (52.4%).

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Component four has three items and is named political/legal related challenges. They include a lack of effective quality policy implementation (81.3%). Insufficient quality control plan (74%). and bribery and corruption (71.8%)

Table 4. 23 Component factor analysis of quality control challenges

Components	Quality control challenges
Component 1: Management-related challenges	Lack of modern information system
	Inadequate on-time supervision
	Lack of quality control inspection programme
	Poor laboratory for material testing
	Poor understanding and coordination between stakeholders
	Poor site safety measures
	Non-provision for documentation of non-conformance
	A high number of semi-skilled and untrained labour
	Faulty equipment for testing
	Unrealistic project time
Component 2: Knowledge-related challenges	Inadequate technical knowledge
	Supervisors lack of skills and experience
	Inclement weather conditions
	Poor communication among the design and construction team
	Lack of training/education of construction workers
Component 3: Cost-related challenges	Inadequate funds/ budgetary allocation
	Poor conduct of review meeting
	Delay in delivering materials
	The high cost of materials and equipment
	No good stores on the site
	High cost of testing materials
	Lack of supplier evaluation
	Cost of correcting non-conformance by the contractor
Component 4: Political/legislative-related challenges	Lack of effective quality policy implementation
	Insufficient quality control plan
	Bribery and corruption

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4.6. SECTION E: SUCCESS CRITICAL FACTORS FOR EFFECTIVE QUALITY CONTROL OF BUILDING CONSTRUCTION PROJECTS.

This section of the study is obtained from section B of the questionnaire, which identified the critical success factors for quality control management of building projects. The mean and standard deviation and relative important index analysis are presented below in tables 1 and 2. To determine the importance attributed to each factor as ranked by the respondents for the relative important index analysis, a ranking level used by Lawrence et al. (2021) was adopted in this study; variables with RII <0.53 are assigned =not important, variables with RII>0.599< 0.73=important and those with RII > 0.73 are 'very important'. Also, the factors with the same RII were ranked based on the standard deviation value. That is, the factor with the lowest standard deviation is placed first and given the highest weight.

Based on the RII and the ranking level adopted as shown in table 4.24. The result revealed the relatively important factors as follows. Continuous quality improvement (RII= 0.91, R=1). Quality teamwork (RII=0.91, R=2). Adequate quality control planning (RII= .91, R=3). Testing and measurement of work done (RII=0.91, R=4). Well-defined policies and objectives by the senior management for efficient use of the resource (RII=0.90, R=5). Employees employed with the necessary skills (RII=0.90, R=6). Education and Training (RII=0.90, R=7). Strong commitment of leadership to quality control (RII=0.90, R=8). Availability of funds (RII=0.90, R=9). Communication/Improved employee-management relationship (RII=0.90, R=10). Quality documentation (RII=0.90, R=11). Monitoring and evaluation of construction quality control by third party consultancy (RII=0.89, R=12). Monitoring and evaluation of construction quality control by government agencies (RII=0.89, R=12. Quality control cost (RII=0.89, R=12) and Customer focus (RII=0.87, R=12).

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Table 4. 24 Success critical factors for effective quality control management of building construction projects

Success Factors	Mean	SD	RII	Rank	importance
15. Continuous quality improvement	4.54	.665	.91	1	Very important
12. Quality teamwork	4.53	.652	.91	2	Very important
9. Testing and measurement of work done	4.53	.665	.91	3	Very important
8. Adequate quality control planning	4.53	.727	.91	4	Very important
2. Well-defined policies and objectives by the senior management for efficient use of resources	4.52	.679	.90	5	Very important
7. Employees employed with the necessary skills	4.51	.763	.90	6	Very important
6. Education and Training	4.50	.704	.90	7	Very important
1. Strong commitment of leadership to quality control	4.50	.775	.90	8	Very important
13. Availability of funds	4.48	.704	.90	9	Very important
11. Communication/ Improved employee-management Relationship	4.48	.716	.90	10	Very important
14. Quality documentation	4.48	.716	.90	11	Very important
5. Monitoring and evaluation of construction quality control by third-party consultancy	4.46	.806	.89	12	Very important
4. Monitoring and evaluation of construction quality control by government agencies	4.45	.738	.89	13	Very important
10. Quality control cost	4.43	.749	.89	14	Very important
3. Customer focus	4.36	.739	.87	15	Very important

Chapter Summary

This chapter presents the analysis of the primary data collected from construction professionals working in various construction firms in Lagos, Nigeria, through a well-structured questionnaire and analyzed using SPSS. Descriptive and inferential method of analysis was used to interpret the

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data, while the processed data was represented in the form of tables, figures, graphs, and charts for easy interpretation and understanding.

The next chapter discusses the findings considering the research questions and objectives.

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CHAPTER FIVE

DISCUSSION OF FINDINGS

5.1 INTRODUCTION

This chapter discussed the research findings as analysed in chapter four of this study. The discussion is aimed at answering the research questions, which include:

1. What are the current quality control management practices on Nigerian construction building projects?
2. What is the influence of a quality control manager on achieving effective quality control management on building construction projects?
3. What are the challenges of quality control management practices on building construction projects?
4. What are the critical success factors for effective quality control management practices on construction projects?

5.2 BACKGROUND INFORMATION OF RESPONDENTS

This section presents the background information of the respondents. A total of one hundred and sixteen valid responses were received from the research survey. The survey report of the respondents' information revealed that the construction industry in Lagos is dominated by males (Figure 4.1, page 45). This result is in line with the empirical findings by Adeyemi et al. (2006) that 16.3% of the worker in the construction industry in Lagos are females while males are 83.70% . According to Olatunji et al. (2014), the construction industry needs a more welcoming work atmosphere to attract female professionals.

In terms of the educational qualifications of the respondents, above 70% of the respondents were degree holders, as 42.2% had a bachelor's degree, 21.6% had a master’s degree, and 0.9% had a doctoral degree, 26.7% had a higher national diploma while 4.3% had a national diploma and post graduate diploma. This indicates that the respondents possess the basic knowledge required for data collection. More also, a higher percentage of the respondents comprised civil engineers

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(42.2%), followed by builders (25.9%), quantity surveyors (12.1% project managers (9.5%), and Architects (10.3%). In addition, above 50% of the respondents have working experience of more than six years.

The data analysis on the respondents' positions in their respective organisations revealed that 34.50% were site managers, 25.9% were project managers, 13.8% were managing directors, 11.2% were QA/QC managers, 10.3% were works inspectors and 4.3% were facility managers. In terms of respondents' type of organisation, the most engaged organisational sector is the contractor's organisation (69.8%), followed by the consultant (15.5%), sub-contractor (12.1%), and government organisation (2.6%).

Lastly, the construction industry in Lagos is mostly characterized by small and medium firms, and they are locally owned. The result revealed that 57.8% are small firms, 27.6% are medium firms, and 14.7% are large firms. In terms of the respondents' organisation size and status, 84% of the organisations are locally owned, while 16% are non-indigenous.

In conclusion, the demographic result of the respondents revealed that the respondents are eligible to provide contributions to the study based on their education, experience, and designation.

5.3 OBJECTIVE ONE: THE CURRENT QUALITY CONTROL PRACTICES ON BUILDING CONSTRUCTION PROJECTS IN LAGOS

RQ1: What are the current quality control practices on building construction projects in Lagos?

The knowledge of the respondents on quality control management practices was investigated by asking about their level of awareness of quality control management and the management's attention to QC management. Furthermore, the respondents' knowledge was tested by asking them how familiar they are with quality control standards for driving quality and the quality certification their firms have obtained. Moreover, their application of quality control tools was investigated as well as their awareness and usage of digital QC tools. Lastly, the extent of their firms' involvement in some listed QC practices as obtained from reviewed literature.

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Findings

Based on the descriptive analysis of the respondents' level of awareness of quality control management and the rating adopted. The obtained data revealed that the level of awareness of QC management by the respondents is very high, with a mean score of 4.10 (82%). This lies within the 80 and above percent range set for a very high level of awareness. Also, in terms of the respondents' firm quality certification, 56% (average) of the firms have been certified by ISO, while 78% of the firms claimed to have received certification from SON.

Regarding the standards used to drive quality by the respondents and their firms, the research findings revealed that the respondents' familiarity with British standards is very high (mean= 4.22; 84%) and ranked first, followed by ISO 9000:2015, National Building Code 2006 and The American National Standards Institute (ANSI) with a mean score of 3.85 (77%), 3.84 (77%) and 3.52 (70%), 3.20 (64%) respectively. This indicates that the respondents are highly familiar with quality standards as they fall within the scale of 60-80% for a high level of familiarity. Furthermore, in terms of quality certification of the firms, the findings revealed that an average of 56% of the respondents had their organisations certified by ISO 9000 while 78% had their organisations certified by the standard organisation of Nigeria (SON) certification.

About the respondents' level of familiarity with the seven statistical quality control tools used for quality control management. The result revealed that the histogram was ranked first (MIS=3.40 SD= 1.257). Flow charts ranked second (MIS=3.35 SD=1.144). Control charts ranked third (MIS=3.22 SD=1.156). Cause and effect diagrams ranked fourth (MIS=3.35 SD=1.144). Check sheets ranked fifth (MIS=3.12 SD=1.181). Scatter diagrams ranked sixth (MIS=3.11 SD=1.277) and Pareto charts ranked the least (MIS=2.70 SD=1.203).

Concerning the awareness level of the respondents on digital QC tools, the result revealed that the level of awareness of digital QC is high with a mean of 3.70 (74%). Also, the result of the respondents' level of usage of digital QC tools revealed that the use of a camera was ranked first with a mean score of 3.78 (76%). Building Information Modelling ranked second with a mean score of 3.71 (74%). Geographical Information System ranked third with a mean score of 3.47 (69%). Laser detection and ranging system ranked fourth with a mean score of 3.31 (66%). Laser

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scanners ranked fifth with a mean score of 3.28 (66%). Sensor ranked sixth with a mean score of 3.23. Mobile Computing Technology ranked seventh with a mean score of 3.22. Drones/ Unmanned Aircraft Systems/Vehicles ranked eighth with a mean score of 3.0. Personal digital assistant ranked ninth with a mean score of 3.00 and radio frequency identification ranked tenth with a mean score of 2.85.

Furthermore, as rated by the respondents, the result of the QC practices carried out by their organisations revealed that inspection and testing of executed works ranked first with a mean score of 4.23 (84.6%). The construction process adopted ranked second with a mean score of 4.18 (84%). Material selection and usage ranked third with a mean score of 4.11 (82%). Quality control of material ranked fourth with a mean score of 4.02, (80%). The use of checklist ranked fifth with a mean score of 4.01 (80%). These are the top five QC practices practiced by the firms out of the identified eighteen QC practices while the five least ranked QC practices are quality control laboratory at the construction site which ranked 18th with a mean score of 3.45 (69%), keeping of spare parts/materials for laboratory equipment ranked 17th with a mean score of 3.58 (72%). Maintaining the sequence of construction ranked sixteenth with a mean score of 3.78 (76%). Quality control training ranked fifteenth. Coordination with the project purchase department ranked fourteenth with a mean score of 3.79 (76%) and record of changes ranked thirteenth with a mean score of 3.80 (76%).

Discussion

Historically, quality control is not a recent invention, monitoring the production of goods and services has been a culture right from the olden days. The findings on the quality control practices on building construction projects revealed that the professionals possess a high level of knowledge on QC management, but their level of involvement in QC practices is average. This disagrees with the findings of (Bustani, 2014), that the involvement of professionals in Nigeria's construction industry in QC practices is still low. This implies that there is an improvement in the management of construction-by-construction firms in Lagos. However, inspection and testing of works is the most common QC practice among construction firms in Lagos as it was rated high. The result agrees with the findings of Abdullahi et al. (2019) that the quality technique commonly used by the Nigerian construction industry is inspection. Also, an empirical study by Ahmed et al. (2005)

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revealed that the quality management system adopted by Hong Kong and USA construction industries is constant inspection and monitoring. Additionally, Oyedele (2018) states that a way to control quality is by inspecting and verifying the work done to check compliance with specified standards. This implies that the quality of inspection and testing carried out is dependent on the supervisor's level of training, experience and technical know-how and this in turn determines the quality of work carried out by the firms. In contrast, according to Oludare and Olugboyega (2016), poor quality might be the result of a job supervised by an unknowledgeable supervisor.

