



JIMMA UNIVERSITY
JIMMA INSTITUTE OF TECHNOLOGY
SCHOOL OF GRADUATE STUDIES
FACULTY OF CIVIL AND ENVIRONMENTAL ENGINEERING
CONSTRUCTION ENGINEERING AND MANAGEMENT CHAIR

ASSESSMENT OF KEY FACTORS CONTRIBUTING TO QUALITY
REDUCTION IN PUBLIC BUILDING CONSTRUCTION
PROJECTS: A CASE OF GAMBELLA TOWN

A Thesis submitted to the School of Graduate Studies, Jimma University, Jimma Institute of Technology, Faculty of Civil and Environmental Engineering in Partial Fulfillment of the Requirements for the Degree Master of Science in Construction Engineering and Management

by

Muluken Azanaw Asre

September 2024
Jimma, Ethiopia

JIMMA UNIVERSITY
JIMMA INSTITUTE OF TECHNOLOGY
SCHOOL OF GRADUATE STUDIES
FACULTY OF CIVIL AND ENVIRONMENTAL ENGINEERING
CONSTRUCTION ENGINEERING AND MANAGEMENT CHAIR

ASSESSMENT OF KEY FACTORS CONTRIBUTING TO QUALITY
REDUCTION IN PUBLIC BUILDING CONSTRUCTION
PROJECTS: A CASE OF GAMBELLA TOWN

A Thesis submitted to the School of Graduate Studies, Jimma University, Jimma Institute
of Technology, Faculty of Civil and Environmental Engineering in Partial Fulfillment of
the Requirements for the Degree Master of Science in Construction Engineering and
Management

Advisor: Dr. Bien Mercado Maunahan

NAME

SIGNATURE

Co - Advisor: Engr. Frikot Mulatu

NAME

SIGNATURE

September 2024
Jimma, Ethiopia

DECLARATION

I declare that this research entitled “***Assessment of Key Factors Contributing to Quality Reduction in Public Building Construction Projects: A Case of Gambella Town***” is my original work and has not been submitted as a requirement for the award of any degree at Jimma University or anywhere else.

Muluken Azanaw Asre

NAME

SIGNATURE

DATE

As research Adviser, I wish to certify that I have read and evaluated Muluken Azanaw Asre's thesis paper, “***ASSESSMENT OF KEY FACTORS CONTRIBUTING TO QUALITY REDUCTION IN PUBLIC BUILDING CONSTRUCTION PROJECTS: A CASE OF GAMBELLA TOWN,***” prepared under my guidance. I recommend it and believe it would be accepted as a fulfilling requirement for the Master of Science in Construction Engineering and Management degree.

Advisor: Dr. Bien Mercado Maunahan

NAME

SIGNATURE

DATE

Co - Advisor: Engr. Frikot Mulatu

NAME

SIGNATURE

DATE

ACKNOWLEDGMENT

In the preparation of this thesis, many have contributed priceless data, ideas, resource books, and moral support. First and foremost, my deepest gratitude goes to my God and his mother, Virgin Mary, for their unwavering love and blessings throughout my life. I also extend my heartfelt appreciation to my sisters, Mastewal Azanaw and Tsion Azanaw, for their love, endless support, and encouragement.

I would then like to express my heartfelt gratitude to my main advisor, Dr. Bien Maunahan (Associate Professor), for his valuable and constructive ideas and all his precious time spent reviewing and improving the quality of the thesis work. I am also grateful to my co-advisor, Engr. Frikot Mulatu (M.Sc.), for his valuable contributions and support.

I would also like to thank all the people and organizations that have kindly opened their doors, accepted me, and filled out my questionnaires for this research work. They are too numerous to name. I want to thank them all for their cooperation and their time.

Finally, I would like to express my eternal gratitude to my beloved mother for her infinite sacrifice and her belief in me, which inspires me always to do better; Engineer Mhiretu Senbeto; Instructor Tsegaye Abebe; Tesfaye Ayele; Adiss Abebaw; Instructor Getachew Amaze; and Engineer Abenzer Kebede; Engineer Tewoderos G/mariyam and his wife for their guidance, sacrifice, and endless support. Thank you for always being there; my older brother Enderis Yemer Adem and his wife for his encouragement, who has given me material and moral support during my time at the university; the rest of my very supportive family; and my good friends for all their help and support.

Thank you all for your support and encouragement.

ABSTRACT

In Ethiopia, the construction industry is crucial to the nation's economic development, with public building projects playing a significant role. However, the quality of these construction projects has become a growing concern, particularly in Gambella Town, where various factors continue to undermine construction outcomes. This study aimed to assess the key factors contributing to quality reduction in public building construction projects in Gambella Town and to develop practical strategies to address these issues.

The research employed a mixed-methods approach, combining qualitative insights from interviews with quantitative data from structured surveys. A total of 62 respondents, including contractors, consultants, clients and project managers involved in public building projects, were selected through purposive sampling. Data were analyzed using the Relative Importance Index (RII) and statistical tools, including Microsoft Excel and SPSS version 29, to rank the factors contributing to quality reduction.

The findings revealed several factors significantly impact the quality of construction projects in Gambella Town. These include unfavorable climatic conditions (RII value 0.96), communication gaps between stakeholders (RII value 0.95), ineffective project management systems by contractors, poor oversight by consultants (RII value 0.94), and the use of low-quality materials. Unsuitable climatic conditions were identified as the most critical factor. Furthermore, the study highlighted that these factors reduce construction quality and lead to time wastage and cost overruns.

The study proposes practical strategies to mitigate the identified issues in response to these findings. These include engaging experienced and competent contractors, implementing rigorous project management practices, and establishing effective stakeholder communication protocols. Enhancing quality control through regular inspections and digital monitoring tools is also recommended. By adopting these strategies, stakeholders in Gambella Town can significantly improve the quality of public building construction projects, ensuring they meet the required standards and provide long-term value.

Keywords: *Construction industry, Construction quality, Public building construction projects, Quality reduction factors.*

TABLE OF CONTENTS

DECLARATION	i
ACKNOWLEDGMENT.....	ii
ABSTRACT.....	iii
TABLE OF CONTENTS.....	iv
LIST OF TABLES.....	viii
LIST OF FIGURES	ix
ABBREVIATIONS	x
CHAPTER 1	1
INTRODUCTION	1
1.1 Background of the Study	1
1.2 Statement of the Problem.....	2
1.3 Research Questions.....	3
1.4 Objectives	3
1.4.1 General Objectives.....	3
1.4.2 Specific Objectives	3
1.5 Scope and Limitation of the Study.....	3
1.6 Significance of the Study	4
1.7 Structure of the Study	5
CHAPTER 2	6
LITERATURE REVIEW	6
2.1 Quality.....	6
2.1.1 Definitions Quality.....	6
2.2 Quality Standards.....	7
2.2.1 Standards Organizations	7
2.2.2 International Organization for Standardization (ISO)	8

2.3 Quality System.....	8
2.4 Quality Inspection.....	10
2.5 Quality Control	10
2.6 Quality Assurance	11
2.7 Total Quality Management	11
2.8 Integrated Quality Management Systems	12
2.8.1 Contractor’s Quality Control Plan (CQCP)	12
2.9 Quality in Construction Projects	13
2.10 The Causes of Quality Failures.....	16
2.11 Factors Affecting Construction Quality	19
2.12 Studies on Quality Issues in Public Building Projects.....	19
2.13 Methodologies and Models.....	20
2.14 The Effects of Poor Quality	22
2.14.1 Cost of Quality	22
2.14.2 Categories of Costs	23
2.15 Classification and Categorization of Quality Influencing Factors.....	25
2.16 Strategies for Minimizing Quality Failure	26
CHAPTER 3	28
RESEARCH METHODOLOGY.....	28
3.1 Study Area	28
3.2 Research Design and Approach	29
3.3 Study Variables	29
3.3.1 Dependent Variables.....	29
3.3.2 Independent Variable	29
3.4 Sources of Data	30
3.5 Population, Sample Size and Sampling Method.....	30
3.5.1 Population	30

3.5.2 Samples Size	30
3.5.3 Sampling Method.....	31
3.6 Data Collection Methods	31
3.6.1 Pilot Study.....	32
3.6.2 Structured Questionnaire	32
3.6.3 Interview	32
3.7 Data Analysis and Presentation	33
3.7.1 Relative Importance Index	33
3.8 Validity and Reliability.....	34
3.8.1 Validity of Data.....	35
3.8.2 Reliability of Data.....	35
3.9 Data Quality Assurance	37
3.10 Ethical Considerations	37
CHAPTER 4	38
RESULTS AND DISCUSSIONS	38
4.1 Questionnaire Response Rate	38
4.2 Demographic Characteristics	39
4.3. Factors Reducing Construction Quality	44
4.3.1 Project Management and Planning Factors.....	44
4.3.2 Budgetary and Time Constraints Factors.....	45
4.3.3 Design and Specification Factors.....	46
4.3.4 Workmanship and Construction Practices Factors	48
4.3.5 Material Selection and Quality Factors.....	49
4.3.6 Environmental Factors	51
4.3.7 Regulatory Compliance Factors.....	52
4.3.8 Quality Control and Assurance Processes Factors.....	54

4.4 Effects Due to Quality Reduction in the Public Building Construction Project in Gambella Town.....	56
4.5 Strategies for Addressing Recognized Factors	58
4.5.1 Employing Skilled and Competent Contractors, Subcontractors, and Suppliers	58
4.5.2 Implementing Comprehensive Pre-Project Planning.....	59
4.5.3 Enhancing Communication and Collaboration Among Stakeholders	59
4.5.4 Continuous Training and Capacity Building	59
4.6 Summary of Key Findings	60
CHAPTER 5	62
CONCLUSIONS AND RECOMMENDATIONS	62
5.1 Conclusions.....	62
5.2 Recommendations.....	63
REFERENCES	65
APPENDIXS.....	69
APPENDIX A	69
APPENDIX B	79
APPENDIX C	80

LIST OF TABLES

Table 2.1 Project failure factors.....	17
Table 2.2 Different quality problems factors	18
Table 3.1 Values assigned for the likert scale in the questionnaire	32
Table 3.2 Questionnaires reliability checking with cronbach's alpha.....	35
Table 3.3 Correlation coefficient factors with quality	36
Table 4.1 Percentage of returned questionnaires	38
Table 4.2 Demographic characteristics.....	39
Table 4.3 The relative importance index (RII) and the rank of factors project management and planning.....	44
Table 4.4 The relative importance index (RII) and the rank of factors budgetary and time constraints	45
Table 4.5 The relative importance index (RII) and the rank of factors design and specification	47
Table 4.6 The relative importance index (RII) and the rank of factors workmanship and construction practices.....	48
Table 4.7 The relative importance index (RII) and the rank of factors material selection and quality.....	50
Table 4.8 The relative importance index (RII) and the rank of factors environmental	51
Table 4.9 The relative importance index (RII) and the rank of factors regulatory compliance	53
Table 4.10 The relative importance index (RII) and the rank of factors quality control and assurance processes.....	55
Table 4.11 The relative importance index (RII) and the rank of effect due to quality reduction	57

LIST OF FIGURES

Figure 3.1 Map of gambella town (Source: Arc GIS Software)	28
Figure 3.2 Cronbach's coefficient alpha	36
Figure 4.1 Type of organization.....	41
Figure 4.2 Work experience.....	41
Figure 4.3 Profession of the respondents	42
Figure 4.4 Educational level of the respondents	43
Figure 4.5 Respondents' field of specialization	43
Figure 4.6 Project management and planning factors.....	45
Figure 4.7 Budgetary and time constraints factors	46
Figure 4.8 Design and specification factors.....	48
Figure 4.9 Workmanship and construction practice factors	49
Figure 4.10 Material selection and quality factors.....	51
Figure 4.11 Environmental factors	52
Figure 4.12 Regulatory compliance factors	54
Figure 4.13 Quality control and assurance process factors.....	56
Figure 4.14 Effect due to quality reduction	58

ABBREVIATIONS

ASQ	American Society for Quality
ASTM	American Society for Testing and Materials
BOQ	Bill of Quantities
BSI	British Standards Institution
COQ	Cost of Quality
QCP	Contractor's Quality Control Plan
DAS	Delay Analysis System
FIDIC	Federation International des Ingenieurs - Conseils
GC	Gregorian Calendar
GC-1	General Contractors
GIS	Geographical Information System
IQMS	Integrated Quality Management
ISO	International Organization for Standardization
JIT	Jimma Institute of Technology
OHSAS	Occupational Health and Safety Assessment Series
PFFs	Project Failure Factors
QA	Quality Assurance
QC	Quality Control
QCP	Quality Control Plan
RII	Relative Importance Index
SPSS	Statistical Package for Social Science
TQM	Total Quality Management
US	United State

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

The construction industry plays a pivotal role in the economic and infrastructural development of a country, providing a substantial number of employment opportunities and essential infrastructures. The successful completion of construction projects is a key factor in maintaining a robust construction industry. Adherence to quality specifications is a fundamental requirement for the successful execution of construction projects. The quality of a construction project is measured by the satisfaction of client requirements and end-user satisfaction. (Ayegun, Abiola-falemu and Olawumi, 2018).