Furthermore, the other most used QC practices among construction firms in Lagos as indicated by the respondents, are the construction process, selection of materials, and usage and checklist. Unfortunately, quality control laboratory at the construction site, keeping spare parts/materials for laboratory equipment, and the documentation of quality changes are QC practices scarcely observed by the firms during the execution of work as these practices were ranked least. A quality control laboratory at a construction site is necessary for on-time testing and verification of materials and construction works. It can be assumed that there is inadequate planning for QC management on construction projects in Lagos, thereby resulting in the delay of work verification by quality managers, site managers, and other personnel responsible for QC on construction projects. Also, the maintenance culture of the organisations is average, as adequate provisions for storage and replacement of spare parts and equipment for testing are observed by half of the firms. These inadequacies by these firms may have contributed to the quality issues faced by the industry. Salvi and Kerkar (2020) affirm that compliance with specified standards is possible through a well-equipped laboratory located on-site and at the office.

Abdullahi et al. (2019) argued that a documented quality management system that successfully integrates quality assurance, control, and improvement could only ensure consistency in quality. The respondents indicated that they observe quality data documentation (quality changes and quality status). Moreover, when quality data are merely recorded for the sake of recording rather than being thoroughly examined or subjected to a quality audit to identify failures, successes, and areas for improvement, the quality documentation is useless and may not have any bearing on how well the construction projects perform in terms of quality.

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Also, the level of statistical control tool usage is average among the professionals in Lagos. Histograms, control charts, and check sheets are their most common statistical control tools, while scatter diagrams, and Pareto charts are ranked as the least used by them. This agrees with the situation in Ghana as revealed by Adinyira et al. (2014) that check sheets, flow charts, and histograms are the most used tools. Similarly, as revealed by the study findings, digital tools awareness level and application to QC are just gaining popularity among construction firms in Lagos. The application of PDA, drones and RFID for quality control of building construction projects is, however, average among professionals in Lagos and their organisations as they were ranked least while cameras, BIM, and GIS are the top used digital tools. This agrees with the findings of Ezeokoli et al. (2016) that the construction industry is still in its early stages of digital transformation due to managerial teams' lack of ability, essential knowledge, and passion for digital transformation. Levy (2012) reported that a technique that has assisted Japanese construction projects is the application of technology devices to construction works to solve the complex and strenuous work carried out by humans. There is a need for Nigeria's construction firms to fully embrace digital applications to solve quality issues caused by human errors.

Furthermore, the respondents are highly familiar with the standards used to drive quality, especially the international standards, British standards, and ISO 9000:2015 standards. This agrees with the study by (Emeka, 2020a) which states that in the southeastern part of Nigeria, their level of awareness of quality control regulatory policies of building projects is very high. However, being familiar with quality standards does not only solve quality issues but rather, ensures adequate compliance and commitment to the QC standards. Construction firms in Lagos can be said to be familiar with the quality standards but do not fully comply with their standards. This was verified by the findings of (Adenuga, 2012, Oludare and Olugboyega, 2016) that the compliance of construction firms in Lagos to quality standards is low. Fadason et al. (2017) ascertained that most of the accidents happening on building construction projects are not caused by the workers' negligence alone but by non-compliance of management to standards and controls. Additionally, a higher percentage of the respondents have their organisation certified by SON which implies that most of the construction firms obtained SON certification to be registered and for advertisement purposes. In contrast, ISO 9000 certification has not been fully accepted by construction firms in Lagos. (Abdullahi et al., 2019) agree that ISO 9000 has not been fully implemented in Nigeria's

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construction industry. This low level of certification by ISO could be due to their lack of knowledge about the effects of ISO certification and implementation on construction projects. The empirical findings by Pheng and Wee (2001), Neyestani and Juanzon (2017) revealed that IS0 certification helps to reduce the frequency of defects in building projects.

Implication: The findings imply that construction firms and professionals in Lagos have yet to fully adopt the concept of modern latest QC practices. This agrees with the findings of Bustani (2014) that the involvement of professionals in Nigeria's construction industry in QC practices is still low. Lagos firms do not efficiently use both statistical tools and digital QC tools. This agrees with the situation in Ethiopia industries as found by Ahmad (2018). Their inefficiency could be due to the lack of technical knowledge or the high costs of digital tools thereby hindering the timely and effective QC of construction projects.

Therefore, to proactively identify defects on construction sites and in real-time, the use of technology devices for quality control on building construction projects is essential. Hence, the industry needs to transition to the application of digital tools for quality control management to ensure speed and accurate work control in real-time.

Furthermore, some of the construction firms in Lagos do not continue in the quality management process once the certification has been endorsed, resulting in quality issues on construction projects. It can also be assumed that the construction firms are not consistent with the quality control management practices adopted on the execution of construction projects in Lagos projects due to a lack of adequate quality control planning and program for quality management and improvement.

5.4 OBJECTIVE TWO: QUALITY CONTROL MANAGER INFLUENCE ON ACHIEVING EFFECTIVE QUALITY CONTROL MANAGEMENT

RQ2: What is the influence of a quality control manager on achieving effective quality control management on building construction projects?

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5.4.1 The Influence of Quality Control Managers

Findings

The descriptive result of the percentage of firms with quality managers revealed that 69.8% of the population claimed to have a quality manager, while 30.2% had no quality manager. Regarding the level of agreement of the professionals on QC manager influence on the QC management of building construction projects through MIS and standard deviation of the variables, every construction site should have a quality control manager responsible for implementing quality plans and checklists have a mean of 4.59 and a standard deviation of .769. Based on the rating scale adopted, this indicates that 92% of the respondents indicated that a quality control manager should be resident on a construction site to implement quality plans and checklists. The findings also revealed that 89% of the respondents agreed that hiring a quality control manager to commit to the project would ensure quality compliance, with a mean score of 4.46 and a standard deviation of .888. Ninety-one percent (91%) agreed that assigning responsibility for quality control management on-site to a quality control manager causes an increased level of success. Furthermore, the results on the level of agreement by the professionals revealed that there is no significant difference in their level of agreement on QC influence.

Discussion: More than an average of the construction firms have a quality manager while the remaining firms do not have a quality manager. It can be assumed that these firms employ quality managers to get a contract and fulfil contractual obligations rather than implementing quality management to meet the client's needs. Moreover, firms without a quality manager in their firms might be due to the firm size, job size, or income level. Concerning the influence of quality control on construction projects, most respondents indicated that every construction site must have a QC manager who will be responsible for implementing quality plans and checklists. This agrees with the argument of (Bustani, 2014) that a qualified professional should be a resident on a construction site whose responsibility will be mainly QC management. However, Marasini and Quinnell (2010) argued that assigning quality management to the quality manager might cause other people who should be responsible for quality management to ignore their duty.

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Implications: This implies that there is a need for construction sites to have a quality control manager on site to implement quality plans even if others forget or decide to ignore compliance with specified standards. Similarly, the respondents opined that doing this will ensure quality compliance and in turn result in an increased level of success. However, the duty of ensuring quality work should be the priority of each member of the construction team to make the quality control officer's duty easy. Hence, the reduction of reworks in construction projects.

5.4.2 Roles of a Quality Control Manager

Findings

The surveyed respondents were asked to rate the quality control roles required for effective QC management. Based on the descriptive analysis and the ranking through MIS and standard deviation, respectively. The findings revealed the most important quality control roles for effective quality control management on building projects as follows; Ensuring compliance with national and international standards of production processes. Supervised construction processes to identify defects and deviations in the quality policies. Monitors the compliance of suppliers to quality. Engages in meetings, gets feedback from clients, submits documented reports, and helps external auditors. Develops ways to improve the production process techniques to ensure high-quality outputs. Devise ways to come up with new techniques to reduce waste during the production phase and maximize resources. Sets quality standards as regards the safety of workers during the production process. Keeping accurate documentation and statistical analysis. Monitors technicians and other members to ensure that they perform their assigned duty following quality standards. Have an in-depth understanding of customer requirements and communicate with them to have adequate quality control processes. Reviews the final product, compares it with the initial requirements, and rejects or approves the final product complying with quality standards.

Furthermore, the Kruskal-Wallis test findings compared the level of agreement of individual respondents against their profession, and the test revealed that the level of significant factor (P value) for each QC role is greater than the significant level; 0.05%<Pvalue, indicating that there is no significant difference among the professionals. Hence, the acceptance of all the hypotheses.

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Discussion: Based on the data analysis and findings, all the roles were rated high, indicating that all the QC manager roles are of utmost importance and are to be conducted by the QC manager. Furthermore, from the test of agreement between the professionals and their response, there was a common agreement between the professionals that all the quality control manager roles are required for effective QC management. This implies that ensuring compliance with construction quality standards, monitoring of workmanship and supervision of the construction process, quality reports and documentation as well as feedback from the client for quality improvement, and devising ways for improvement of the construction process and methods are the key significant roles of a quality control manager or project control team on building construction projects based on the respondents ranking. The findings concur with that of Gremyr et al. (2021) that quality departments' roles in terms of practices are firefighters, auditors, process improvers, and orchestrators. All these are conducted to improve the quality of the product manufactured.

Implication: This implies that the companies adopt the quality control manager role to manage the quality of building construction projects. Therefore, the operational role of the quality control manager can be narrowed down to the customer's voice, production process improvement, standardisation, performance monitoring, communication, and reporting. However, quality control management must involve a complex effort that has the support of the entire building crew.

5.4.3 Competency of Quality Control Manager

Findings

The respondents' opinion on the important competencies required for quality control management on building construction projects in Lagos, Nigeria, based on their rankings through the mean score and standard deviation revealed that knowledge of building codes and standards with a mean score of 4.33 and standard deviation of .902 was ranked first, commitment and willingness to learn new methods and systems ranked second with a mean score of 4.28 and standard deviation of .940. Character ranked third with a mean score of 4.27 and a standard deviation of .888. Teamwork ranked fourth with a mean score of 4.27 and a standard deviation of .898. Sound judgment and decision-making ranked fifth with a mean score of 4.27 and a standard deviation of .908. Furthermore, the least ranked competency was good and effective

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supervisory skills, ranked tenth with a mean score of 4.07 and a standard deviation of 1.069. Leadership and development skills ranked ninth with a mean score of 4.15 and a standard deviation of .99., Good working knowledge and QA/QC implementation ranked eighth with a mean score of 4.25 and a standard deviation of .986. Construction experience ranked seventh with a mean score of 4.25 and a standard deviation of .922 and knowledge of material tests and equipment ranked sixth with a mean score of 4.27 and a standard deviation of .972.

Discussion: The use of quality control managers in building construction projects in Lagos has called for construction companies to manage their competencies, as these are required for better project performance. The survey responses revealed that knowledge of building codes and standards is what most of the respondents deem as the most significant competence. This means that the respondents believe that the competency to be looked at in construction QC managers is the knowledge of the standards governing building construction to ensure effective QC implementation. This is in line with Ingason and Jónsdóttir (2017) findings that knowledge is one of the pillars of a quality manager's competency. Brooks et al. (2021) also emphasized that knowledge and construction experience are required of quality experts. This was revealed in his empirical survey of the quality management system of the construction sector in the UK. They found that the construction experience possessed by the quality experts that set up the quality systems in the organisations is less than those that are expected to use the system. Thus, leading to a faulty quality management system. Therefore, there is a need for quality experts on construction projects to possess vast knowledge and more construction experience as this is required in establishing procedures or strategies that will help deliver quality.

Furthermore, the respondents also believe that commitment and willingness to learn new methods and systems, character, teamwork, sound judgment and decision-making are important. This indicates that aside from knowledge competency, the other requirement is personal competency. The findings of Lee et al. (2011) also point out that judgment is among the competency required of a QC team. A quality manager must interact with staff members at all organisational levels and with other stakeholders to hear other points of view and make choices without being biased.

Implication: This implies that the competency required of a quality control manager in construction projects is knowledge and personal competency. The knowledge competency

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includes knowledge of building standards and codes, good and effective supervisory skills, good working knowledge and QA/QC implementation, construction experience and knowledge of material tests and equipment while the personal competency includes commitment and willingness to learn new methods and systems, character, teamwork, sound judgment, decision making and leadership.

5.5 OBJECTIVE THREE: THE CHALLENGES OF QUALITY CONTROL MANAGEMENT PRACTICES ON BUILDING CONSTRUCTION PROJECTS.

RQ3 What are the challenges of quality control management practices on building construction projects?

Findings

From the descriptive analysis, the result revealed the quality control challenges as follows: bribery and corruption (MIS= 4.57, SD=.701). Lack of effective quality policy implementation (MIS=4.48, SD=.740). Inadequate technical knowledge (MIS=4.47, SD=.739). Inadequate funds/budgetary allocation (MIS=4.45, SD=.838). Lack of quality control inspection program (MIS=4.40, SD=.779). Insufficient quality control plan (MIS=4.38, SD=.742). Unrealistic project time (MIS=4.36, SD=.879). Lack of training/education of construction workers (MIS=4.34, SD=.874). Supervisors lack of skills and experience (MIS=4.30, SD=.867). Inadequate on-time supervision (MIS=4.29, SD=.914). Lack of modern information system (MIS=4.28, SD=.832). Cost of correcting non-conformance by the contractor (MIS=4.28, SD=.850). Poor communication among the design and construction team (MIS=4.27, SD=.917). Non-provision for documentation of non-conformance (MIS=4.26, SD=.905). Faulty equipment for testing (MIS=4.24, SD=1.004). Poor testing procedures (MIS=4.21, SD=.890). High number of semi-skilled and untrained labor (MIS=4.17, SD=.916). Poor understanding and coordination between stakeholders (MIS4.16=, SD=.941). The high cost of materials and equipment (MIS=4.16, SD=.941). Lack of supplier evaluation (MIS=4.16, SD=.956) and poor laboratory for material testing (MIS=4.15, SD=.944),

The five least ranked variables are poor conduct of review meetings (MIS=4.10, SD=.999). High cost of testing materials (MIS=4.10, SD=1.050). Delay in delivering materials (MIS=3.99,

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SD=1.146). Inclement weather conditions (MIS=3.96, SD=). No good stores on the site (MIS=3.93, SD=1.053) respectively.

The factor analysis result revealed that the challenges facing building construction projects in Lagos are in four categories: management-related challenges, knowledge-related challenges, cost-related challenges, and political or planning-related challenges.

From the analysis, 10 factors were grouped as management-related challenges. The knowledge-related challenges identified were 5 factors, the cost-related challenges were described by 8 factors and the political or planning-related challenges comprises of three factors. (Please kindly see Table 4.23, page 76)

Discussions

5.5.1 Component 1: Management-Related Challenges

The lack of modern information systems has the highest factor loading, followed by inadequate on-time supervision, lack of quality control inspection program, poor laboratory for material testing, poor understanding and coordination between stakeholders, poor site safety measures, non-provision for documentation of non-conformance, a high number of semiskilled and untrained labour, faulty equipment for testing and unrealistic project time. This coincides with the findings of Arowolo et al. (2019).

Among the items in this group, the lack of modern information systems is also a challenge facing quality control on building projects in Lagos. This agrees with the findings of Datti et al. (2019) that the means of acquiring and disseminating information in Nigeria's construction industry is still paper-based. Some of the organisations in Lagos are not willing to change the information collection system. This may be a result of the high cost of the information system or lack of technical know-how of the professionals, or awareness of its full benefit. However, quality control management requires efficient and real-time quality data collection and collaboration among project participants right from the planning phase through to the completion of the project.

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Furthermore, from the responses of the respondents, another challenge facing quality control in Lagos is the lack of a quality control inspection program. The quality control inspection program outlines the item to be inspected, means of inspection, inspection time, and personnel to ensure that work conforms to the specified standard. A lack of quality control inspection programs can result in poor and late inspection exercises. Hence, reducing its effectiveness in error prevention (Serpell et al., 2002). Poor planning for inspection can be said to have contributed to the increasing number of failures in building structures in Lagos.

The study's result also disclosed that poor laboratory for material testing is a factor affecting quality control of construction buildings in Lagos. This is in line with the findings of Arowolo et al. (2019) that insufficient laboratories are a factor hindering quality control in Nigeria. As it is known that material is one of the important resources in construction projects that determine the output of the work. However, some of the laboratories available for testing the quality of materials do not have sufficient facilities for material testing, and in some cases, the equipment was old and faulty. This affects the test result. Similarly, the respondents identified that a high number of unskilled and untrained labourers is a threat to quality control management. Poor skill makes it difficult for workers to perceive and apply the concepts of quality control and limits of tolerance for building production. More also, Ayodeji (2011) and Ede et al. (2021) revealed that the use of unskilled workers is the cause of building collapse in Nigeria. This indicates that most of the firms do not make sufficient provisions for the training of the workers to increase their skills and knowledge of the latest method for carrying out construction work. Ahmad (2018) recommends that different types of training, both short-term and long-term should be provided to the staff to increase the effectiveness and quality of their individual management systems.

Additionally, the research respondents also disclosed that non-provision for documentation of non-conformances is a factor affecting QC management. This inadequacy prevents them from monitoring the productivity changes, having reasonably accurate estimates of rework costs and reviewing for better performance. Lastly, setting unrealistic project times is said to be another challenge facing the QC of building constructions in Lagos. Due to unrealistic project time, tests and necessary action for quality verification are being omitted or uncompleted by the project manager or quality manager due to the clients' pressure on delivering the work. As a result, the quality of construction projects suffers.

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Implication: It can be said that there is no full support by the top management of the construction firms and the government towards the essential needs required for effective quality control implementation. This agrees with the findings of Baguma (2021) that a lack of management commitment is a critical challenge in the quality control of buildings. The attitude or commitment of an organisation's management to quality determines the effectiveness of quality control. The top management is the main driver of quality control implementation as they have the power to establish and support the QC practices required for the customer requirements to be met. Lack of support by the management can cause quality managers, supervisors, and construction professionals to experience drawbacks in carrying out their duty effectively. Thus, top management needs to participate in the quality management movement.

5.5.2 Component 2: Knowledge-Related Challenges

The factors in this group agree with the findings of Idris Othman et al. (2020) and Kimeria et al. (2019) on the limited knowledge of supervisors on QA/QC procedure. The respondents stated that inadequate technical knowledge, lack of supervisor skills and experience, and ack of training and education of construction workers are challenges of quality control management. This finding implies that some supervisors and managers in Lagos do not possess the necessary expertise and sufficient skills needed to discharge their duties accordingly. This conforms with the findings of Boadu et al. (2020) that a lack of skill is a major characteristic of the construction industry, especially in developing countries. Lee et al. (2011) as well ascertained that construction experience is an important competence required by the project control team. In addition, the findings revealed that lack of training is also a challenge facing quality control management of building projects. This indicates that some construction industries rarely embark on training programs. This attribute of lack of training by the organisation and government can be said to have contributed to the lack of technical knowledge by construction workers in Lagos. QC personnel do not have the technical knowledge of the innovation and modern equipment used for QC management.

Iruobe et al. (2012) emphasised that training helps individuals and organisations to improve quality, competitiveness, productivity, incoming changes, and set out future ideas. Furthermore, an unclear project scope is said to be a challenge to quality control management. Ashokkumar

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(2014) opines that unclear construction details are a factor that prevents quality from being achieved and that the complexity of construction projects requires a high level of skill as well as experience. Also, there is poor coordination among the design and construction team in Lagos, Nigeria, regarding the difficulties and non-conformances with the quality of work to provide strategies for improvement. Each team sees itself as superior to the other by pointing out the finger at the error caused by another rather than cooperating to enhance the buildability and quality of construction works. Therefore, communication and coordination must be improved between the parties to the project to empower them to address the issues brought about by what they perceive as the pervasive uncertainties of work on site.

5.5.3 Component 3: Cost-Related Challenges

The items in this group were named cost-related challenges because the factors addressed cost-related issues. As indicated by the respondents, the challenges are inadequate funds and budgetary allocation, the high cost of materials and equipment, the poor conduct of review meetings and delay in delivering materials. In addition, the high cost of testing materials, difficulty in supplier evaluation, poor on-site stores facilities, and cost of correcting non-conformance by the contractor were also noted as cost-related challenges. The findings agree with Baguma (2021) that inadequate funds, the high cost of materials and equipment, poor conduct of review meetings and delays in delivering materials are critical challenges of construction quality control.

Furthermore, the respondents reported that one of the challenges facing QC of construction projects in Lagos is the high cost of purchasing materials and necessary equipment. The rise in building material costs could be a result of the general inflation rate trends in the country. The costs of materials are constantly being adjusted to account for the market's rocketing price increase. Due to this restriction, most firms are unable to procure high-quality materials or obtain the appropriate tools for quality control in laboratories. Similarly, the high cost of testing materials limits the organisations in carrying out the required test in each stage of construction projects effectively. Some of the quality personnel are being constrained by their organisation's inadequacy in providing funds to carry out material tests. There is a need for government to ensure adequate control of material and equipment costs. Also, the testing laboratories are to be equipped with modern equipment to fast-track the testing procedures and enhance accurate test results. Moreover,

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both organisations and governments should allocate enough funds for QC exercises to reduce building failure costs.

Furthermore, inadequate provision for storage is a factor affecting the quality control of construction projects. This agrees with the findings of Idris Othman et al. (2020) that among the challenges of quality implementation in the construction industry is poor storage which eventually leads to material wastage. In addition, the lack of good storage provisions for materials results in the deterioration and theft of materials and equipment on site.

A building construction project involves the delivery of various items, such as materials and components, to the site for final use. However, supplier evaluation has been a challenge. This problem might result from the complex and one-off nature of projects and many independent contractors, consultants, sub-contractors and suppliers involved in the project.

AlMaian et al. (2015) ascertain that most engineering managers struggle to increase supplier performance while working with constrained time, financial, and technical resources. The study recommends that engineering managers can create plans to improve supplier performance through efficient quality personnel training and education to identify the underlying causes of poor-quality issues, strategic supplier selection procedures to address quality issues and long-term supplier partnership decisions to establish a reliable supplier base for upcoming projects.

5.5.4 Component 4 - Political/legislative Related Challenges

This component was named political/legislative related challenges because it contains factors addressing issues related to quality control policy. The factors include a lack of effective quality policy implementation, insufficient quality control plan, bribery and corruption. The quality policy is a statement by an organisation concerning its value towards the delivery of a quality project. However, the respondents indicated that the quality policy implementation of the firms in Lagos fails in implementing their promise of achieving quality. This means that some construction firms only make this policy for advertisement and reputation building. They do not comply with quality standards and fully implement quality management practices, thus affecting the quality control of building projects. This may be because of the cost implication of quality implementation or lack of awareness of the full benefit of the quality cost. However, it is beneficial for the government

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and these firms to embark on activities that will improve their performance than spending more on reworks.

The findings also revealed that there is no sufficient quality control plan for construction quality management in Lagos. This is contrary to the findings of Oludare and Olugboyega (2016) that construction firms in Lagos usually develop plans to control the quality of work and materials on site and adhere to the client's specifications.

A quality control plan is a document prepared to outline all steps required in managing quality through the phases of the project: preconstruction (planning and peer-reviews), construction and post-construction. Some construction firms and government agencies do not make provisions for adequate QC planning, thereby resulting in poor QC implementation. Therefore, there is a need for an adequate plan for QC practices to eliminate confusion and delay and ensure strict compliance with specified standards.