The construction sector is a complex process that involves the building or assembling of infrastructure. It is a result of the collaborative efforts of various professionals such as project managers, construction managers, design engineers, construction engineers, architects, and other stakeholders. The construction sector is a significant economic investment, and its contribution to national development and growth is well-established. Quality and construction projects are interdependent. Quality in construction is a prerequisite for a successful project, and a construction project cannot exist without quality. In the modern construction market, construction companies are required to ensure the quality of their product to their clients. (Vadivel *et al.*, 2016).

Every construction project stakeholder's goal is to compete for a project that meets the objectives of time, cost, and quality. In Ethiopia, there are many problems associated with quality. (Particularly in the construction projects of government), This is usually due to poor quality control, poor workmanship, poor quality of materials, poor production, quality failures, and additional costs incurred on those projects. Achieving project objectives and completing projects within pre-defined time, cost, and quality constraints is not an easy task in the construction of buildings (Al-tmeemy *et al.*, 2011). During construction, contractors are often required to re-work portions of the project due to unacceptable quality (Muhumuza *et al.*, 2016). Quality is evident in the

amount of re-work and in the overall expenditures of a project (Smith *et al.*, 2009). Quality failure can occur during any stage of the construction process (Ede, 2011). These circumstances have directed scholars and experts to reconsideration models and basest hat think through the cost of quality failure as not a single act measure. Quality control is critically significant to a successful building project and should be followed to during a project from beginning and design to construction and installation. Inspection through construction will avoid costly maintenances after the project is completed. In order to have a good quality in the construction projects it should have well knowledge about the different causes which lead to quality reduction including the effects (Chan and Tam, 2006).

Therefore, in this research, an attempt will be made to identify the major causes and effects of quality reduction factors and the possible ways to reduce the quality factors on public building construction projects in Ethiopia, specifically Gambella town.

1.2 Statement of the Problem

Public building construction projects in Gambella Town are prone to substandard or poor-quality outcomes due to many factors that significantly affect their successful completion and overall quality. Despite continuously examining the factors contributing to the quality reduction of construction projects, many quality concerns remain visible. The quality of ongoing and completed construction projects continues to be compromised by various issues. These include deficiencies in materials and equipment, insufficient project management, financial limitations, technical and design deficiencies, concerns regarding the environment and society, and challenges related to stakeholders. (Dorcas, Elkanah and John, 2019; Su, Wai and Cho; Oke, Aigbavboa and Dlamini, 2017).

Ongoing challenges confront the construction industry, including insufficient planning, substandard material selection and control, and inadequate implementation of quality systems. These challenges not only lead to a rise in adjustments but also affect the budget and timetable of the project, ultimately causing client discontent and compromised project standards. It is imperative to comprehend the numerous and interconnected factors that contribute to a quality reduction during construction projects to formulate proactive measures and execute enhancements. The absence of

an all-encompassing compilation and classification of these influential factors creates a deficiency in the comprehensive resolution of quality concerns (Dorcas, Elkanah, and John, 2019).

The primary concern in Gambella Town's public building construction projects pertains to the assurance and maintenance of superior quality standards. The primary objective of this research is to identify, evaluate, and suggest effective measures that target the key factors contributing to the quality reduction of these projects. Through a thorough investigation of the factors that contribute to quality reduction, potential preventive measures, and causes thereof, this study aims to fill the current knowledge deficiencies and propose useful strategies for improving the standard of construction in Gambella Town.

1.3 Research Questions

In order to achieve the objective of the study, the following research questions were answered:

1. What are the primary factors significantly impacting the quality of public building construction in Gambella Town?
2. How significant is the influence of each identified factor on the overall quality of public building construction in Gambella Town?
3. How can identified quality reduction factors in public building construction projects in Gambella Town be effectively addressed through strategic interventions?

1.4 Objectives

1.4.1 General Objectives

To assess and analyze the key factors contributing to quality reduction in public building construction projects in Gambella Town and to propose effective strategies for mitigating these factors to enhance construction quality.

1.4.2 Specific Objectives

1. To identify the main factors that influence the quality of public building construction

2. To assess and rank the magnitude of influence of the identified factors on the quality of public building construction
3. To develop and propose practical strategies for addressing the key factors contributing to quality reduction in public building construction projects

1.5 Scope and Limitation of the Study

The study was limited to public building construction projects in the Gambella region, specifically in Gambella. Its scope was to assess the key quality reduction factors in these projects, identify the key causes of the quality reduction factors, determine the effects of quality reduction factors on these projects, and come up with a possible way to minimize the quality reduction factors in Gambella town.

The research did not include another type of construction project except public building construction projects, and it did not study another area except Gambella town because of the limitations of time and cost availability. The project organization could not give the researcher full information, such as desk documents.

1.6 Significance of the Study

The findings of this study were to help clients, consultants, and contractors understand the key factors contributing to quality reduction in public building construction projects in Gambella town. Identification of critical factors: The study aims to identify the key factors contributing to reducing the quality of public building construction projects. The study can help improve project performance, ensuring that public buildings are safe, functional, and durable. Cost savings: The study can help reduce these additional costs and optimize the use of public funds. The study can enhance stakeholder satisfaction and confidence in the construction industry. The study can inform future research and guide the development of best practices and guidelines for quality management in similar contexts.

1.7 Structure of the Study

This research consists of five main chapters as follows:

Chapter One: Introduction: This chapter shows the main objectives of the research, the statement of the problem, the scope and limitations, and the significance of the research.

Chapter Two: Literature Review: This chapter provides a historical review of previous studies to identify the main quality reduction factors in construction projects.

Chapter Three: Methodology: This chapter shows the main methodologies used in previous studies and the method used in this research to achieve the required objectives.

Chapter Four: Results Analysis: This chapter presents the analysis and discussion of the research results.

Chapter Five: Conclusions and Recommendations

CHAPTER 2

LITERATURE REVIEW

This chapter presents a comprehensive review of the existing literature on the factors contributing to quality reduction in public building construction projects, focusing on the context of Gambella Town. It explores key theories, models, and empirical research shaping our understanding of construction quality management. By critically examining these studies, this chapter aims to identify the specific factors that impact construction quality in similar settings, highlight gaps in the current knowledge, and establish a theoretical framework that supports the objectives of this study.

2.1 Quality

2.1.1 Definitions Quality

Quality is the world's oldest documented profession. Quality professionals use some definitions to define project quality. Quality in its simplest form can be defined as: 'meeting the customer's expectations' or 'compliance with the customer's specification.' No matter what definition we follow for quality, it becomes very complex when we try to put it into actual practice. For a user, quality is nothing but satisfaction with the project's appearance, performance, and reliability for a given price range. (Collins and Baccharini, 1987) In addition, quality means a predictable degree of uniformity and dependability at a low cost that is suitable for the market. (Mishra *et al.*, 2009). (Andersson and Eriksson, 2006), has stated that "in the last century, quality has moved through four distinct "quality eras": inspection, statistical quality control, quality assurance, and strategic quality management. A fifth era is emerging: complete integration of quality into the overall business system. Managers in each era were responding to the problems they faced.

According to (Kazemi *et al.*, 2018) Quality has different meanings for different people. The American Society for Quality (ASQ) glossary defines quality as a subjective term for which each person has his or her own definition.

In technical usage, quality can have two meanings:

- The product or service characteristics that bear on its ability to satisfy stated or implied needs.
- A product or service free of deficiencies. Its further states that it is based on customers' perceptions of a product's design and how well the design matches the original specifications and the ability of a product and service to satisfy stated or implied needs achieved by conforming to established requirements within an organization.

However, the definition of quality for construction projects is different from that of manufacturing or services industries as the product is not repetitive but a unique piece of work with specific requirements. The quality of construction depends mainly upon the control of construction, which is the primary responsibility of the contractor (Kazemi *et al.*, 2018).

2.2 Quality Standards

Standards are documents used to define acceptable conditions or behaviors and provide a baseline for ensuring that conditions or behaviors meet the acceptable criteria. In most cases, standards define minimum criteria; world-class quality is, by definition, beyond the standard level of performance. Standards can be written or unwritten, voluntary or mandatory. Unwritten quality standards are generally not acceptable. (Fahmy, 2001). He defines standards as a reference base required to judge a quality system's adequacy. Further, it states that a "quality system has to cover all the activities leading to the finished product. Depending on the scope of operation of the organization, these activities include planning, design, development, purchasing, production, inspection, storage, delivery, and after-sales service". Also, Standards ensure that a product, system, or service meets its specifications and is safe for use. Standards are the key to any conformity assessment activity. (Kazemi *et al.*, 2018).

2.2.1 Standards Organizations

Many organizations produce standards; some of the best-known organizations in the quality field are (Kazemi *et al.*, 2018):

- International Organization for Standardization (ISO)
- American Society for Quality (ASQ)
- American Society for Testing and Materials (ASTM)
- British Standards Institution (BSI)

2.2.2 International Organization for Standardization (ISO)

ISO is the world's largest developer and publisher of international standards. It is a nongovernmental organization that forms a bridge between the public and private sectors. ISO has more than 16,500 international standards. Of all the standards produced by ISO, the most widely known are the ISO 9000 and ISO 14000 series. ISO 9000 has become an international reference for quality requirements in business-to-business dealings, and ISO 14000 looks to achieve at least as much, if not more, in helping organizations to meet their environmental changes (Kazemi *et al.*, 2018).

ISO standards are updated periodically since they were originally published in 1987. ISO 9000 comprises several standards. The 1994 version of the ISO 9000 series was made up of the following standards:

- ISO 9000: Quality management and quality assurance standards.
- ISO 9001: Quality systems Model for quality assurance in design, development, production, installation, and servicing.
- ISO 9002: Quality systems Model for quality assurance in production installation and servicing.
- ISO 9003: Quality systems Model for quality assurance in final inspection and test.
- ISO 9004: Quality management and quality systems element guidelines (Kazemi *et al.*, 2018).

2.3 Quality System

It embraces the organizational structure, procedure, and processes needed to implement quality management. The adequacy of the quality system and the quality of products, services, and processes are judged by their compliance with specified/relevant standards. (Kazemi *et al.*, 2018).

Quality system standards require that responsibilities, authority, and inter-relationships should be clearly defined by management. People with delegated responsibility for quality must have the freedom and authority to stop and reject sub-standard work and to act to prevent repetition. Inspecting, testing, and other verification staff must be properly trained. (Zwetsloot and Ashford, 2003). Also, the quality system should only be as comprehensive as needed to meet the quality objectives. A quality management system should be developed and implemented to accomplish the objectives in a company's quality policies. (Zwetsloot and Ashford, 2003).

The quality system depends entirely on the scope of operation of the organization and particular circumstances such as the number of employees, type of organization, and physical size of the premises of the organization. (Kazemi *et al.*, 2018).