Lastly, the research findings also revealed that bribery and corruption is a significant factors affecting the effective quality control of projects in Lagos. This agrees with the findings of Arowolo et al. (2019) and Oni et al. (2019). Bribery and corruption practices can cut across the phases of construction projects if not curbed. During the procurement exercise, quality control management ensures that the contractor or individual that will be assigned to execute the project meets the criteria for selection and is awarded the contract. These criteria include experience, expertise, success history, manpower and resource commitment, price, and many more. But due to bribery and corruption by some stakeholders and government officials, regulatory agents and quality personnel, contractor selection was not based on merit, which significantly impacts the overall project quality management.

Aside from this, bribery and corrupt attitudes of the client in disobeying laws and regulations controlling the construction of work in achieving quality is one of the critical factors facing quality control management of construction projects. In addition, some quality experts alter quality control reports and test results to suit their client's requests because of money.

According to Ayodeji (2011), unethical behaviour, such as bribe collection from consultants, contractors and professionals acting in a capacity out of the job scope, has a negative effect on

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building compliance and may finally result in a building collapse. Brooks et al. (2021) recommend that the forging of quality regulations should be socially made undesirable, and this should begin with official induction training on the quality systems, which will set expectations from the outset of employment and eliminate the justification of ignorance and "social contagion" that occurs when undesirable behaviours are passed down from old hands to new hires.

Implication: The research findings imply that all the factors critically affect quality control management and should be addressed to ensure adequate quality control management on construction projects.

5.6 OBJECTIVE FOUR: THE CRITICAL SUCCESS FACTORS FOR EFFECTIVE QUALITY CONTROL MANAGEMENT PRACTICES ON CONSTRUCTION PROJECTS

RQ4: What are the critical success factors for effective quality control management practices on construction projects?

Findings

The result of the relative importance index revealed the critical important factors for effective quality control management as follows: continuous quality improvement (RII= 0.91, R=1), quality teamwork (RII=0.91, R=2), adequate quality control planning (RII=.91, R=3), testing and measurement of work done (RII=0.91, R=4), well-defined policies and objectives by the senior management for efficient use of resource (RII=0.90, R=5), employees employed with the necessary skills (RII=0.90, R=6), education and training (RII=0.90, R=7), strong commitment of leadership to quality control (RII=0.90, R=8), availability of funds (RII=0.90, R=9), communication/improved employee-management relationship (RII=0.90, R=10), quality documentation (RII=0.90, R=11), monitoring and evaluation of construction quality control by third party consultancy (RII=0.89, R=12), monitoring and evaluation of construction quality control by government agencies (RII=0.89, R=12), quality control cost (RII=0.89, R=12) and customer focus (RII=0.87, R=12).

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Discussions

The result revealed that all the factors are very important in achieving effective QC management of building projects as they all have RII > 0.73, which was assigned for critically important factors. Also, these identified factors are in agreement with the findings of other studies, such as (Lawrence et al., 2021). However, from the factors, continuous quality improvement was ranked first. Some of these factors are explained below:

5.6.1 Continuous Quality Improvement

According to Liepiņa et al. (2014), the quality control process gives information about the product, the process of production, and the necessity for improvement. This suggests that Lagos's quality control procedures have been designed to identify errors rather than to target issues before they arise and prevent a recurrence. According to Mitra (2016), efforts involved in the elimination of non-conformances in production should be continuous as quality improvement is a non-ending process.

Quality improvement is concerned with identifying and eliminating the causes of poor project performance which can be achieved only by the joint effort and support of both the management and individuals involved in the construction process. Quality control exercise is incomplete until the QC reports and feedback are reviewed to determine the root causes and devise ways for improvement of the construction process and methods. The quality control system provides bases for continuous improvement as it helps individuals to ensure all aspects are done correctly. Tam et al. (2000) suggest that for continuous quality improvement to be achieved, quality systems should be completely incorporated into the organisation and industrial culture as well as provision of monetary quality awards to construction companies who are performing excellently in quality. A method adopted by Singapore construction firms. Delgado-Hernandez and Aspinwall (2008) conducted a research survey on seven construction companies in the UK by investigating the strategies adopted by these firms in handling quality issues. The strategies used by these companies for continuous improvement include quality is the responsibility of all the departments, the company’s quality system evaluation conducted by a third-party, constant personnel training on quality policies, improving workers motivation and incentives, quality audits, efficient

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communication and quality document control, the use of key performance indicators (KPI) and customer satisfaction surveys.

It can also be observed that the top management's commitment to quality is a factor that drives continuous improvement. In conclusion, the goal of quality improvement should be geared toward customer satisfaction and not toward profitability alone.

5.6.2 Commitment of Leadership to Quality Control

According to Standardization (2005), commitment to quality management is recognised when the top management demonstrates leadership and commitment to customer satisfaction, the establishment of a quality policy that sets out quality objectives, continuous improvement of the quality management system, communication of quality policy within the organisation, assignment and communication of organisational roles, responsibility and authorities within the organisation. Mane and Patil (2015) suggest that the pillars of continual improvement are dedication and teamwork, which must start with the top management and expand throughout the entire firm.

5.6.3 Quality Control Planning

Unclear requirements are often reported as the cause of project failure (Taylor, 2008). Quality control planning involves the establishment of the quality requirement of the project phases, the cost, the best way and the time to implement them. Quality control planning is an essential step that must be carried out before a project's commencement to prevent failure. The QA/QC is saddled with the responsibility of implementing the quality control plan. The QC plan of a project comprises information on the planned techniques to be used in accomplishing quality control for all work products, including organisation, quality assurance records, quality control reviews, the suggested method of documentation of comments and coordinating answers (Salvi and Kerkar, 2020).

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5.6.4 Education and Training

This concurs with the findings of Bustani (2014) and Aichouni (2012) that training is a critical factor required in meeting the desired quality control goals in the building production process

Training personnel has been proven to be key to ensuring standardisation and reducing error and mistakes, reducing rework and cost. Stephens (1979) reported that a factory in the US had about 4000 employees trained its staff beginning from the top management, inspectors and workers for seven years. A total of twenty-seven million dollars was saved as there was a reduction in waste and excessive supervision. Joseph and Joseph (2010) ascertained that training must not be meant for quality departments alone but should extend to all levels, including the top managers, to achieve better results. Furthermore, the quality control training should cover the QC concept, methodology and management, and all aspects of the work. Also, technicians and the industry at whole should be trained on quality tools, testing procedures and techniques. This training can be organised by quality control organisations, government bodies, professional bodies, industry associations, and many more.

Odusami et al. (2007) analyzed the education requirements for managers of several building sites in Lagos. The findings showed that human and industrial relations, building production and project management, communication skills, and computing should all be covered in site manager training. Lastly, the purpose of the training program should be to improve the employees capabilities and skills to achieve improvement (Pheng and Hong, 2005).

5.6.5 Quality Teamwork

According to Tengan and Aigbavboa (2021) the nature and the changing needs of construction projects, as well as the complexity of the construction processes in an organisation, makes the control of construction projects by an individual difficult. Teamwork is the only effective option to address process improvement. Quality teamwork in construction is the collective agreement and effort of the project participants starting from the leadership through to the workers, thus ensuring that quality work is done. A comparative study by Xiao and Proverbs (2002) on the quality performance of contractors in the UK, US and Japan revealed that Japan has a superior quality performance than the other countries on construction projects due to the good working relationship

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trait possessed by Japanese contractors. Tabassi et al. (2014) suggest that teamwork can be improved through training and motivation programs for employees.

5.6.6 Communication

Day-to-day and constant discussion on issues or problems is essential among project participants. There should be clear communication among the stakeholders, managers, foremen and all the workers involved in the project. This is essential to prevent clashes, errors, and delays in construction work. These communications are often in the form of QC reports. A project stakeholder is an individual or group of people who has a vested interest in the success of a project and the environment in which the project operates (Olander and Landin, 2005). Stakeholder involvement in building construction involves determining how to plan, developing the scope statement, selecting the planning team, identifying deliverables and creating the work breakdown structure. Additionally, it involves identifying the activities needed to complete those, networking these activities in their logical sequence and estimating the resource requirements for the activities (Lawrence et al., 2021). They also have the power to withdraw necessary resources from an organisation. Stakeholder influence on a company's quality management determines the performance of the organisation. Therefore, better communication and coordination among stakeholders, project participants, workers and supervisors can enhance teamwork and the quality of construction projects.

According to Levy (2012), one of the traits that have helped Japanese contractors is adequate information. All the project participants, as well as workers, are fully informed of the project requirements. The managers and top officials are committed to keeping all workers informed collectively and personally. Al-Musleh (2011) denotes that it is also the responsibility of the QA/QC department to clearly and timely communicate the work progress as well the implementation of changes to the top management, the client, stakeholders and all project participants. Therefore, if Lagos construction firms can also put all efforts into ensuring an effective communication and information system, the constant argument among project participants, as well as errors made by workers, will reduce.

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5.6.7 Monitoring and Evaluation of construction quality by Third-Party Consultancy

Project monitoring refers to the evaluation of a project's performance to see whether it complies with the stated objectives or goals, while project evaluation involves the review of a project that already exists (Igbokwe-Ibeto, 2012). A project that is not well monitored could result in project failure. The hiring of consultants to monitor and evaluate the quality of construction is an act of assuring that goods and services meet the specified or required standard. This is usually conducted by a competent organisation independent of trading interests. Using external consultants for monitoring and evaluating construction projects is a common practice in developed countries (Otieno, 2000). A third-party consultant is an independent body apart from the contractor, who is responsible for the inspection and certification of the quality of every aspect of the construction projects undertaken.

According to Dudgikar et al. (2012), the inspection generates the following reports: performance report (workmanship), material tests reports (materials), conformance report (codes and specifications) and quality cost reports (failure, appraisal and prevention costs). However, these consultants must provide an accurate, timely and transparent report to the right body.

5.6.8 Availability of Funds

Financial resources are necessary for the success of any business (Al-Musleh, 2011). According to Tengan and Aigbavboa (2021), budgetary allocation is a factor influencing monitoring and evaluation. Finance is necessary to pay supervisors, inspectors, quality personnel or other professionals responsible for monitoring or assessment of construction projects for their time, the information support system, their transportation, and other requirements. These also include the cost of training and educating labours to improve their skills and knowledge of quality control, as well as non-operational expenses like stationery, meetings and allowances for key stakeholders and project developers (Shihemi, 2016).

Therefore, there is a need for the government to allocate adequate funds for the management and control of building projects. Additionally, when salaries are not paid on time and other concerns, such as job insecurity, the workers motivation is negatively affected, resulting in reduced output (Shoar and Banaitis, 2019). Therefore, there is a need for construction firms and clients to set aside

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sufficient funds for the project before the start, as this would help effective quality control management implementation on construction projects and improve the quality of work at large.

5.6.9 Quality Documentation

Documentation control in quality management entails the following records material procurement records, construction process changes, field testing, and the facility's final inspection (Khan et al., 2008). Documentation helps to aid quality review and quality improvement processes. According to Al-Musleh (2011), documentation is necessary for lessons learned to avoid the repetition of errors, and it should be used in conjunction with training. Therefore, the government should help improve the quality documentation process by providing modern information technologies. Also, sections of training should be established by government and professional bodies to increase the technical abilities of professionals, quality personnel, and control agencies.

5.6.10 Monitoring and Evaluation of construction quality by Government bodies

The government has long been involved in quality management to ensure the safety and health of the citizens and the state's economy. The quality reputation of a city may be an asset or liability (Joseph and Joseph, 2010). However, the government can protect its quality reputation by enforcing quality control on construction projects and construction industries. Though many strategies have been put in place to control quality such as the SON, whose responsibility is to control the quality of both imported and local materials by inspecting the finished product and affirming their seal on it to verify the product quality.

Also, the local government is saddled with the responsibility of control of activities in their domain. The Lagos state also established bodies such as the Ministry of Physical Planning and Urban Development and the Lagos State Building Control Agency (LASBCA) for inspection and quality control of construction projects in the state. However, studies have shown that some of these bodies lack sufficient resources to carry out their duties (Igbokwe-Ibeto, 2012). These shortages of resources include a lack of qualified workers, inadequate finance, and insufficient modern quality control devices and information technology. Therefore, adequate plans and resources for quality control should be enforced and supported by the government to enhance efficient QC management of building projects.

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5.6.11 Quality costs

Quality cost is a cost that makes the difference between a costly and a better way of achieving quality (Low and Yeo, 1998). Quality costs are set aside to meet the specified requirements of a product. They are costs associated with conformance to quality standards and non-conformance to quality standards. They include prevention costs, appraisal costs and failure costs (Keogh, 1994). However, most organisations do not make provision for quality costs, thereby affecting the QC of building projects. This may be a result of them not being aware of the full benefits of QC cost. There is a need for construction firms and the government to invest more in activities that will prevent rework. Activities that are beneficial such as quality improvement activities (prevention cost) rather than spending money to rectify non-conformances. These improvement practices can include training, quality auditing and process control.

5.7 DEVELOPMENT OF A QUALITY CONTROL MANAGEMENT FRAMEWORK

Figure 5.1 presents a proposed quality control framework for managing building projects in Lagos, Nigeria. This framework was developed based on the findings of this research objectives: the quality control practices, the influence of quality control managers, the challenges facing quality control management and the critical success factors for the effective management of building projects in Lagos, Nigeria. Also, literature on quality management, quality assurance, and project management by other researchers was considered, as a few studies had addressed the quality control framework. The developed framework covers the quality control of construction projects from inspection to completion. Factors required for successful and effective quality control management on building construction projects were incorporated into the framework.

The framework starts with quality control management practices in terms of the control of all the factors involved in the execution of construction projects. These factors include workmanship, construction materials, process, plants and equipment and the construction environment (refer to pages 20-23). The causes of ineffective quality control management on building construction projects and the factors for efficient QC management were identified in the framework. Moreover, the influence of QC managers on building projects was presented as well as their roles and competencies. The performance indicator of an efficient quality control system in terms of its

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outcome on a construction project was also highlighted. These include an increase in customer satisfaction, efficient use of resources, reduced cost, increase in productivity and profitability, employee improvement, increased goodwill, safety performance and faster project delivery.

In conclusion, the framework below is suggested as a solution that will help improve the quality control management practices on building construction projects in Lagos, Nigeria.

Framework Application

Achieving effective QC management on construction projects in developing countries has been a challenge, especially in Lagos, Nigeria. In light of this, this study proposes a framework that can be applicable to the control and management of building construction projects in Lagos. Aside from this, the proposed framework is unique as in terms of usage, it is capable of assisting construction professionals, construction firms and all other construction stakeholders in tackling the root cause of poor quality control management of construction projects through the quality control challenges highlighted. Besides this, from the graphical framework, it can be established that, in spite of the quality issues faced in the management of construction projects, the inadequacies in a project can still be curbed and improved and that effective quality control management practices have the ability to produce a better result on construction projects.

In essence, the proposed framework shall serve as a guide to construction stakeholders and firms for the successful implementation of effective quality control of construction projects in Lagos and other developing countries.

Framework Validation

The developed framework, as shown in figure 5.1, was tested using qualitative method of validation by consulting five professionals who are academicians and construction practitioners. The professionals were chosen based on their working experience of fifteen years and above in the construction industry. The professionals evaluated the proposed framework's relevance, correctness and effectiveness, and various opinions were made on areas needed for improvement. As examined by the professionals and with all corrections made, it can be concluded that the

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proposed framework would be effective for quality control management of building construction projects in Lagos, Nigeria.

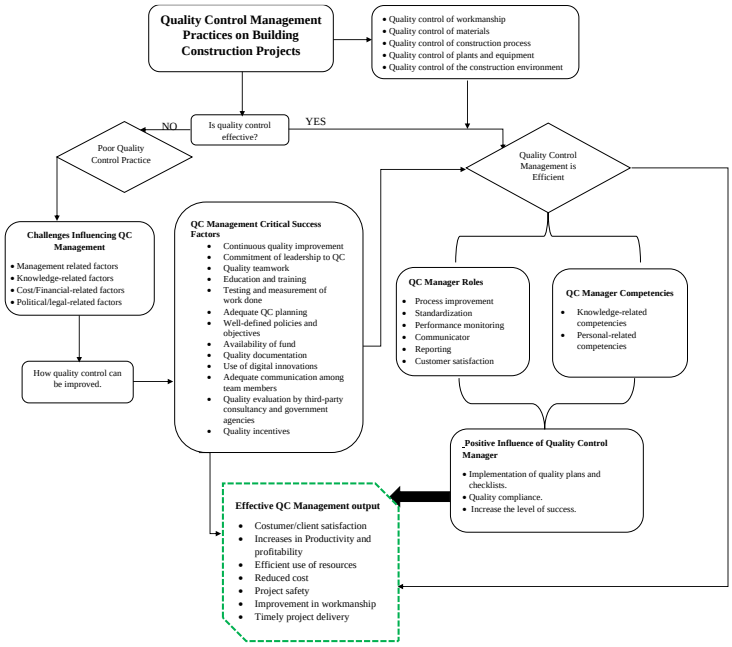

Figure 5. 1 A framework towards effective quality control management on building construction projects in Lagos, Nigeria.

Chapter Summary

This chapter discussed and summarised the research findings concerning the study's goal and objective, thereby achieving the study's primary goal.

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CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 INTRODUCTION

This chapter presents the conclusion and recommendation on the research objectives and findings.

6.2 CONCLUSION

This study investigated the current quality control management practices on building construction projects in Lagos, the challenges inhibiting effective quality control and the influence of construction quality control managers in terms of their role and competency in achieving effective quality management toward the development of a framework for effective quality control management practice on building construction projects in Lagos Nigeria.

The study successfully revealed that the professionals and the construction firms in Lagos are aware of QC management, but the implementation of QC management practices is average. The most common QC practices on building construction projects in Lagos are inspection and testing of executed works, construction process, quality control of material and use of a checklist. The study concludes that the firms still adopt a traditional method and firefighting approach to control the quality of work being carried out, and control the effect, instead of focusing on practices that will improve project performance and reduce failures. Additionally, there was insufficient preparation and provision for a lab with the right tools, training for managers and employees, recording quality data, storing materials, and maintaining spare parts and testing equipment, which are crucial for quality control and improvement procedures. Regarding QC tools, the most common statistical control tools used are histograms, control charts, and check sheets. In contrast, the use of digital tools for quality control is still in its infancy. Construction firms in Lagos are only now becoming more aware of them and using them, thus limiting the ability of quality managers and quality control agencies to identify and address non-conformances quickly.

Furthermore, the professionals are highly familiar with the standards that drive quality, but their compliance is low. Familiarity with quality standards would not only solve quality issues faced by

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the industry but also create adequate compliance and commitment to the QC standards. Similarly, construction firms are certified mainly by SON and few by ISO 9001, however, the industry faces quality issues. This implies that the firms received certification for registration, advertisement, and contracting purposes. The certification bodies need to continue in the certification exercise by visiting the production process of the certified firms from time to time.

Regarding the influence of quality control managers on a quality control management system of building construction projects, the study found that having quality managers and inspectors involved from the project's conception through to its completion will help to ensure the implementation of quality plans and checklists, boost quality compliance and increase the project's level of success. The primary role of QC required for effective QC management should focus on customer satisfaction, production process improvement, standardisation, performance monitoring, communication, and reporting. However, their duties should not focus on pointing fingers at errors but rather on collaborating with the design and construction team, and the purchasing department to improve the quality of building projects.

Furthermore, based on the study findings on QC competencies, the study concludes that their competency should be based on knowledge-related and personal-related competencies. QC managers should have full knowledge of construction standards and building codes, material tests and equipment, QA/QC implementation process, practical supervisory skills, and adequate construction experience. On the other hand, the personally related competencies should include commitment and willingness to learn new methods and systems, character, teamwork, leadership, sound judgment, and decision-making.

The challenges facing quality control management on building construction projects in Lagos were classified into management, knowledge, cost, and political/legal related challenges. The implementation of QC management in Lagos lacks full support from the top management of the construction firms and the government concerning the essential needs required for effective quality control management of building projects. These include non-provision for lack of quality control inspection program, poor laboratory for material testing, poor understanding and coordination between stakeholders, poor site safety measures, non-provision for documentation of non-conformance, a high number of semiskilled and untrained labour, faulty equipment for testing and

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unrealistic project time. The critical challenges related to knowledge were a lack of skilled workers, knowledgeable supervisors and quality control training programs relating to eliminating reworks and failures in building projects. The cost-related challenges are inadequate funding allocation for quality control programs implementation and poor economy, resulting in high prices of construction materials and laboratory equipment for testing. This indicates that the government needs to implement strategies to reduce and control the cost of purchasing construction materials as well as the fee imposed on material testing. In terms of the political/legislative-related challenges, bribery and corruption were the most significant factors affecting Lagos QC management. Some quality control agencies and inspectors who are responsible for enforcing quality standards, conformity and building safety are involved in bribery. This attitude makes them approve faulty drawings, provide false quality reports and certify a project without adequate inspection. Hence, resulting in construction fatalities.

On this note, the study identified success factors required for effective QC management in Lagos and presented a framework for effective QC management of building projects in Lagos. The factors include continuous quality improvement, quality teamwork, adequate quality control planning, testing and measurement of work done, well-defined policies and objectives by the senior management, employees with the necessary skills, education and training, availability of funds, communication/ improved employee-management relationship, quality documentation, monitoring and evaluation of construction quality control by third party consultancy, monitoring and evaluation of construction quality control by government agencies, quality control cost and being customer focused.

In conclusion, an effective QC of building projects can help reduce the possibility of alterations, mistakes and omissions on building projects in Lagos, Nigeria, provided that the QC management is appropriately implemented and embraced by all construction stakeholders, professionals and regulatory agencies. The focus is the direction of an improved and satisfactory project quality performance of building projects in Lagos. Lastly, individuals need to have a quality mindset of doing things right to achieve quality control goals.

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6.3 RECOMMENDATIONS

This research developed a framework for effective QC management by investigating the QC practices on building projects in Lagos. Based on the study findings and conclusion, the following recommendations were drawn:

1. Quality control management should transition from a traditional control method to a digitalised quality control system.
2. The government and professional bodies should create more awareness of the benefits and applications of digital QC tools on building projects among construction professionals, as this will help put the industry ahead of others and reduce human error in production.
3. The government should legalise the use of QA/QC managers or third-party QC consultants from project inception through to completion to ensure strict compliance to quality standards.
4. To reduce building failure costs, the government should allocate sufficient funds for the implementation of quality control programs.
5. The management of construction firms in Lagos State needs to consider its hiring standards and the areas where it can develop its human resources. They should embark upon quality control training programmes such as conferences, workshops, seminars, radio and television to advance and develop quality managers and all construction project participants' knowledge of QC management practices. Practical exercises should be included to allow for the application of the newly acquired knowledge.
6. The government should ensure that information about organisations involved in construction projects in Lagos, such as quality record history, is made available publicly and easily accessible. This will serve as a means of controlling the organisations' performance and execution of projects in Lagos.
7. The government, construction firms and professional bodies should embark more on quality control promotional programs such as awareness, training and quality awards to organisations that are performing excellently.
8. For efficient quality audits and improvement, adequate arrangements should be provided for the documentation of quality data and feedback by clients.

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In conclusion, the foundation of a high-quality reputation is not based on one organisation but on a group of organisations. Achieving quality should be the obligation and responsibility of the government, the public, associations, organisations and construction professionals. In addition, quality control agencies, ministries, quality certification organisations, and professional bodies should collaborate towards implementing a successful quality control management of construction projects in Lagos.

6.4 LIMITATION

The study is limited to construction firms in Lagos, Nigeria. Also, uncertainty existed regarding respondents' readiness to disclose failings in their organisations. Therefore, further studies should investigate the quality control practices on construction sites in Lagos.

Furthermore, the developed framework is yet to be experimentally validated on construction projects and construction firms as a real-life outcome is needed to determine its appropriateness and reliability.