The first objective in establishing a quality system should be to satisfy the organization's internal needs. It follows, therefore, that it should be cost-effective, compatible with accepted good practices within the particular industry concerned, and beneficial to the organization. Most of these tend to fall into one of two general categories. These may be identified as the 'centralized' or 'de-centralized' concepts. (Zwetsloot and Ashford, 2003).

Centralized Systems

Centralized systems stress quality control, or 'the operational techniques and activities that are used to fulfill requirements for quality'. These obviously vary from one application to another. However, they will almost certainly include taking samples at various stages, comparing them with specified requirements, and rejecting items that do not comply (Zwetsloot and Ashford, 2003).

Such centralized organizations can be very powerful. They provide both control and assurance of quality (QA/QC). They have the advantage that the authority and independence of the quality manager and his staff are established, and they can be effectively insulated from commercial pressures that might compromise their judgment. The disadvantage is that quality control departments tend to grow into separate empires working in parallel with but in isolation from those responsible for production (Zwetsloot and Ashford, 2003).

De-Centralized Systems

The de-centralized systems are that in the latter, the responsibility for controlling quality is placed firmly on the shoulders of those doing the work. In a de-centralized system, production managers are required to develop plans, procedures and routines for inspection and testing which will ensure that work is done properly (Zwetsloot and Ashford, 2003). It is evident that the quality system in its different forms has moved through distinct quality eras such as quality inspection, quality control, quality assurance and total quality (Kazemi *et al.*, 2018).

2.4 Quality Inspection

According to (Kazemi *et al.*, 2018) An inspection is a specific examination, testing, and formal evaluation exercise and overall appraisal of a process, product, or service to ascertain if it conforms to established requirements. It involves measurements, tests, and gauges applied to certain object or activity characteristics. The results are usually compared to specified requirements and standards for determining whether the item or activity aligns with the target. Inspections are generally nondestructive. (Kazemi *et al.*, 2018) States that the established requirements limit the degree to which inspection can be successful. Inspection accuracy depends on the level of human error, the instruments' accuracy, and the inspection planning's completeness.

Also (Kazemi *et al.*, 2018) It shows that Human errors in inspection are mainly due to technique errors, inadvertent errors, conscious errors, and communication errors.

Most construction projects specify that all the contracted works are subject to inspection by the owner/consultant/owner's representative. (Kazemi *et al.*, 2018).

2.5 Quality Control

The ASQ termed the quality control era a process orientation consisting of product inspection and statistical quality control. (Kazemi *et al.*, 2018). Also (Watson and Gryna, 2001) Quality control is the process employed to consistently meet standards. The control process involves observing actual performances, comparing them with some standards, and then acting if the observed performance is significantly different from the standard.

According to (Kazemi *et al.*, 2018) Quality control in construction projects is performed at every stage through the use of various control charts, diagrams, checklists, etc., and can be defined as:

- Checking of executed/installed works to confirm that works have been performed/executed as specified, using specified/approved materials, installation methods, and specified references, codes, and standards to meet the intended use
- Controlling budget
- Planning, monitoring, and controlling project schedules
- Control involves a universal sequence of steps as follows:

There are a variety of methods, tools, and techniques that can be applied for quality control and the improvement process. These are used to create an idea, engender planning, analyze the cause, analyze the process, foster evaluation, and make various situations for continuous quality improvement. These tools can also be used during various stages of a construction project. (Kazemi *et al.*, 2018).

2.6 Quality Assurance

Quality assurance is according to (Choy, 2015). Quality assurance also includes efforts external to these processes that provide information for improving the internal processes. It is the quality assurance function that attempts to ensure that the project scope, cost, and time functions are fully integrated. Also (Watson and Gryna, 2001) Quality Assurance provides evidence to establish confidence that quality requirements will be met.

2.7 Total Quality Management

TQM is a philosophy that makes quality values the driving force behind leadership, design, planning, and activity improvement. TQM is widely accepted as the basis for achieving sustainable competitive advantage. It is required to achieve customer satisfaction and ensure survival in the competitive world because of the global nature of competition, which never rests. There is no end to product or service improvement. (Kazemi *et al.*, 2018).

TQM is a management philosophy that evolved in Japan after World War II. It places quality as a strategic objective and focuses on continuously improving products, processes, services, and costs to compete in the global market by minimizing rework and maximizing profitability to achieve market leadership and customer satisfaction. (Kazemi *et al.*, 2018)

2.8 Integrated Quality Management Systems

IQMS consists of any aspect or activity that affects quality. Furthermore, it states that An IQMS is developed by merging recommendations and specifications from ISO 9000 (Quality Management System), ISO 14000 (Environmental Management System), and OHSAS 18000 (Occupational Health and Safety Management) together with other contract documents (Kazemi *et al.*, 2018).

If an organization has a certified Quality Management System (ISO 9000), it can build an IQMS system by adding environmental, health, safety, and other requirements of management system standards. (Kazemi *et al.*, 2018).

The benefits of implementing an IQMS are reduced duplication and, therefore, cost, improved resource allocation, standardized process, elimination of conflicting responsibilities and relationships, consistency, improved communication, reduced risk, increased profitability, facilitated training development, simplified document maintenance, reduced record keeping, ease of managing legal and other requirements. (Kazemi *et al.*, 2018).

2.8.1 Contractor's Quality Control Plan (CQCP)

Normally, quality management system manuals consist of procedures to build project quality control plans, taking into consideration contract specifications. This plan is called the Contractor's Quality Control Plan (CQCP), and the contractor must include these while developing the CQCP. This plan can be termed an Integrated Quality Management System (IQMS) for construction projects (Kazemi *et al.*, 2018).

The contract documents specify the details of the Quality Control Plan (QCP) to be prepared by the contractor for the construction project; the plan has to be submitted to the consultant for approval. The following is the outline for the preparation of a QCP.

(Kazemi *et al.*, 2018): Purpose of the QCP, project description, site staff organization chart for quality control, quality control staff and their responsibilities, construction program, and subprograms, schedule for submission of subcontractors, manufacturer of materials, and shop drawings. QC procedure for all the main activities such as procurement (direct bought out items), Off-site manufacturing, inspection and testing, inspection of site activities (checklists), inspection and testing procedure for systems, procedure for laboratory testing of material, inspection of material received at site Protection of works.

- Method statement for various installation activities
- Project-specific procedures for site work instructions and remedial notes
- Quality control records
- List of quality procedures applicable to the project in reference to the company's quality manual and procedure
- Periodical testing procedure for construction equipment and tools
- Quality updating program
- Quality auditing program
- Testing
- Commissioning
- Handover
- Site safety

2.9 Quality in Construction Projects

Construction projects are mainly capital investment projects. They are customized and are not repetitive. Construction projects have become more complex and technical, and the relationships and the contractual grouping of those involved are also more complex and contractually varied. (Kazemi *et al.*, 2018).

Also (Kazemi *et al.*, 2018) Quality management in construction projects is different from that in manufacturing.

The quality management of work on the construction site takes place in three phases:

- Planning what is to be done.

- Controlling the execution of the plan.
- Verifying that the work has been carried out according to plan (Zwetsloot and Ashford, 2003).

The nature of the contracts between the parties plays a dominant part in the quality system required from the project. Therefore, the responsibility for fulfilling them must be specified in the project documents. The documents include plans, specifications, schedules, bill of quantities (BOQ), and so on. (Kazemi *et al.*, 2018).

Quality control in construction typically involves ensuring compliance with minimum standards of material and workmanship to ensure the facility's performance according to the design. These minimum standards are contained in the specification documents. To ensure compliance, random samples and statistical methods are commonly used as the basis for accepting or rejecting completed work and material batches. Rejection of a batch is based on nonconformance or violation of the relevant design specifications (Kazemi *et al.*, 2018). Hence, it is less expensive to make things right the first time than to make them over and do it right on the final try. It is less costly to provide satisfactory service to a customer the first time than to do it the second time after giving the service once and dealing with dissatisfied customers. (Mishra *et al.*, 2009).

The quality of building work is difficult to quantify since many construction practices cannot be assessed in numerical terms. The framework of reference is commonly the appearance of the final product. “How good is good enough?” is often a matter of personal judgment and, consequently, a subject of contention. Therefore, a quality building construction product meets all contractual requirements (including statutory regulations) at optimum cost and time. A building is of good quality if it will function as intended for its design life. As the true quality of the building will not be revealed until many years after completion, the notion of quality can only be interpreted in terms of the design attributes. (Kazemi *et al.*, 2018).

The quality of construction is even more difficult to define. First, the product is usually not a repetitive unit but a unique piece of work with specific characteristics. Secondly, the needs to be satisfied include not only the client's but also the community's expectations into which the completed building will integrate. The construction cost and time of delivery are also important characteristics of quality.

Construction project quality is the fulfillment of the owner's needs as per a defined scope of work within a budget and a specified schedule to satisfy the owner's/user's requirements. The phenomenon of these three components can be called the "construction project trilogy," which are Defined Scope, Schedule, and Budget (Kazemi *et al.*, 2018).

Quality has many meanings; however, conformance to established requirements has relevance and clarity for projects. While simple, this definition cannot stand alone. Another term is needed for the term requirements. Requirements are contractually established characteristics of a product, process, or service. A characteristic is a physical or chemical property, a dimension, a temperature, pressure, or any other specification used to define the nature of a product, process, or service (Kazemi *et al.*, 2018).

The requirements are initially set by the client/customer (ordinarily the user/operator of the facility). They are then translated during the preplanning phase into a conceptual design and estimate developed into a project scope that is more fully defined. During the Design phase, the requirements are translated into specific design documents (drawings, plans, specifications, purchase orders, and the like). Procurement of fabricated items often proceeds concurrently with design. The products of design and procurement reach the construction site for erection and installation during the construction phase. (Kazemi *et al.*, 2018).

(Kazemi *et al.*, 2018) stated Based on the philosophies of quality gurus, the quality of construction projects can be evolved as follows:

- Properly defined scope of work.
- The owner, project manager, design team leader, consultant, and constructor's manager are responsible for implementing quality.
- Continuous improvement can be achieved at different levels: owner—Specify the latest needs. Designer specifications should include the latest quality materials, products, and equipment; the constructor should use the latest construction equipment to build the facility.

Establishment of performance measures

Owner

- Review and ensure that the designer has prepared the contract documents that satisfy his or her needs.
- Have to check the work progress to ensure compliance with the contract documents.

Consultant

- As a consultant designer, to include the owner's requirements explicitly and define them in the contract documents.
- As a supervision consultant, supervise contractor's work as per contract documents and the specified standards.

Contractor

- **Team approach:** Every project team member should know that TQM is a collaborative effort, and everybody should participate in all the functional areas to improve the quality of the project work. They should know that it is a collective effort by all the participants.
- **Training and education:** The consultant and contractor should have customized training plans for their management, engineers, supervisors, office staff, technicians, and laborers.
- **Establish leadership:** Organizational leadership should be established to achieve the specified quality. Encourage and help the staff and laborers understand the quality of the project.

2.10 The Causes of Quality Failures

The survey of construction quality by FIDIC (Federation Internationals des Ingenieurs-Conseils, the International Association of Consulting Engineers) confirmed that failure to achieve appropriate construction quality is a problem worldwide. (Kazemi *et al.*, 2018).

(Yates and Lockley, 2002) The causes of failure have been classified into seven categories: fundamental concept, site selection and development, programming, design, construction, materials, and operation. A survey carried out by (Yates and Lockley, 2002).

- Unqualified labor
- Poor review of drawings
- Financial pressures
- Inadequate inspection methods
- Improper safety and value review
- Poor constructability review
- Poor reviewing, checking, inspecting, testing and observation
- Ineffective communication
- Poor decision-making.

(Baccarini, Salm and Love, 2004) identified several factors that impede the construction quality of buildings, which leads to reworking, such as lack of understanding of end-user requirements, poor contract documentation and low consultant fees, incompetent standard of workmanship, lack of focus on quality, and inadequate supervision and inspection. According to (Josephson and Hammarlund, 1999) attributed these factors to knowledge, information, motivation, stress, and risk. Also, different researchers listed and classified different factors related to quality reduction as project failure factors. The table shown below shows some project failure factors that are Identified and Classified according to the failure factors source.