6.5 AREAS FOR FURTHER STUDIES

Further studies should address the following:

1. Quality control management of building projects at the national level.
2. Awareness and adoption of digital quality control systems for quality management of construction projects.

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REFERENCES

Abdullahi, U., Bustani, S., Hassan. A. and Rotimi, F. 2019. Assessing Quality Management Practice in Nigerian Construction Industry. *Journal of Construction Business and Management,* (3)2: 17-25.

Acharya, A. S., Prakash, A., Saxena, P. and Nigam, A. 2013. Sampling: Why and how of it. *Indian Journal of Medical Specialties,* 4**,** 330-333.

Adedoyin, O. 2020. Research Methodology.

Adenuga, O. 2012. Compliance to Quality Standards in the Construction of Infrastructural Services in Lagos State, Nigeria.

Adeyemi, A. Y., Ojo, S. O., Aina, O. O. And Olanipekun, E. A. 2006. Empirical evidence of women under-representation in the construction industry in Nigeria. *Women in Management Review,* 21**,** 567-577.

Adinyira, E., Ayarkwa, J. And Aidoo, I. 2014. Knowledge and usage of the Seven Basic Quality Control tools by producers of precast concrete products in Ghana. *Journal of Construction Project Management and Innovation,* 4**,** 966-975.

Ahmad, I. 2018. Implementation of Quality Control.

Ahmed, S. M., Aoieong, R. T., Tang, S. L. And Zheng, D. X. 2005. A comparison of quality management systems in the construction industries of Hong Kong and the USA. *International Journal of Quality & Reliability Management*.

Aichouni, M. 2012. On the Use of the Basic Quality Tools for theImprovement of the Construction Industry: A Case Study of a Ready Mixed Concrete production process. *International Journal of Civil & Environmental Engineering IJCEE-IJENS,* 12**,** 30-38.

``

Akande, B., Debo-Saiye, B., Akinjobi, S., Alao, T. And Akinrogunde, O. 2016. Causes, effects and remedies to the incessant building collapse in Lagos State, Nigeria. *International Journal of Basic & Applied Sciences IJBAS-IJENS,* 16**,** 15-30.

Akinci, B., Boukamp, F., Gordon, C., Huber, D., Lyons, C. And Park, K. 2006. A formalism for utilization of sensor systems and integrated project models for active construction quality control. *Automation in construction,* 15**,** 124-138.

Al-Musleh, A. M. 2011. *Development of a framework for total quality management principles in the construction companies with special reference to the construction companies in the state of Qatar.*

Almaian, R. Y., Needy, K. L., Walsh, K. D. And Alves, T. D. C. L. 2015. Supplier Quality Management Inside and Outside the Construction Industry. *Engineering Management Journal,* 27**,** 11-22.

Alvi, M. 2016. A manual for selecting sampling techniques in research.

Amade, B. 2016. Constructability tools and techniques in use in the Nigerian construction industry. *PM World Journal,* 5**,** 1-19.

Amani, M. 2017. Quality control and safety during construction. *Int. J. Mech. Eng. Technol,* 8**,** 108-113.

Arber, S. 2001. Designing samples. *Researching social life,* 2**,** 58-82.

Arditi, D., Gluch, P. And Holmdahl, M. 2013. Managerial competencies of female and male managers in the Swedish construction industry. *Construction Management and Economics,* 31**,** 979-990.

Arditi, D. And Gunaydin, H. M. 1997. Total quality management in the construction process. *International journal of project management,* 15**,** 235-243.

Arora, N. And Ogra, A. 2012. Mobile GIS for construction quality managers and surveyors. *Proc. GISSA Ukubuzana*.

``

Arowolo, T., Kolawole, O., Adewale, A. And Adeyemi, O. 2019. Factors Affecting Quality Control in Building Construction.

Ashokkumar, D. 2014. Study of quality management in construction industry. *International Journal of Innovative Research in Science, Engineering and Technology,* 3**,** 36-43.

ASQ. 2022. *the definition of quality* [Online]. American Society for Quality (ASQ). Available: https://asq.org/quality-resources/quality-glossary [Accessed 2022].

Awoyera, P., Alfa, J., Odetoyan, A. And Akinwumi, I. Building Collapse in Nigeria during recent years–Causes, effects and way forward. IOP Conference Series: Materials Science and Engineering, 2021. IOP Publishing, 012021.

Ayodeji, O. 2011. An examination of the causes and effects of building collapse in Nigeria. *Journal of Design and Built environment,* 9.

Baguma, A. 2021. *Assessment of quality management practices of building construction firms in Uganda: a case of Kamwenge district.* Kyambogo University (unpublished work).

Boadu, E. F., Wang, C. C. And Sunindijo, R. Y. 2020. Characteristics of the construction industry in developing countries and its implications for health and safety: An exploratory study in Ghana. *International journal of environmental research and public health,* 17**,** 4110.

Bowman, K. O., Hopp, T. H., Kacker, R. N. And Lundegard, R. J. 1991. Statistical Quality Control Technology in Japan. *CHANCE,* 4**,** 15-21.

Brooks, T., Gunning, J. G., Spillane, J. P. And Cole, J. 2021. Regulatory decoupling and the effectiveness of the ISO 9001 quality management system in the construction sector in the UK – a case study analysis. *Construction Management and Economics,* 39**,** 988-1005.

Bustani, S. And Oyemogum, I. 2014. Quality control mechanisms in building production management in nigeria.

``

Code, B. 2006. Federal Republic of Nigeria: National Building Code. *Abuja*.

Crosby, P. B. 1982. One Point of View: Quality Assurance: The Management of Quality. *Research Management,* 25**,** 10-12.

Datti, Y. U., Dahiru, A. And Olamilokun, O. 2019. Assessment of Information Technology Adoption in Project Information Exchange in Nigerian Construction Industry. *ARID ZONE JOURNAL OF ENGINEERING, TECHNOLOGY AND ENVIRONMENT,* 15**,** 226-236.

Delgado-Hernandez, D. J. And Aspinwall, E. 2008. Quality management case studies in the UK construction industry. *Total Quality Management & Business Excellence,* 19**,** 919-938.

Dudgikar, C., Kumthekar, M. And Khot, S. 2012. Development of ERP module for quality management in construction industry. *International Journal of Electronics and Communications (IJEC),* 1**,** 29-40.

Ede, A. N., Akpabot, A. I., Oyebisi, S. O., Olofinnade, O. M., Okeke, C. A., Oyeyemi, K. D., Ugwu, E. I. And Gambo, F. The trend of collapse of buildings in concrete materials in Lagos State, Nigeria (2013-2019). *IOP Conference Series: Earth and Environmental Science, 2021.* IOP Publishing, 012078.

Elg, M., Gremyr, I., Hellström, A. And Witell, L. 2011. The role of quality managers in contemporary organisations. *Total Quality Management & Business Excellence,* 22**,** 795-806.

Ellis, G. 2010. *Construction Quality Management 101* [Online]. Available: https://constructionblog.autodesk.com/construction-quality-management/ [Accessed].

Emeka, O. H. 2020. Assessment of Awareness and Compliance to GovernmentRegulation Policy Aspect on Quality Control of Building Projects in the Nigerian Construction Industry. *International Journal of Research in Engineering and Science (IJRES),* 8**,** 8-16.

``

Ezeokoli, F. O., Okolie, K. C., Okoye, P. U. And Belonwu, C. C. 2016. Digital transformation in the Nigeria construction industry: The professionals' view. *World Journal of Computer Application and Technology,* 4**,** 23-30.

Fadason, R., Danladi, C. And Sharon, J. 2017. Construction Standard and Regulation in Nigeria. *Surveying the world of tomorrow-From digitalisation to augmented reality***,** 15.

Feigenbaum, A. V. 1983. *Total Quality Control,* McGraw-Hill, New York.

Field, A. 2005. Discovering Statistics Using SPSS For Windows. SAGE Publications Ltd p. 816.

Fox, M. J. 2013. *Quality assurance management*, Springer.

Gbonegun, V. And Olorunlomeru, A. 2021. Lagos and burden of recurring collapse of structures. *The Guardian Nigeria News – Nigeria and World News.*

Getu, A. And Quezon, E. T. 2021. Factors Affecting Supervision Practice of Public Building Construction Projects in Dire Dawa Administration. *Available at SSRN 3925018*.

Gordon, C. And Akinci, B. Technology and process assessment of using LADAR and embedded sensing for construction quality control. Construction Research Congress 2005: Broadening Perspectives, 2005. 1-10.

Goundar, S. 2012. Research methodology and research method. *Victoria University of Wellington*.

Gremyr, I., Elg, M., Hellström, A., Martin, J. And Witell, L. 2021. The roles of quality departments and their influence on business results. *Total Quality Management & Business Excellence,* 32**,** 886-897.

Hooper, D. 2012. Exploratory factor analysis.

``

Idris Othman, H. M., Napiah, M., Ghani, S. N. M. And Zoorob, S. 2020. FRAMEWORK TO ENHANCE THE IMPLEMENTATION OF QUALITY MANAGEMENT SYSTEM IN CONSTRUCTION. *International Journal of Engineering*, 78-91.

Igbokwe-Ibeto, C. J. 2012. Issues and challenges in local government project monitoring and evaluation in Nigeria: The way forward. *European Scientific Journal,* 8.

Imafidon, M. And Ogbu, C. 2020. A taxonomy of building collapse causes in Lagos State Nigeria. *Nigerian Journal of Technology,* 39, 74-86.

Ingason, H. Þ. And Jónsdóttir, E. R. 2017. The house of competence of the quality manager. *Cogent Business & Management,* 4, 1345050.

Iruobe, O. J., Ojambati, T. S., Akinpade, J. A. And Iruobe, T. 2012. An investigation into the impact of total quality management application in the construction industry (a case of training). *Journal of Emerging Trends in Engineering and Applied Sciences,* 3, 344-348.

ISO, 9000:2015. Quality management systems: Fundamentals and vocabulary. *London: British Standards Institution*.

Joseph, M. J. And Joseph, A. D. F. 2010. *Juran's Quality Handbook: The Complete Guide to Performance Excellence, Sixth Edition,* New York, McGraw-Hill Education.

Juran, J., Taylor, F., Shewhart, W., Deming, E., Crosby, P., Ishikawa, K., Feigenbaum, A., Taguchi, G. And Goldratt, E. 2005. Quality control. *Joseph M. Juran: Critical Evaluations in Business and Management,* 1, 50.

Keogh, W. 1994. The Role of the Quality Assurance Professional in Determining Quality Costs. *Managerial Auditing Journal,* 9, 23-32.

``

Khan, A. H., Azhar, S. And Mahmood, A. Quality assurance and control in the construction of infrastructure services in developing countries–a case study of Pakistan. First International Conference on Construction in Developing Countries (ICCIDC-I), 2008.

Kimeria, N. W., Kising'u, T. M. And Oyoo, J. J. 2019. Effect of project management practices on quality control of building construction in Nairobi County. *International Journal of Social Sciences and Information Technology,* 6**,** 33-46.

Lakshmi, R. Quality control and quality assurance in building construction. National Conference on Research Advances in Communication, Computation, Electrical Science and Structures (NCRACCESS-2015), 2015.

Lawrence, M., Andrew, B. And Joel, M. 2021. Assessment of Quality Management Practices of Building Construction Firms in Uganda: A Case of Kamwenge District. *Journal of Civil, Construction and Environmental Engineering,* 6**,** 77.

Lee, T. S., Kim, D.-H. And Lee, D. W. 2011. A competency model for project construction team and project control team. *KSCE Journal of Civil Engineering,* 15**,** 781-792.

Leedy, P. D. And Ormrod, J. E. 2005. *Practical research*, Pearson Custom Saddle River, NJ, USA.

Levy, S. M. 2012. *Japanese construction: an American perspective*, Springer Science and Business Media.

Liepiņa, R., Lapiņa, I. And Mazais, J. 2014. Contemporary issues of quality management: relationship between conformity assessment and quality management. *Procedia-Social and Behavioral Sciences,* 110**,** 627-637.

Lou, J., Xu, J. And Wang, K. 2017. Study on construction quality control of urban complex project based on BIM. *Procedia engineering,* 174**,** 668-676.

Low, S. P. And Yeo, H. K. 1998. A construction quality costs quantifying system for the building industry. *International Journal of Quality & Reliability Management*.

``

Magar, V. M. And Shinde, V. B. 2014. Application of 7 quality control (7 QC) tools for continuous improvement of manufacturing processes. *International Journal of engineering research and general science,* 2**,** 364-371.

Mane, P. P. And Patil, J. R. Quality management system at construction projects. Proceedings of the Civil Engineering PG Conference-2015, 2015. 24.

Marasini, R. And Quinnell, P. 2010. Investigation of quality management practices in building construction sites in the UK. *Association of Researchers in Construction Management, Leeds, UK***,** 1307-1316.

Matranga, G. 2021. *11 Essential Skills Your Quality Management Team Needs* [Online]. Available: https://www.infinityqs.com/blog/january-2019/quality-team [Accessed].

Mitra, A. 2016. *Fundamentals of quality control and improvement*, John Wiley and Sons.

Ndubisi, O. 2019. Why buildings keep collapsing in Lagos and what can be done about it. *The Conversation Africa*.

Neyestani, B. And Juanzon, J. B. Impact of ISO 9001 standard on the quality cost of construction projects in the Philippines. Proceedings of 2017 Manila International Conference on "Trends in Engineering and Technology"(MTET-17) Jan, 2017. 23-24.

Nyakala, K. S., Pretorius, J.-H. And Vermeulen, A. 2019. Factor analysis of quality assurance practices in small and medium-sized road-construction projects: A South African perspective. *Acta Structilia,* 26**,** 1-41.

O'brien, J. J. 2013. *Construction inspection handbook: Quality assurance/quality control*, Springer Science and Business Media.

Odeyemi, S. O., Giwa, Z. & Abdulwahab, R. 2019. Building collapse in Nigeria (2009-2019), causes and remedies–a review. *USEP: Journal of Science and Engineering Production,* 1**,** 123-135.

``

Odiba, O. 2018. *A model for effective quality management practices in construction organisations: the case of Nigeria.* Loughborough University.

Odusami, K., Oyediran, O. And Oseni, A. 2007. Training needs of construction site managers. *Emirates Journal for Engineering Research,* 12**,** 73-81.

Odutola, A. 2021. The rising spate of building collapse in Nigeria. *Nairametrics.* Nairametrics.

Oke, A., Aigbavboa, C. And Dlamini, E. Factors Affecting Quality of Construction Projects in Swazilland. Conference: Conference: 9th International Conference on Construction in the 21st Century, At Dubai, UAE, 2017.

Oke, A. E. And Aghimien, D. O. 2018. Drivers of value management in the Nigerian construction industry. *Journal of Engineering, Design and Technology,* 16**,** 270-284.

Okoye, P., Ngwu, C. And Ugochukwu, S. 2015. Evaluation of management challenges facing construction practice in Nigeria. *International Journal of Application or Innovation in Engineering & Management,* 4**,** 19-28.

Okunola, O. H. 2022. Survival of the fittest: Assessing incidents of building collapse and reduction practices in Lagos, Nigeria. *Environmental Quality Management,* 31**,** 141-150.

Oladinrin, T., Ogunsemi, D. And Aje, I. 2012. Role of construction sector in economic growth: Empirical evidence from Nigeria. *FUTY Journal of the Environment,* 7**,** 50-60.

Olander, S. And Landin, A. 2005. Evaluation of stakeholder influence in the implementation of construction projects. *International journal of project management,* 23**,** 321-328.

Olatunji, S., Oke, A. And Owoeye, L. 2014. Factors affecting performance of construction professionals in Nigeria. *International journal of engineering and advanced technology,* 3**,** 76-84.

``

Oludare, O. S. And Olugboyega, O. 2016. Quality management practices among construction firms in Lagos State, Nigeria. *PM World J,* 5**,** 1-13.

Oni, O., Amusan, L., Owolabi, J. And Akinbile, B. Factors affecting quality management practices on building construction sites in Nigeria. Journal of Physics: Conference Series, 2019. IOP Publishing, 012009.

Osegbo, C., Okolie, K., Okeke, A., Ezeokoli, F. And Akaogu, A. 2021. Quality Management Practices of Building Construction Firms in Project Delivery in Anambra State, Nigeria. *International Journal of Progressive Research in Science and Engineering,* 2**,** 113-121.

Oseghale, G., Ikpo, I. J. And Ajayi, O. 2015. Causes and Effects of building collapse in Lagos State, Nigeria. *Civil and Environmental Research,* 7**,** 34-43.

Osuizugbo, I. C. 2018. Builder's view on the incessant building failures and collapse in Nigeria: A call for an effective national building code. *American Journal of Engineering Research,* 7**,** 173-180.

Oyebode, O. J. 2013. Solid waste management for sustainable development and public health: A case study of Lagos State in Nigeria. *Universal journal of public health*.

Oyedele, O. A. 2018. A study of control measures of building collapse in Lagos State, Nigeria. *FIG Congr*.

Pallant, J. 2020. *SPSS survival manual: A step by step guide to data analysis using IBM SPSS*, Routledge.

Palmer, B. 2006. Selling quality ideas to management. *Quality progress,* 39**,** 27.

Peters, W. S. 1987. Quality Control. *Counting for Something.* Springer.

Pheng, L. S. And Hong, S. H. 2005. Strategic quality management for the construction industry. *The TQM Magazine,* 17**,** 35-53.

``

Pheng, L. S. And Wee, D. 2001. Impact of ISO 9000 on the reduction of building defects. *Architectural Science Review,* 44**,** 367-377.

Preethi, S. And Manoharan, M. 2017. Project management and its effects of quality control in construction sector. *International Journal of Engineering and Management Research (IJEMR),* 7**,** 92-96.

Priya, S., Dhanasekar, R., Vijayalakshmi, P., Siva, A. And Vignesh, P. 2017. Experimental investigation on partially replacement of cement, coarse aggregate by corn cob ash and steel slag. *International Journal for Innovative Research in Science & Technology,* 3**,** 209-214.

Priyadharsan, A. K. S. And Raja, M. N. 2020. Impact of Quality Control and Management in Constructions. *International Research Journal of Engineering and Technology (IRJET),* 7**,** 3968-3974.

Rojas, E. 2013. Identifying, Recruiting, and Retaining Quality Field Supervisors and Project Managers in the Electrical Construction Industry. *Journal of Management in Engineering* 04**,** 424-434.

Romanova, A. 2016. Improving the Quality of Construction Works in Terms of the Self-regulation. *Procedia Engineering,* 150**,** 2108-2112.

Salvi, M. S. S. And Kerkar, M. S. S. 2020. Quality assurance and quality control for project effectiveness in construction and management. *International Journal of Engineering Research and Technology (IJERT),* 9**,** 26-29.

Sanni, A. And Windapo, A. Evaluation of contractor's quality control practices on construction sites in Nigeria. Proceedings 24th Annual ARCOM Conference, 2008. 1-3.

Savitha, R. 2012. Importance of quality assurance of materials for construction work. *Building materials Research and Testing division***,** 1-5.

Serpell, A., De Solminihac, H. And Figari, C. 2002. Quality in construction: The situation of the Chilean construction industry. *Total Quality Management,* 13**,** 579-587.

``

Shah, R., Pitroda, J. And Patel, C. 2012. Quality Control Management in Building Construction. *National Conference on Advances in Engineering and Technology (NCAET-2012).* Kalol Institute of Technology and Research Centre, Kalol.

Shammas-Toma, M., Seymour, D. And Clark, L. 1998. Obstacles to implementing total quality management in the UK construction industry. *Construction Management and Economics,* 16**,** 177-192.

Shihemi, R. 2016. *Influence of monitoring and evaluation tools on projects performance of building and construction projects in Kenyan public universities: A case of the University of Nairobi.* University Of Nairobi.

Shoar, S. And Banaitis, A. 2019. Application of fuzzy fault tree analysis to identify factors influencing construction labor productivity: a high-rise building case study. *Journal of Civil Engineering and Management,* 25**,** 41-52.

Siddiqui, I. 2016. *Practical Lessons in Quality Control for Building Construction*.

Standardisation, I. O. F. 2005. *Quality Management Systems--Fundamentals and Vocabulary*, International Organisation for Standardisation.

Stephens, K. S. 1979. SECTION 4-KNOWLEDGE REQUIRED FOR INDUSTRIAL QUALITY CONTROL. *J SPECIAL PUBLICATION 543***,** 113.

Stojcetovic, B., Misic, M., Živče, Š. And Zvecan, V. 2013. *QUALITY TOOLS IN PROJECT MANAGEMENT*.

Sullivan-Bolyai, S. And Bova, C. 2014. Data analysis: Descriptive and inferential statistics. *Nursing Research-E-Book: Methods and Critical Appraisal for Evidence-Based Practice***,** 310.

Sultan Al Aryani, M. M. 2011. Monitoring and Improving the Effectiveness of Quality Control and Quality Assurance in Road Construction at Al-Ain Municipality.

Symeou, L. And Lamprianou, I. 2008. Approaches of research and methodology.

``

Tabassi, A. A., Ramli, M., Bakar, A. H. A. And Pakir, A. H. K. 2014. Transformational leadership and teamwork improvement: the case of construction firms. *Journal of Management Development*.

Tam, C. M., Deng, Z. M., Zeng, S. X. And Ho, C. S. 2000. Quest for continuous quality improvement for public housing construction in Hong Kong. *Construction Management and Economics,* 18**,** 437-446.

Tang, S., Ahmed, S. M., Aoieong, R. T. And Poon, S. 2005. *Construction quality management*, Hong Kong University Press.

Taylor, J. 2008. *Project scheduling and cost control: planning, monitoring and controlling the baseline*, J. Ross Publishing.

Tengan, C. And Aigbavboa, C. 2021. Validating factors influencing monitoring and evaluation in the Ghanaian construction industry: a Delphi study approach. *International Journal of Construction Management,* 21**,** 223-234.

Wai, K. And Cho, M. 2013. Assessment on Factors Causing Poor Quality in Building Construction of Myanmar. *Fourth International Conference on Science and Engineering(ICSE 2013).*

Wang, J., Sun, W., Shou, W., Wang, X., Wu, C., Chong, H.-Y., Liu, Y. And Sun, C. 2015. Integrating BIM and LiDAR for real-time construction quality control. *Journal of Intelligent & Robotic Systems,* 79**,** 417-432.

Wang, L. C. 2008. Enhancing construction quality inspection and management using RFID technology. *Automation in construction,* 17**,** 467-479.

Wei, J. Application of Quality Control Techniques in Construction Projects. Advanced Materials Research, 2012. Trans Tech Publ, 1513-1518.

``

Xiao, H. and Proverbs, D. 2002. The performance of contractors in Japan, the UK and the USA: An evaluation of construction quality. *International Journal of Quality & Reliability Management*.

Yong, A. G. and Pearce, S. 2013. A beginner's guide to factor analysis: Focusing on exploratory factor analysis. *Tutorials in quantitative methods for psychology,* 9**,** 79-94

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APPENDIX

APPENDIX A

Questionnaire Survey on "Developing a Framework towards Effective Quality Control Management Practice on Building Construction Projects in Nigeria: A Case Study of Lagos"

I am Oyewole Margaret Damilola, a Master's student in the Department of Construction Management and Quantity Surveying, Durban University of Technology, Steve Biko Campus, Durban, South Africa. I am currently conducting research on "**Quality Control Management Practices on Building Construction Projects in Lagos, Nigeria."**

This study aims to develop a framework towards effective quality control management practices on building construction projects in Lagos, Nigeria.

This questionnaire, therefore, seeks to:

1. Investigate the current quality control management practices on building construction projects in Lagos, Nigeria.
2. Examine the challenges of quality control management practices on building construction projects in Lagos, Nigeria.
3. Determine the influence of quality control managers on quality control management on building construction projects in Lagos, Nigeria.
4. Identify the critical success factors for effective quality control management practices on building construction projects in Nigeria.