Table 2.1 Project failure factors

Project Failure Factors (PFFs)	Managerial factor	Financial Factor	Design & technical factor	Human factor	Social factor
Poor project management	X				
Poor planning and scheduling	X				
Inaccurate cost estimation	X				
Unclear scope and goals	X				
Inefficient resource allocation.	X				
Poor design, Frequent design changes, Design errors			X		
Poor communication.	X			X	
Lack of financial capacity		X			
Bureaucracy and corruption				X	X

Leadership problems	X		
Lack of experience and knowledge		X	X
Payment delays.	X		
Lack of technical performance.		X	X
Subcontractor failure	X		
Poor quality.	X		
Poor monitoring and tracking.	X		
Poor site management	X		
Cultural Differences in Global Projects			X
Poor management of expectations	X		
Weather and social environment			X

Source of table: (El-sokhn, N.H. and Othman, 2014)

Table 2.2 Different quality problems factors

Lack of contractor supervision	(Arditi&Gunaydin, 1998; Wong & Fung, 1999)
Poor relationship and partnering among project participants	(Arditi&Gunaydin, 1998; Jha&lyer, 2006; Tang <i>et al.</i> , 2009)
Reduced Subcontractor responsibility	(Leonard, 2008; Pheng& Wei, 1996; Wong & Fung, 1999)
Inappropriate method of contractor selecting.	(Arditi&Gunaydin, 1998; Pheng& Wei, 1996)
Poor quality procedure and Department	(Chan & Tarn, 2000; Moody, 2005; Saraph, <i>et al.</i> , 1989)
Lack of auditing system	(Pheng& Wei, 1996; Samuels, 1994)
Poor Training system	(Arditi & Gunaydin, 1998)
Low quality continues improvement	(Joaquin <i>et al.</i> , 2008; Pheng& Wei, 1996)
Lack of process improvement	(Pheng& Wei, 1996; Saraph, <i>et al.</i> , 1989)
Lack of Management commitment	(Hiyassat, 2000; Marosszeky, <i>et al.</i> , 2002; Yung & Yip, 2010)
Low effective project management system	(Anderson, 1992; Chan & Tarn, 2000; Yung & Yip, 2010)
Bureaucracy	(Marosszeky, <i>et al.</i> , 2002)
Supplier impact	(Arditi&Gunaydin, 1997; Wong & Fung, 1999)
Low quality drawing and specification	(Arditi&Gunaydin, 1998; Pheng& Wei, 1996)
Design complexity	(Chan & Tarn, 2000)
Poor performance of quality tools	(Arditi&Gunaydin, 1997; Leonard, 2008)
Difficult application of quality system	(Mohammed & Abdullah, 2006; Serpell, 1999)
Project size and complexity	(Chan & Tam, 2000; Jha&lyer, 2006)
Material/Equipment specification	(Hiyassat, 2000; Pheng& Wei, 2001)
Project Environment	(Chan & Tam, 2000)
Low quality & poor availability of resources	(Joaquin, <i>et al.</i> , 2008; Yung & Yip, 2010)
Lack of motivation	(Marosszeky, <i>et al.</i> , 2002; Pheng & Wei, 2001; Serpell, 1999)

Source of table: (Butler, Seigel and Mealey, 2006)

2.11 Factors Affecting Construction Quality

It was further stated that material and equipment costs rarely affect the cost performance of construction projects. The rate of material ordered and delivered late to construction sites is another constraint affecting time performance as it relates to contractual relationships between consultants and contractors (Enshassi and Ayyash, 2014). Factors affecting the cost and quality of construction were studied by (Jamaludin, Mohammad, and Ahmad, 2014). They include fraudulent practices and kickbacks, incorrect planning, level of competition, number of competitors, lack of coordination between designers and contractors, poor financial control on site, wastage on site, previous experience of contractors, and frequent design changes. (Oke, Aigbavboa and Dlamini, 2017) they have identified a lack of technical and professional expertise and resources to perform tasks, a lack of employee commitment and understanding, and a lack of education and training to drive the improvement process.

Other factors affecting the performance quality of construction projects included project managers' competence, poor monitoring and feedback, lack of on-site project manager, inadequate project team capability, poor planning and control techniques, poor/insufficient information and communication channels, lack of early and continual client/consultant consultation by the contractor and insufficient project managers experience. (Mane and Patil, 2017) . (Enshassi and Ayyash, 2014) further stated that the average delay in payment from client to contractor affects the performance of the construction project. Management commitment to continuous quality improvement, management leadership in promoting high process quality, quality training of all personnel, efficient teamwork to promote quality issues at the corporate level, and effective cooperation between parties taking part in the project are generic factors that affect process quality.

2.12 Studies on Quality Issues in Public Building Projects

According to study conducted by (Oke, Aigbavboa and Dlamini, 2017) The factors contributing quality reduction within the Swaziland in public building construction suggests that the major factors are the use of unskilled trade subcontractors and poor on site supervision. Other important factors are inadequate construction labor skills

and lack of induction; commitment by the supervising team and poor planning and scheduling of works. Other factors are lack of communication; project manager's ignorance and lack of knowledge; scarcity of resources; poor material and plan management; delays in decision making, issue of number of projects at hand (workload); design changes; conformation with specifications; involvement of end-user client; and assurance with client's funding.

2.13 Methodologies and Models

Delay Analysis System (DAS)

The DAS system process was divided into four sub-sections: the identification of the the influence value of each critical delay factor, the selection of the delay factors affecting each critical activity, the identification of the risk distribution for generating random numbers, and the integration of delay factors with critical activity.

A) Selection of delay factors affecting each critical activity

The possible types and numbers of critical delay factors, affecting each critical activity were selected through site knowledge base approach. The site knowledge was collected from construction professionals through interviews) during the construction industry survey. The influence value of each delay factor is calculated using equation below, which is the ratio of IW of each delay factor to the sum of IW of all delay factors, affecting a critical activity. The IW of each delay factor was identified by analyzing the survey data, collected through the industry survey. Each activity has (risk) delay factors where the total influence of all risk factors should be 100% for an activity (Shebob, Dawood and Shah, 2012).

$$\text{Influence of each delay factor} = \frac{(IW)}{\sum_1^n IW}$$

Whereas,

IW = Important Weight of each critical delay factor.

n = Number of delay factors affecting each critical activity

B) Generation of random number

Random numbers for each delay factor are generated from a particular representative distribution. The random values are generated between minimum and maximum (0, 1) using the Monte Carlo simulation technique, assuming a suitable risk distribution. There are different types of random distribution values, such as uniform, triangular, normal, and beta. The type of distribution can vary from one activity to another activity (Shebob, Dawood, and Shah, 2012). However, this depends on the types of (risk) delay factors and their nature of impact on each critical activity in a project. These aspects were considered to assume the risk distribution for delay analysis in this system. The risk distribution types depend on the nature of delay factors, which is selected past experience and knowledge of construction professionals through construction industry.

C) Integration of random numbers and influence value

The equation developed by (Dawood, 2010) was used in the DAS to calculate the possible duration of activity the impact of delay factors because the equation assists to quantify the expected project duration considering the impacts of delay factors affecting each critical activity. The equation also helps to identify/predict the best possible duration of the activity.

$$\text{Duration of activity} = \text{Min Time} + [\text{Max Time} - \text{Min Time}] \times [(\text{RF1} \times \text{Random1}) + (\text{RF2} \times \text{Random2}) + (\text{RF3} \times \text{Random3}) + (\text{RF n} \times \text{Random n})]$$

$$\text{RF n} = \text{Influence factor} = \frac{(\text{IW})}{\sum_1^n \text{IW}}$$

D) Outputs of delay analysis system

The DAS outputs are the possible duration of a construction project and the sensitivity report of each critical delay factor affecting the project. This includes the maximum, mean, and minimum possible duration of each critical activity and the whole project. The outputs are produced by processing the inputs through the DAS using the above equation.

Moreover, the system also provides a sensitivity report of all critical delay factors, considered in the system for analyzing the impact of delay. This sensitivity report

provides information about the sensitivity of each critical delay factor (which delay factors have high influence in project duration in comparison to others). The possible delay in a project is identified by comparing the project duration between actual project duration and the system generated project duration (Shebob, Dawood and Shah, 2012).

2.14 The Effects of Poor Quality

Compliance with quality specifications is an important performance measure of any construction project. The repercussions and consequences of poor quality can be loss in productivity, additional expenditure by way of rework and repair, loss of reputation, leading to loss in market share, eventually being put out of business (Jha *et al.*, 2006).

Defects or failure in construction facilities can result in very large costs. Even with minor defects, reconstruction may be required and facility operation impaired. According to (Al-tmeemy *et al.*, 2011). Failure can be classified as internal and external. Internal failure pertains to those found before delivery to the customer, such as scrap, rework, retesting, defects, and so on.

External failure costs, on the other hand, are discovered after delivery to the customer. These include repair and litigation, which may lead to loss of reputation. Indeed, these failures (internal and external) have consequences such as cost overrun, schedule slippage, and customer dissatisfaction when non-conformance is observed in the building (Al-tmeemy *et al.*, 2011).

2.14.1 Cost of Quality

Quality costs consist of the cost of prevention, the cost of appraisal & the cost of failure. Prevention cost are those resulting from quality activities used to avoid deviations or errors, while appraisal costs consist of costs incurred from quality activities used to determine whether a product, process or service conforms to established requirements. Failure costs are those resulting from not meeting the requirements & can be divided into 2 aspects (Estimates, 2001).

According to study of (Al-tmeemy et al., 2011) the implication of COQ cannot be realized without reporting and establishing all the true quality costs. Therefore, establishing quality cost is very important; however, it faces many barriers. Barriers to the implementation of a quality cost system are divided into three categories, namely, culture and knowledge, system, and company. The most significant barrier was related to culture and knowledge. Quality has an impact on the costs of products and services. The cost of poor quality is the annual monetary loss of products and processes that are not achieving their quality objective (Kazemi *et al.*, 2018). Poor quality results in higher maintenance and warranty charges. In construction projects, these costs are mainly due to

- Rejection of work during construction: This results in rework by the contractor to meet the specification requirements. If any extra time and cost is required to redo the work, the contractor is not compensated for the same.
- Rejection of shop drawings: Repeated rejection of shop drawings results in the contractor spending extra time and cost, and a delay in start of relevant activities (Kazemi *et al.*, 2018).

The cost of poor quality is the annual monetary loss of products and processes that are not achieving their quality objectives. The main components of the cost of low quality are cost of nonconformities, cost of inefficient processes, cost of loss opportunities of sales revenue (Watson and Gryna, 2001).

2.14.2 Categories of Costs

According to (Fahmy, 2001) Costs of poor quality are the costs related with provided that poor-quality goods or services. These costs are eliminated if things were done right from the start up time and at each phase thereafter in order to attain the quality objective. Also according to Cost of quality is a combination of following costs: costs to control quality (prevention and appraisal) and costs of failure to control quality (internal and external failures) (Mishra *et al.*, 2009).

Cost of quality becomes the cost to the company, of doing things wrong, of not conforming to the specification. Quality costs can be divided into four major categories the first two include the costs to try to control quality and the second two include the costs that result from failure to control quality (Mishra *et al.*, 2009).

Prevention costs: The cost of preventing defective work is usually extended before the product is made or service rendered. These costs include:

- Design reviews and drawing checks
- Quality orientation program, education and training
- Process control
- Process orientations
- Suppliers evaluation and presentation
- Workers training

Appraisal costs: The cost of appraisal is incurred for auditing service procedures to make sure they conform to prescribed work practices. These include

- Process capability measurement (e.g. control charts)
- Tests, gauges and test equipment
- Prototype inspection and tests
- In process and final inspection and tests
- Checking material furnished by suppliers
- Work in process goods testing and inspections

Internal failure cost: Internal failure cost is applicable when the product is in factory and not been sold. These costs include:

- Expenses for producing items that are scrapped and scrap it self
- Redesign.
- Reworking and downtime.
- Retesting defective items.
- Lost value of items sold as seconds.
- Cost of delays.
- Administration time to review non
- conforming materials for disposition

External failure costs: These costs are applicable to goods when product has been sold. It includes:

- Warranty cost.