You are kindly requested to complete this questionnaire. There are no names required in this survey. Participation is voluntary, and you can withdraw at any time with no negative consequences. The questionnaire will take about 20 to 25 minutes to complete. The data collected will be treated anonymously,and the survey findings will be used for the research purposes only. Please note that there are no risks, current or anticipated, to you as a participant in this research. Your cooperation will be appreciated. For any queries or comments regarding the survey, please contact 22175863@dut4life.ac.za Cell:+27711777142, or modupem@dut.ac.za cell: +27744870101.

Your completion of the survey will be understood to meet the requirements of informed consent according to the following:

"I have been invited to participate in the above-named study and have also been informed about my involvement in the research and what is required of me. I understand that:

- My participation in this research is voluntary
- I may withdraw from the research at any time with no negative consequences for myself
- This study has been described to me in a language that I understand
- My answers will be kept confidential
- I agree that my responses from the questionnaire can be used for the research

With full knowledge of all the foregoing, I agree to participate in this study.
Thank you in anticipation of your positive response to this request

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Section A: Background Information

This section of the questionnaire refers to background information. Please note that your response will remain anonymous. Your co-operation is appreciated.

1. **Please indicate your Gender**
- ☐ Male
- ☐ Female

2. **Indicate your highest educational qualification completed?**
- ☐ National Diploma (ND)
- ☐ Higher National Diploma (HND)
- ☐ B. tech/BSc
- ☐ PGD
- ☐ Master's Degree
- ☐ Doctorate (PhD)
- ☐ Other (please specify) …….

3. **Please indicate your profession**
- ☐ Builder
- ☐ Quantity Surveying
- ☐ Architect
- ☐ Engineer
- ☐ Other (please specify)……..

4. **Please indicate your position in the company**
- ☐ Managing Director
- ☐ Project Manager
- ☐ Site Manager
- ☐ QA/QC Manager
- ☐ Facility Manager
- ☐ Works Inspector

5. **Indicate the type of organization**
- ☐ General contractor
- ☐ Consultant
- ☐ Client
- ☐ Government agency

6. **Kindly indicate your years of professional experience?**
- ☐ 0- 5 years
- ☐ 6 to 10 years
- ☐ 11 to 15 years
- ☐ 16 to 20 years
- ☐ More than 21 years

7. **Kindly indicate the size of your firm**
- ☐ Small (0-5 employees)
- ☐ Medium (6-19 employees)
- ☐ Large (20 and above employees)

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8. **Kindly specify**
□ Indigenous firm
□ Non-Indigenous firm

Section B: The Current Quality Control Management Practices on Building Construction Projects in Lagos, Nigeria.

9. **Kindly indicate your level of awareness on quality control management using a 5 point Likert's scale**

1 = very low; 2 = low; 3= average; 4 = high; 5 = very high

1	2	3	4	5

10. **How familiar are you with the following standards used to drive quality?**
Use the following rating scale: 1=Not familiar; 2=Less familiar; 3=Neutral; 4=Familiar;5= Very familiar

S/N	Standards	1	2	3	4	5
1	American Society for Testing and Materials(ASTM)					
2	The American National StandardsInstitute(ANSI)					
3	British Standard (BS)					
4	National Building Code 2006					
5	International standard organization (ISO 9000series)					
6	Other, please specify					

11. **Has your firm obtained any of the following quality standard certifications?**

S/N	Standards	Yes	No
1	International standard organization (ISO 9000)		
2	Standard Organization of Nigeria (SON)		
3	Other, please specify		

12. **Kindly rate the attention your company gives to Quality control Management.**
1 = very low; 2 = low; 3= average; 4 = high; 5 = very high

1	2	3	4	5

13. **How familiar are you with the following quality control tools?**
Use the following rating scale: 1=Not familiar; 2=Less familiar; 3=Neutral; 4=Familiar;5= Very familiar

S/N	Quality control tools	1	2	3	4	5
1	Flow charts					
2	Check sheets					
3	Control charts					
4	Scatter diagrams					
5	Histograms					
6	Cause and effect diagrams					
7	Pareto charts					
8	**Other, please specify**					

14. **Digital quality control is the application of modern systems and automated equipment to control and manage construction projects.**
Kindly indicate your level of awareness of digital quality control tools for quality control management using a 5-point Likert's scale
1 = very low; 2 = low; 3= average; 4 = high; 5 = very high

``

14. **Digital quality control is the application of modern systems and automated equipment to control and manage construction projects.**
Kindly indicate your level of awareness of digital quality control tools for quality control management using a 5-point Likert's scale
1 = very low; 2 = low; 3= average; 4 = high; 5 = very high

1	2	3	4	5

15. **Below are some digital tools for quality control management on building construction projects, kindly rate your level of usage of the listed tools using the following 5-point scale where: 1 = very low; 2 = low; 3= average; 4 = high; 5 = very high**

S/N	Quality Control Tools	1	2	3	4	5
1	Building Information Modelling (BIM)					
2	Radio Frequency Identification (RFID)					
3	Drones/ Unmanned Aircraft System/Vehicles (UAS/UAV)					
4	Geographical Information System (GIS)					
5	Sensor					
6	Mobile Computing Technology					
7	Personal Digital Assistant (PDA)					
8	Laser detection and ranging system (LADAR)					
9	Laser scanner					
10	Cameras					

16. **Please indicate the extent of your organization's involvement in the following quality control management practices on construction sites using the following 5-point scale where: 1= To no extent; 2= Small extent; 3=Moderate extent; 4= Large extent; 5= Very large extent.**

S/N	Quality Control Practices	1	2	3	4	5
1	Inspection and testing of executed works					
2	Material selection and usage					
3	Construction process adopted					
4	Use of code of conduct					
5	Use of checklist					
6	Report of non-conformity of quality standards					
7	Record of changes					
8	Evaluation and Correction of deviations in quality					
9	Coordination with the project purchase department					
10	Quality control plan					
11	Quality of workmanship in all construction activities					
12	Quality Control laboratory at the construction site					
13	Maintaining sequence of construction					
14	Observation of regular schedule					
15	Keeping of spare parts/materials for laboratory equipment					
16	The practice of sound housekeeping					
17	Quality control training					
18	Quality control of material					

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Section C: Influence of Quality control manager on effective quality control management on building construction projects?

17. **Do you have a quality manager in your firm?**
    a. **Yes ( ) (b) No ( )**

18. **To what extent do you agree or disagree with the following statement regarding the influence of a Quality control manager on achieving effective quality control management on building construction projects? Use the following rating scale: 1=strongly disagree; 2= disagree; 3= neutral; 4= agree; 5= strongly agree**

S/N	Quality control Manager Influence	1	2	3	4	5
1	Every construction site should have a Quality Control Manager responsible for implementing Quality Plans and Checklists					
2	Hiring a quality control manager to commit to the project will ensure quality compliance					
3	Assigning responsibility of quality control management on- site to a quality control manager results in an increased level of success					

19. **Please rate the Quality control manager's roles required on building construction project. Use the following rating scale: 1=strongly disagree; 2=Disagree; 3=Averaage; 4=Agree; 5= strongly agree**

S/N	Quality Control Manager Roles	1	2	3	4	5
1	Ensuring compliance with national and international standards of production processes					
2	Supervises Construction processes to identify defects and deviations inthe quality policies.					
3	Have an in-depth understanding of customer requirements and communicate with them to have adequate quality control processes.					
4	Monitors technicians and other members to ensure that they perform their assigned duty following quality standards.					
5	Monitors the compliance of suppliers to quality					
6	Engages in meetings, gets feedback from clients, submits documented reports, and helps the external auditors					
7	Sets quality standards as regards the safety of workers during the production process.					
8	keeping accurate documentation and statistical analysis					
9	Reviews the final product, compares it with the initial requirements, and rejects or approves the final product complying with quality standards.					
10	Develops ways to improve the production process techniques to ensure high-quality outputs					
11	Devise ways to come up with new techniques to reduce waste during the production phase and maximize resources.					

20. **Kindly rate the following competencies that are very important for quality control managers to carry out their duties on building construction projects in Lagos, Nigeria. 1=Not important; 2=Less important; 3= moderately important; 4= Important; 5=Very important**

S/N	Quality control manager competencies	1	2	3	4	5
1	Good and effective supervisory skills					
2	Leadership and Development skills					
3	Good working knowledge & QA/QC implementation					
4	Knowledge of building codes and standards					
5	Construction experience					
6	Teamwork					
7	Character					
8	Sound judgement and decision making					

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9	Commitment and willingness to learn new methods and systems					
10	Knowledge of material tests and equipment					

Section D: Challenges inhibiting effective quality control management on building construction projects in Lagos, Nigeria.

21. To what extent do you agree that the following factors are challenges inhibiting effective quality control management practice on building construction projects in Lagos, Nigeria? 1=strongly disagree; 2= disagree; 3= neutral; 4= agree; 5= strongly agree

S/N	Quality control challenges	1	2	3	4	5
1	Inadequate funds/ budgetary allocation					
2	High cost of testing materials					
3	Delay in delivering materials					
4	Poor conduct of review meeting					
5	No good stores on the site					
6	Lack of training/education of construction workers					
7	Poor site safety measures					
8	Inadequate on-time supervision					
9	Lack of quality control inspection programm					
10	Insufficient quality control plan					
11	Unrealistic project time					
12	Bribery and corruption					
13	Lack of effective quality policy implementation					
14	Inadequate technical knowledge					
15	Poor communication among the design and construction team					
16	Cost of correcting non-conformance by the contractor					
17	Non-provision for documentation of non-conformance					
18	Inclement weather conditions					
19	Supervisors' lack of skills and experience"					
20	Faulty equipment for testing					
21	The high cost of materials and equipment					
22	The high number of a semiskilled and untrained labour					
23	Poor understanding and coordination between stakeholders					
24	Lack of supplier evaluation					
25	Lack of modern information system					
26	Poor laboratory for material testing					

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Section E: Critical success factors for effective quality control management practices on building construction projects in Lagos, Nigeria.

22. To what extent do you agree that the following critical success factors for effective quality control management on building construction projects in Lagos, Nigeria? 1=strongly disagree; 2= disagree; 3= neutral; 4= agree; 5= strongly agree

S/N	Quality control success factors	1	2	3	4	5
1	Strong commitment of leadership to continuous Improvement					
2	Well-defined policies and objectives by the senior management for efficient use of resources					
3	Customer focus					
4	Monitoring and evaluation of construction quality control by local government managers					
5	Monitoring and evaluation of construction quality control by third-party consultancy					
6	Education and Training					
7	Employees employed with the necessary skills					
8	Adequate quality control planning					
9	Testing and measurement of work done					
10	Quality control cost					
11	Communication/ Improved employee-management relationship					
12	Quality teamwork					
13	Availability of funds					
14	Quality documentation					
15	Continuous quality improvement					
16	**Other (Please specify)**					

Section F: Additional comments

If you have any additional comments based on this survey questionnaire, kindly add on the section below.

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APPENDIX B

Institutional Research Ethics Committee
Research and Postgraduate Support Directorate
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Gate 1, Steve Biko Campus
Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

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11 July 2022

Ms M D Oyewole
23 Penzance Rd
Glenwood
Durban

Dear Ms Oyewole

Developing a framework towards effective quality control management practice on building construction projects in Nigeria; A case study of Lagos
Ethical Clearance number IREC 043/22

The Institutional Research Ethics Committee acknowledges receipt of your final data collection tool for review.

We are pleased to inform you that the data collection tool has been approved. Kindly ensure that participants used for the pilot study are not part of the main study.

In addition, the IREC acknowledges receipt of your gatekeeper permission letter.

Please note that FULL APPROVAL is granted to your research proposal. You may proceed with data collection.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC Standard Operating Procedures (SOP's).

Please note that any deviations from the approved proposal require the approval of the IREC as outlined in the IREC SOP's.

Yours Sincerely,

Prof J K Adam
Chairperson: DUT-IREC