- Product liability (insurance and settlements)
- Consumer affairs (dealing primarily with customer complaints about quality).
- Field service (mostly repairs of what should have worked).
- Product returns, recalls.

2.15 Classification and Categorization of Quality Influencing Factors

Reviewing the literature for potential factors that affect quality performance, (Iyer, K and Jha, K, 2017) identified among other factors;

- Lack of management commitment to continual quality improvement
- Lack of quality training of staff
- Management leadership and efficient teamwork among stakeholders.

It was further stated that material and equipment costs rarely affect the cost performance of construction projects.

Factors affecting the cost and quality of construction were studied by (Jamaludin, Mohammad and Ahmad, 2014) they include:

- Fraudulent practices and kickbacks; incorrect planning
- level of competition; number of competitors;
- Lack of coordination between designers and contractors
- Poor financial control on site
- Wastage on site
- Previous experience of contractor and frequent design changes.

(Oke, Aigbavboa and Dlamini, 2017) Identified lack of technical and professional expertise and resources to perform task, lack of employee commitment and understanding and lack of education and training to drive the improvement process. Other factors affecting performance quality of construction projects include:

- Project managers competence
- Poor monitoring and feedback
- Lack of on-site project manager
- Inadequate project team capability

- Poor planning and control techniques
- Poor/insufficient information and communication channels
- Lack of early and continual client/consultant consultation by contractor and insufficient project managers experience (Mane and Patil, 2017)

2.16 Strategies for Minimizing Quality Failure

Six possible measures suggested by researchers in order to minimize quality problem. Below is the explanation for some of them

A. Strict Supervision

Enhance the quality by strict supervision in construction site is one of the criteria of recent practices in the construction sector (Liu *et al.*, 2019). Daily supervision should be carried out by the contractors or subcontractors so the problem can be identified and the remedy work can be executed immediately. Besides, when executing the supervision, contractor supervisory staff must possess the knowledge, expertise, and capabilities to administer the construction work and superintend the craft worker efficiently (Liu *et al.*, 2019).

B. Training and Education

Many researchers agreed that appropriate training and enlarging experience is necessary in producing the quality project. Therefore, labor productivity is significant in construction because of its impact in the process of completing projects (Stevens, 2010). It was supported that the construction quality can be enhanced by increasing the knowledge of site labors (Chan and Tam, 2006).

C. Proper Communication among Parties Involved

From a research had been done, 80% of the workers in U.S. construction sector mentioned that the communication with the supervisors is vital and need to be improved (Cook, Augusto and Jakkula, 2009). Therefore, American supervisors suggested that the training in communication skills is essential to eliminate the language gap among themselves and the foreign labors. It was agreed that effective communication leads the projects complete faster (Ling and Baron, 2007). Apart from the communication between supervisors and construction labors, proper communication and teamwork are also

necessary between contractors and subcontractors (Lenk *et al.*, 2009). Through a continual communication among parties involved, working relationship among the construction parties can be closer. In addition, it was found that better quality performance of Japanese construction projects can be attributed to steady and durable working relationship between Japanese contractors and subcontractors (Rabinowitz *et al.*, 2002). Therefore, proper communication is very important to improve the relationship among the construction team and consequently improve the workmanship quality in construction.

D. Proper Construction Management

Proper construction management would enhance the quality in construction. The capability of construction managers to manage, arrange and lead the work would affect the construction labor productivity (Gong *et al.*, 2009). If a construction manager failed to lead and control the construction project, the quality problems may arise. Thus, a proper construction management is very crucial for every construction project.

E. Proper Manpower Management

Manpower management in terms of amount and quality of skill workers is an important determinant of contractor performance and extremely prioritized by employers (Grandgirard *et al.*, 2002). A construction project which has a well arrangement of manpower will produce a high quality of the project. Besides, manpower is the sole productive source; hence construction productivity is essentially relying on human endeavor and performance (Kazemi *et al.*, 2018). Therefore, the management of manpower in every construction project should be arranged skillfully.

F. Proper Design

A better design can get rid of workmanship defects and help to avoid the defects (Kazemi *et al.*, 2018). Inadequately worded specifications and uncertain designs always cause the low construction quality. In addition, a well-prepared design and drawings affect the future works to become easier and the defects can be identified and rectified more effectively (Grandgirard *et al.*, 2002).

CHAPTER 3

RESEARCH METHODOLOGY

This chapter outlines the research methodology employed in this study to assess the factors contributing to quality reduction in public building construction projects in Gambella Town. It details the research design, data collection methods, sampling techniques, and analytical tools to achieve the study's objectives. This chapter ensures the reliability and validity of the research findings by providing a clear and systematic explanation of the methodological approach. It offers a framework for replicating the study in similar contexts.

3.1 Study Area

The study was conducted in gambella town, which is located on the southwestern frontier of Ethiopia, 766 km from the center of Addis Ababa. Its astronomical location was 8°15'North, 34°35'East, and an elevation between 400 and 550 m above sea level. Gambella is crossed by several large rivers that flow into the Sobat River in South Sudan and, hence, into the White Nile. Rivers like Baro, Akobo, Gilo, and Alwero are natural borders between Gambella and South Sudan and major natural resources for their livelihood and transpiration. Gambella covers a total land area of 25,274 km². (Ababa and Minch, 2013)

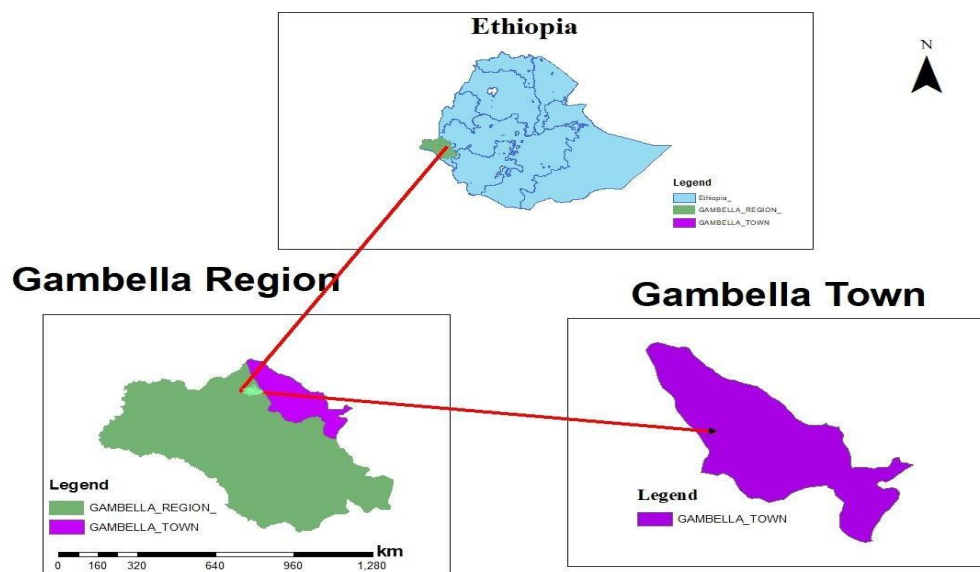


Figure 3.1 Map of gambella town (Source: Arc GIS Software)

3.2 Research Design and Approach

This study used a mixed-methods approach that combines qualitative and quantitative methodologies, and the data were collected using a structured questionnaire survey. The distribution of the questionnaire to the main stakeholders, such as clients, consultants, and contractors, and an interview about the project were conducted. The data was analyzed using the quantitative approach used to gather the factual data to satisfy and fit the objectives of the study. The research design was adopted because it describes the state of affairs, as it exists at present in the study (Kothari, 2010). The availability of time, cost, and skill of the researcher were taken into consideration in deciding the research design and how to get sufficient information for the research purpose; hence, only individuals who have in-depth knowledge of the research topics were contacted. The scientific way of dealing with the sample design and operational design were taken into consideration while dealing with the research design and procedure. The study intends to apply this design to evaluate the relationship between design factors and the quality of construction projects in the selected area. This design is very useful in studying the interrelationships between the variables already mentioned in the conceptual framework. The descriptive study allowed the researcher to describe those data and helps to know the event that took place, whereas the explanatory study examines the relationships between variables.

3.3 Study Variables

3.3.1 Dependent Variables

- Quality reduction in public building construction projects.

3.3.2 Independent Variable

Independent variables of the study are:

- Material selection and quality factors
- Workmanship and construction practices factors
- Project management and planning factors
- Design and specifications factors
- Regulatory compliance factors

- Budgetary and time constraints factors
- Quality control and assurance processes factors
- Environmental factors

3.4 Sources of Data

The data was collected from primary and secondary sources. Primary data sources include questionnaires and interviews, while secondary data sources are reviewed by reviewing related literature, including books, dissertations, document reviews, and journals by various authors and collected from the previous studies done in this particular study.

3.5 Population, Sample Size and Sampling Method

3.5.1 Population

The population of the study was public building construction projects in Gambella town, and the respondents were composed of the different stakeholders in the construction project. Those experts are the role- models in the construction project. The clients, consultants, and contractors were the population involved in the public building construction project in Gambella town.

3.5.2 Samples Size

The sample size for this research was selected from public building construction projects under construction in Gambella town. The sampling technique adopted for this study was the purposive sampling technique. The technique is typically used when focusing on a limited number of informants whom the researcher selects strategically. The sample size was chosen purposefully due to the scope of the work, the knowledge of the population, and the purpose of the study. So the target total population of the firms is 80.

The sample size was calculated using Solvin's formula, which allows a researcher to sample the population with the desired degree of accuracy (Gupta, Ahmadi and Kumar, 2020). Concerning the level of accuracy, a confidence level of 94%, as suggested by means that there are 94 chances in 100 (or.94 in 1) that the sample

results represent the true condition of the population within a specified precision range against four chances in 100 (or.05 in 1).

$$n = \frac{N}{1+N(e)^2} \dots \dots \dots \text{Equation 3.1}$$

Equation 3.1: Solvin's formula

Where: N = total population (80); n = number of sample sizes; e = error margin or margin of error; a 94% confidence level was taken; and e = 6%. So, for a total population of 80, $n = 80/1+80 (0.06*0.06) = 62$ questionnaires were distributed to the target respondents.

3.5.3 Sampling Method

The study used a sampling method called purposive sampling. Based on the nature of the data that was collected from the expected respondents in the questionnaire, a purposive sampling technique was used, which is classified as a non-probability sampling method. This is a sampling procedure that does not afford any basis for estimating the chance that each item in the population is included in the sample (Baccarini, Salm and Love, 2004). This sampling technique was used because the researcher was bound by time and money limitations, and it was almost impossible to randomly sample the entire population. In addition, this is carried out to enable the researcher to select active and qualified experts for the study.

3.6 Data Collection Methods

The data collection process was carried out on both primary data sets. The primary data were quantitative and qualitative data collected by a distributed questionnaire with a closed questionnaire, an interview, and direct observation. Later, the questionnaires were collected from the respondents. Study participants were selected purposefully because of their experience and involvement in different public building construction projects in Gambella town.

3.6.1 Pilot Study

A pilot study, often known as a “feasibility study,” determines the feasibility of your research design, identifies design difficulties, and assesses a project’s feasibility, practicability, resources, time, and cost before conducting primary research. It also assesses the possibility of a future, full-scale project before doing any large-scale investigation, and it should be performed for both quantitative and qualitative studies.(Malmquist *et al.*, 2019). They asked about key factors contributing to quality reduction and their impacts on public building construction projects and gathered a detailed explanation and suggestion from the selected professionals on the project sites.

3.6.2 Structured Questionnaire

The questionnaire was used as the primary tool for collecting data. It helps the researcher collect data faster and cheaper than any other instrument. The purpose of designing the questionnaire statement is to elicit the respondents’ opinions of the significant factor of quality reduction on a five-point Likert scale, with point 1 representing not significant, point 2 representing slightly significant, point 3 representing moderately significant, point 4 representing very significant, and point 5 representing extremely significant.

Table 3.1Values assigned for the likert scale in the questionnaire

Scale	1	2	3	4	5
Item	Very low	Low	Average	High	Very high

Furthermore, the questionnaires were meticulously distributed and retrieved in person to ensure a high response rate among the target respondents. This approach facilitated direct engagement, allowing for clarification of any questions and encouraging thoughtful participation. Upon completion, the questionnaires were systematically collected from the respondents, ensuring that all data was gathered efficiently and accurately.

3.6.3 Interview

Face-to-face conversations with the respondent were collected during the interview. The biggest issue in interviews is respondent willingness. For an effective interview, a literature review is necessary to organize the primary sources of data, particularly the questionnaires. The study used a semi-structured interview style to deal with key themes of the study topic. In addition, it helps to allow flexibility for the researcher to reply to the answers of the interviewees (Harvey, 2010). The interview provided face-to-face interaction with the top senior workers. The interview included open-ended questions. The interview guide for in-depth interviews consisted of open-ended inquiries to provide clarification on the quality reduction factors and their barriers in their company.

3.7 Data Analysis and Presentation

A structured questionnaire survey approach was considered to study the causes of quality reduction factors in public building construction projects in Gambella Town. The respondents had to give a scale rating for each cause depending on their experience in building construction projects regarding the quality reduction factors in public building construction projects. After successful collection of data, the data was arranged according to the context of the research, and analysis of the data was done using both qualitative and quantitative analytical techniques. In order to single out the relevant information by supplying questions and notes, the main quality reduction factors were executed. After sorting out the effective data, the numerical portion of the data was analyzed using Microsoft Word and Microsoft Excel sheets, and all obtained data was analyzed by utilizing the Statistical Package for Social Science (SPSS v29) to get the frequency, percentage, and cumulative percentage. Likewise, this analysis was conducted using percentages to determine the frequency of each category in the questions and then presented in a table, graph, and chart. But the word portion was digested from all the questions in the questionnaires.

3.7.1 Relative Importance Index

The relative importance index method (RII) is a statistical method of determining clients', consultants', and contractors' perceptions of the relative importance of the

identified factors contributing to quality reduction in public building construction projects and ranking the different quality reduction factors. The survey was designed to identify the relative importance of influencing the quality reduction factor of a building construction project. The RII is to determine the relative ranking of the factors; sequential ranks to unique values are transformed into importance indices based on the formula.

$$RII = \sum W A * N = \frac{5 * n_5 + 4 * n_4 + 3 * n_3 + 2 * n_2 + 1 * n_1}{5 * N} \dots\dots\dots (1.1)$$

Where,

W is the weight given to each factor by the respondent, ranging from 1 to 5.

n₁ = number of respondents for not significant.

n₅ = number of respondents for extremely significant.

A is the highest weight (i.e., 5 in the study), and

N is the total number of respondents.

Analyzing the data from the gathering information and ranging using the RII value between $0 < RII \leq 1$. The highest value of RII is the most significant quality reduction factor. RII would be used to rank the different quality reduction factors.

Those rankings make it possible to cross-check the relative importance of the factors as per the respondents' perceptions in order to give an overall viewpoint of the most significant quality reduction factors of public building construction projects in Gambella town. The analyzed data was prioritized, and the results were presented using tables and charts. In order to answer research objectives, study the analysis results, discuss the results, and compare them using the RII values.

3.8 Validity and Reliability

The researcher checked the validity of the questionnaires developed for this study. Before distributing the final questionnaires to the respondents, they were checked and commented on by friends and project personnel, and the researcher's advisor and

pilots conducted a conducted a test to check their validity. The final version of the questionnaires was distributed after incorporating all the comments and feedback obtained from different professionals.

3.8.1 Validity of Data

The validity of data in research refers to the extent to which the data accurately represents the phenomenon being studied. It is crucial for ensuring that the conclusions drawn from the research are meaningful and applicable. Validity can be categorized into several types, each focusing on different aspects of accuracy and relevance.

3.8.2 Reliability of Data

The reliability of the data was analyzed by using Statically Package for Social Sciences Version 29 (SPSS v29). According to a researcher (Hammad, Jusoh, and Ghozali, 2013), Cronbach's alpha coefficient is designed as a measure of internal consistency. Cronbach's alpha can be used to check the reliability of the questionnaire. The normal range of Cronbach's coefficient alpha values is between 0.0 and +1.0. The closer the alpha is to 1, the greater the internal consistency of items in the instrument is assumed.

Table 3.2 Questionnaires reliability checking with cronbach's alpha

No	Independent Variables	Cronbach's Alpha	Number of items
1.A	Project management and planning factors	0.960	11
2.B	Budgetary and time constraints factors	0.966	10
3.C	Design and specification factors	0.937	16
4.D	Workmanship and construction practice factors	0.984	10
5.E	Material selection and quality factors	0.981	10
6.F	Environmental factors	0.981	10
7.G	Regulatory compliance factors	0.982	9
8.H	Quality control and assurance processes factors	0.980	8
9	Effect due to quality reduction	0.964	11
10	Strategies to address the recognized factors	0.989	15

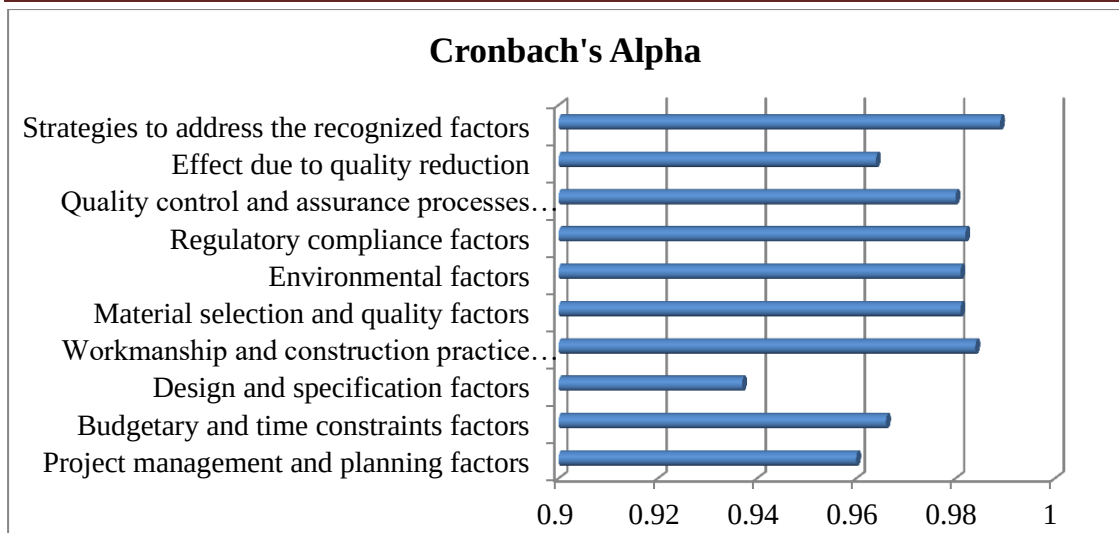


Figure 3.2 Cronbach's coefficient alpha

The reliability of the results was assessed using Cronbach's coefficient alpha, a measure of internal consistency. A coefficient alpha value greater than 0.937 indicates high reliability, while a value between 0.8 and 0.937 suggests moderate reliability. The results from the reliability test In Table 3.2 revealed that all questionnaires demonstrated high reliability, as indicated by their Cronbach's coefficient alpha values exceeding 0.937.

3.8.2 Correlation Coefficient

Spearman's Rank Correlation Coefficient Method R_s is a non-parametric test that is used to measure the correlation between two parties' ranking because of the limited number of filled questionnaires. In this research, it is used to show the degree of ranking of the different factors. The value of R_s ranged from -1 to 1 indicated as if -1 or 1 perfect negative or positive correlation, between -1 to -0.5 or 1 to 0.5, strong negative or positive correlation, between -0.5 to 0 or 0 to 0.5, weak negative or positive correlation, and 0 no correlation. The Spearman rank correlation, the coefficient between variables in this research, is analyzed using SPSS v29.

Table 3.3 Correlation coefficient factors with quality

	A	B	C	D	E	F	G	H
A	1	.892**	-0.061	.943**	.941**	.954**	.985**	.915**
B	.892**	1	-0.026	.962**	.950**	.953**	.903**	.970**
C	0.658	0.849	1	0.731	0.81	0.852	0.71	0.812
D	.943**	.962**	-0.047	1	.979**	.965**	.948**	.967**

E	.941**	.950**	-0.033	.979**	1	.965**	.959**	.947**
F	.954**	.953**	-0.025	.965**	.965**	1	.958**	.933**
G	.985**	.903**	-0.051	.948**	.959**	.958**	1	.919**
H	.915**	.970**	-0.033	.967**	.947**	.933**	.919**	1

The correlation Table 3.3 suggests that "project" and "environmental factors" are strongly positively correlated. This means that as the project progresses, there is a corresponding increase in the impact of environmental factors, or vice versa. This relationship could imply that certain projects are more susceptible to environmental influences. On the other hand, "sufficient" and "project" are negatively correlated. This suggests that as sufficiency increases, the project factor decreases, or vice versa.

Furthermore, "ownership" and "overrun" are strongly positively correlated. This indicates that as ownership increases, so does the likelihood of an overrun occurring. This relationship might suggest that a strong sense of ownership over a project could lead to increased investment or commitment, potentially resulting in overruns.

3.9 Data Quality Assurance

On public building construction projects in Gambella Town, data is necessary for the Assessment of Key Factors Contributing to Quality Reduction in Public Building Construction Projects: A Case of Gambella Town. No invalid data was used to generate a solution for the problems that were solved by the researcher. There were no erroneous conclusions, and every data analysis was performed with the necessary skills and resources. The final report was to discuss key factors contributing to quality reduction and their effects on public building construction projects.

3.10 Ethical Considerations

The study is free from any political consideration; it is based on academic perception. The researcher also ensured that the names of the respondents were noted in the study, and this research was informed by the consent participants. Finally, the researcher took appropriate measures to ensure the research would cause no physical or psychological harm to research participants. As a general rule, therefore, the study did not raise any ethical concerns.

CHAPTER 4

RESULTS AND DISCUSSIONS

This chapter examines and interprets the data gathered through field surveys in depth. The study sample comprised fifty-six respondents who completed the questionnaires, providing valuable insights into the research objectives. Comprehensive demographic information and respondent profiles are provided, followed by a rigorous quantitative analysis of the survey data.

4.1 Questionnaire Response Rate

In Table 4.1 below, 62 questionnaires were distributed to public building construction project stakeholders. The response rates were 100% for clients, 83.3% for consultants, and 88.6% for contractors. Of the 62 questionnaires, 56 were completed, resulting in a response rate of approximately 90.32%. This data is important for evaluating the effectiveness of the survey and ensuring the accuracy of the information gathered from stakeholders.

Table 4.1 Percentage of returned questionnaires

Category	Number of Questionnaires distributed	Number of Questionnaires Returned	Number of valid questionnaires	Response Rate (%)
Client	15	15	15	100%
Consultant	12	10	10	83.3%
Contractor	35	31	31	88.6%
Total	62	56	56	90.32%

Table 4.1 summarizes the survey data collected from the project's major stakeholders. In all, 62 people who represented the Owner/Client (15), Consultant (12), and Contractor (35) received the survey instrument. With 56 questionnaires completed, the survey had a respectable 90% total response rate.

- Owner/Client: All 15 questionnaires distributed to the Owner/Client were returned, demonstrating their high level of engagement in the project's success.

- Consultant: The Consultant group returned 10 out of 12 questionnaires, achieving an 83.3% response rate, indicating their active involvement in providing feedback.
- Contractor: The Contractor group had a response rate of 88.6%, with 31 out of 35 questionnaires returned. This demonstrates their commitment to providing insights into the project's progress and potential challenges.

4.2 Demographic Characteristics

The analysis of the demographic data gathered from the respondents is presented using descriptive statistics, namely frequencies and percentages. This provides insights into the general characteristics of the sample population. Regarding the type of organization and position, the majority of the respondents were contractors at 46 (64.29%) and site engineers at 30 (71.12%). When examining work experience in building construction and various projects, most participants had 5 to 10 years of experience, accounting for 71.42% of the sample. In terms of educational status, the majority of the study participants held a bachelor's degree, representing 67.85% (n = 38) of the sample. Additionally, the predominant field of specialization among the respondents was civil engineering, with 40 (71.43%) individuals within this discipline. These findings offer a comprehensive overview of the demographic profile of the study participants, providing a foundation for further analysis and interpretation of the data collected.

Table 4.2 Demographic characteristics

Type of organization	Frequency	Percent
Owner	3	5.35 %
Consultant	17	30.36%
Contractor	46	64.29%
Total	56	100
Profession of the respondents	Frequency	Percent
Architect	2	3.57 %
Project manager	10	17.85 %
Site Engineer	30	53.57%
Quantity surveyor	5	8.93%

Office Engineer	9	16.07%
Total	56	100
Respondents experience in the construction field	Frequency	Percent
Less than 5 years	6	10.71 %
From 5 to 10 years	40	71.42 %
From 11 to 15 years	7	12.5 %
Above 15 years	3	5.35 %
Total	56	100
Educational level of the respondents	Frequency	Percent
Diploma	15	26.78 %
Degree	38	67.85 %
Master	3	5.35 %
Total	56	100
Respondents' field of specialization	Frequency	Percent
Civil Engineering	40	71.42%
Surveying engineering	2	3.57 %
Construction technology and management	13	23.21 %
Other	1	1.79%
Total	56	100

The results of the study revealed that 64.29% of respondents were contractors, indicating that they are the most prevalent professional role within construction projects. Following contractors, consultants comprised 30.36% of the respondents, highlighting their significant involvement in providing specialized expertise. In contrast, owners represented only 5.35% of the total, suggesting a more strategic, less hands-on role in project execution. These percentages not only illustrate the distribution of professional roles within the sample but also offer insights into the dynamics of stakeholder engagement in the construction industry.

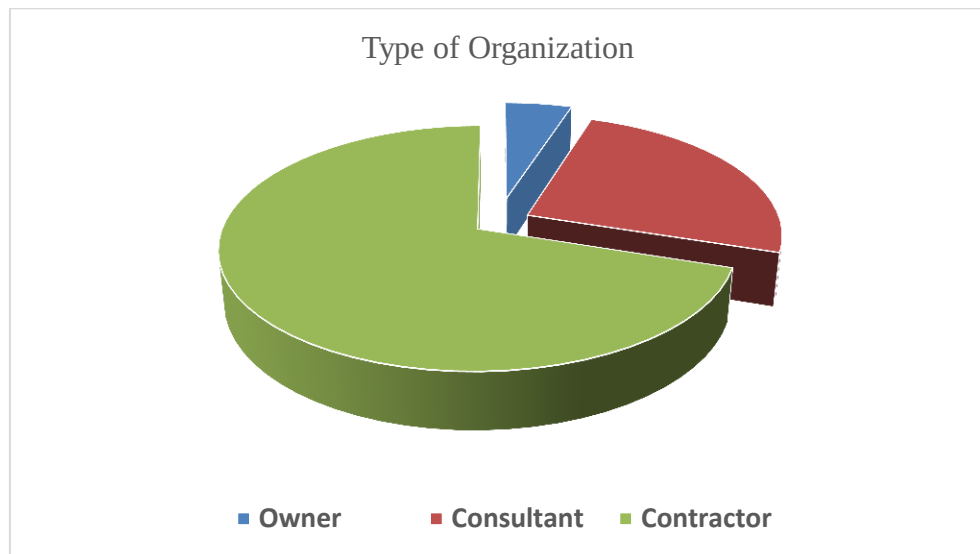


Figure 4.1 Type of organization

The percentages provided indicate the distribution of respondents based on their years of work experience in construction projects. The result revealed that the majority (71.42%) of the respondents have work experience of 5 up to 10 years in construction projects, 12.5% of the respondents have work experience of 11 up to 15 years, and 5.35% of the respondents have work experience of above 15 years.

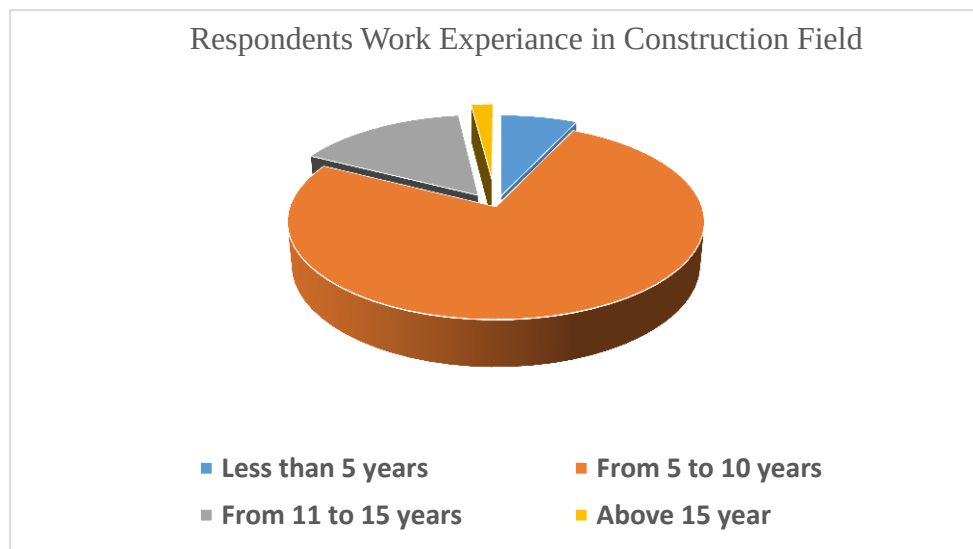


Figure 4.2 Work experience

The study's findings revealed a clear distribution of occupational roles among the respondents involved in construction projects. The majority, comprising 53.57% of the respondents, identified themselves as site engineers. This indicates that site

engineering is the most prevalent role among the respondents. Following this, 17.85% of the respondents reported being project managers, showcasing the significance of this role within construction projects. Additionally, a smaller but still notable 3.57% of the respondents identified themselves as architects. These results provide valuable insights into the occupational composition of professionals engaged in construction projects, highlighting the prevalence of site engineers and the varying degrees of representation for project managers and architects within the sample.

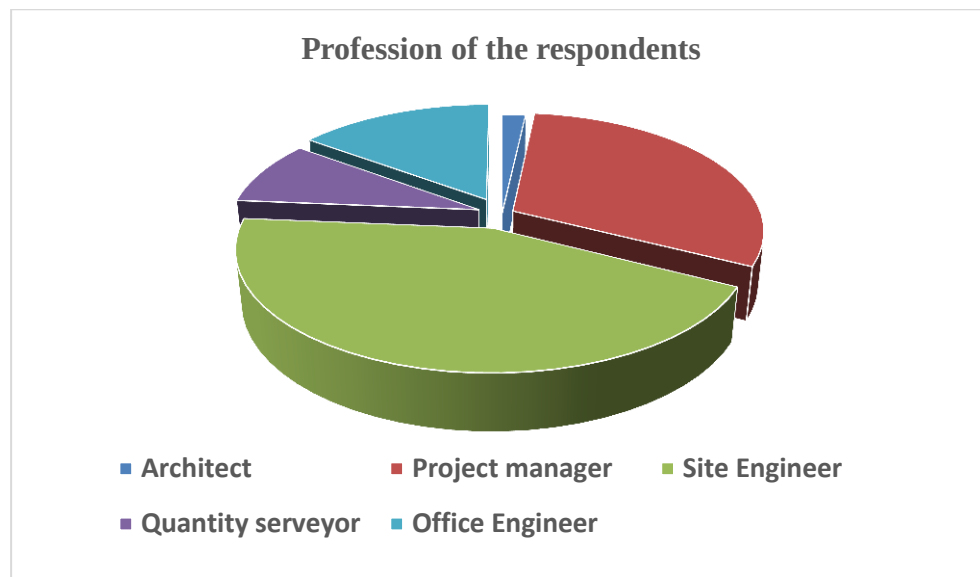


Figure 4.3 Profession of the respondents

The study's findings indicate a clear distribution of educational qualifications among the respondents. A significant majority, comprising 67.85% of the respondents, held a degree, reflecting a high level of formal education within the sample. Additionally, 26.78% of the respondents possessed an academic rank diploma, demonstrating a substantial representation of individuals with this intermediate level of educational attainment. Furthermore, 5.35% of the respondents held an academic rank of master's degree, suggesting a smaller but still notable proportion of individuals with advanced postgraduate qualifications. These results provide valuable insights into the educational background of professionals involved in construction projects, highlighting the prevalence of degree holders and the varying degrees of representation for diploma and master's degree holders within the sample.

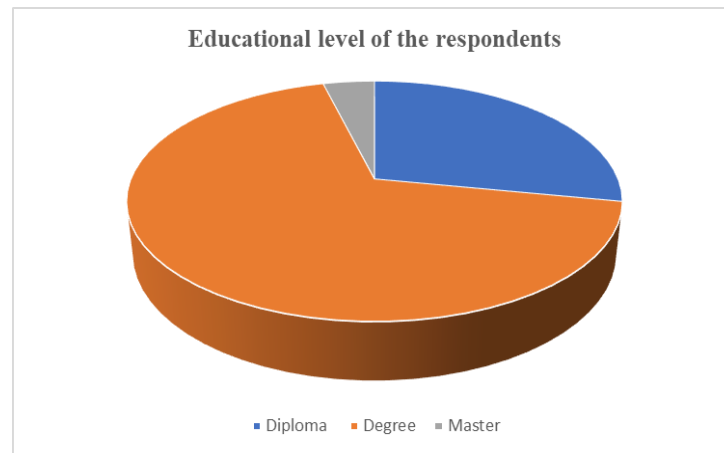


Figure 4.4 Educational level of the respondents

The study's findings revealed the respondents' distinct distribution of professional specializations. Specifically, most individuals (71.42%) identified as civil engineers, indicating a predominant presence of professionals with expertise in civil engineering within the sample. Additionally, 23.21% of the respondents were classified as construction technology and management engineers, highlighting a significant representation of professionals specializing in construction technology and project management. Furthermore, 3.57% of the respondents identified as survey engineers, indicating a smaller but still notable proportion of individuals with expertise in surveying within the sample. Lastly, 1.79% of the respondents belonged to other fields of specialization, suggesting diverse professional backgrounds beyond the main categories identified. These results provide valuable insights into the distribution of specialized expertise among professionals involved in construction projects, emphasizing the prevalence of civil engineers and acknowledging the presence of other specialized roles within the sample.

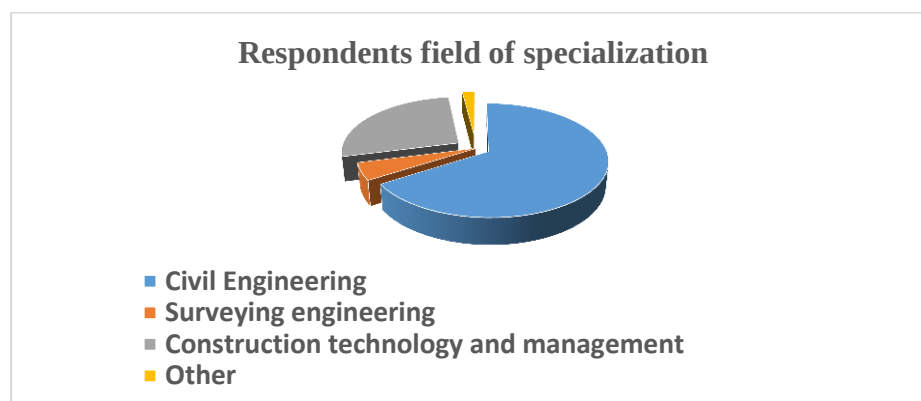


Figure 4.5 Respondents' field of specialization

4.3. Factors Reducing Construction Quality

4.3.1 Project Management and Planning Factors

The study's main focus was the impact of planning and project management variables on the caliber of building projects. Table 4.3 presents the findings and is likely the source of more specific information about the results. At 94.64%, the statement shows that the "Low Effective Project Management System by the Contractor" was determined to have the highest impact on lowering the quality of construction projects in the town of Gambella. This indicates a substantial detrimental impact on the caliber of building projects occurred when the contractor's project management system proved ineffective.

Table 4.3 The relative importance index (RII) and the rank of factors project management and planning

Project Management and Planning Factors	RII value	Rank
Lack of Quality Department by the Contractor	0.846	4
Poor Training System by the Contractor	0.914	2
Lack of Quality Policy by the Contractor	0.764	6
Lack of Management Commitment by the Contractor	0.735	7
Low Effective Project Management system by the Contractor	0.9464	1
Low Quality of Supplier and Sub-Contractor Selection	0.853	3
Effective Decision-Making	0.735	7
Project Delivery System	0.6607	10
Contractor's Cash Flow Management	0.796	5
Leadership Skills of Project Manager	0.682	9
Adequacy of Fund Allocation	0.703	8

Conversely, In Figure 4.6, In contrast, as illustrated in Figure 4.6, the analysis indicates that the "Project Delivery System" exerted the least detrimental effect on the quality of construction projects, contributing to a reduction in quality that accounts for 66.07% of the total observed variance. This finding suggests that, relative to other factors examined in the study, the project delivery system plays a comparatively minor role in influencing the overall quality outcomes of construction projects.

This lower impact may imply that while the project delivery system is a critical component in project execution, it is not the primary factor contributing to quality degradation. Instead, other variables under investigation may have a more significant

influence, warranting further exploration to identify specific elements within those variables that could be targeted for quality improvement. Therefore, understanding the nuances of how various project delivery methods interact with other factors is essential for developing strategies to enhance construction quality.

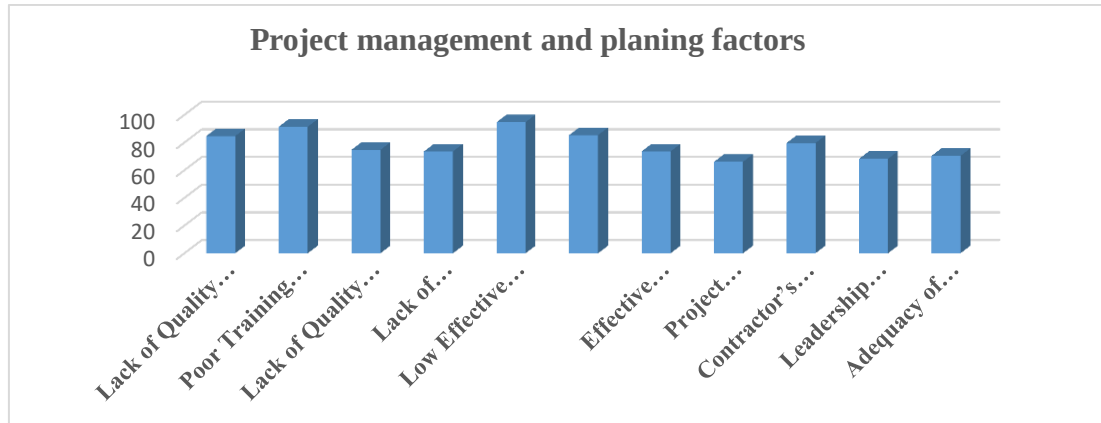


Figure 4.6 Project management and planning factors

4.3.2 Budgetary and Time Constraints Factors

In Table 4.4, which offers comprehensive information on the findings, presents the outcomes. According to the statement, "unsettled and lack of sufficient project funds" had the highest proportion (92.14%) of the effects on worse construction project quality in Gambella town. This implies that the quality of building projects was significantly impacted when there were problems with the availability or sufficiency of project finances. This could apply to circumstances in which the project budget was not completed, or there weren't enough finances to complete the project successfully.

Table 4.4 The relative importance index (RII) and the rank of factors budgetary and time constraints

Budgetary and Time Constraints Factors	RII value	Rank
Contractors' Financial Incapability for the Project	0.857	4
Unsettled and Lack of Sufficient Project Fund	0.9214	1
Difficulties in Financing	0.913	2
Materials Price Escalation	0.739	6
Ineffective Project Planning	0.91	3
Resource Management and Scheduling	0.739	7

Delayed Progress Payments	0.785	5
Skilled Professionals Shortage	0.664	8
Fluctuating Labor Availability	0.6607	9

On the other hand, In Figure 4.7, the statement also mentions that "fluctuating labor availability" had the smallest impact, with a percentage of 66.07% in reducing the quality of construction projects. This implies that fluctuations in labor availability had a relatively smaller impact than the lack of sufficient project funds.

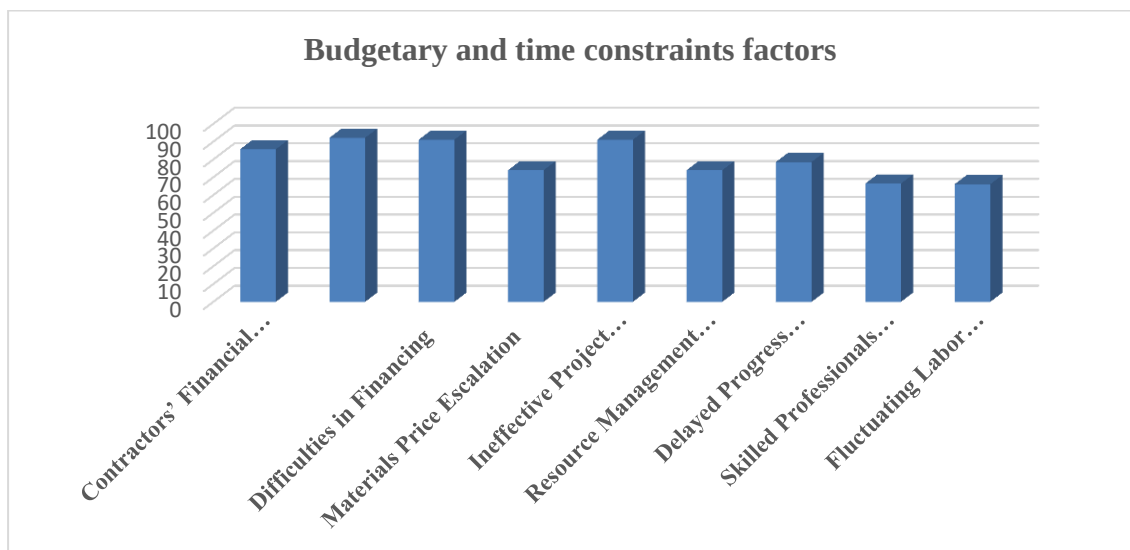


Figure 4.7 Budgetary and time constraints factors

4.3.3 Design and Specification Factors

The statement discusses the results shown. In Table 4.5, we discuss design and specification factors and how they affect the caliber of construction projects in Gambella town. With a percentage of 94.47%, the data show that "poor checking, inspecting, and testing by the consultant" had the biggest effect on lowering the quality of building projects. This implies that the quality of construction projects in Gambella town was significantly impacted when there were flaws in the verifying, inspecting, and testing procedures that the consultant carried out throughout the design and specification phases.

On the other hand, the statement also mentions that "stakeholder engagement" showed the smallest impact, with a percentage of 63.57%, in reducing the quality of construction projects. This implies that the level of stakeholder engagement had a relatively smaller impact compared to poor checking, inspecting, and testing by the consultant. The role of the consultant in ensuring that designs and specifications are thoroughly checked, inspected, and tested is crucial to maintaining the quality of construction projects. When these processes are not performed effectively, it can lead to errors, omissions, or inadequacies in the design and specification, which can ultimately impact the quality of the constructed project.

Table 4.5 The relative importance index (RII) and the rank of factors design and specification

Design and Specification Factors	RII value	Rank
Poor Quality Procedure by the Contractor	0.832	6
Poor Performance of Working Tools, Techniques & Methodology	0.696	10
Changing of actual inspection and Test Results	0.746	8
Poor Checking, Inspecting and Testing by the Consultant	0.9447	1
Low Quality of Drawing and Specification	0.932	2
Unclear or Incomplete Construction Drawings and Specification	0.913	3
Poor Document Control by the Consultant	0.839	5
Lack of Contractor's Performance Supervision by Consultants	0.846	4
Inefficiently Use of Quality Control Inspection Checklists	0.785	7
Design and Project Complexity	0.707	9
Regulatory Framework	0.653	11
Stakeholder Engagement	0.6357	12

In addition, even though stakeholder engagement is still crucial, it could not have as much of an effect on project quality as errors in testing, checking, and inspection. Stakeholder involvement is the process of incorporating several parties, including government agencies, local communities, and other pertinent stakeholders, in the planning and decision-making phases of a project. Figure 4.8 In contrast to the technical components of design and specification, stakeholder engagement may have a less direct impact on project quality, even if it is essential for successful project implementation.

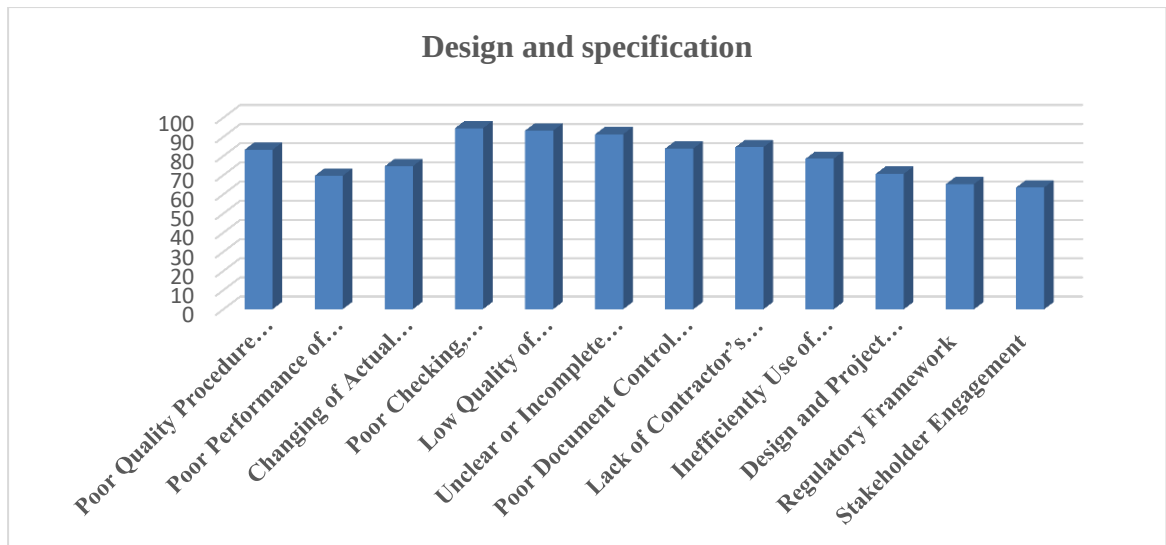


Figure 4.8 Design and specification factors

4.3.4 Workmanship and Construction Practices Factors

The statement discusses the results shown. Table 4.6 discusses issues linked to craftsmanship and construction procedures and how they affect the caliber of construction projects in Gambella town. With a percentage of 93.57%, the results show that "Lack of Responsibility, Ownership, and Carelessness of Workers" had the biggest effect on lowering the quality of building projects. This implies that worker behavior and attitude problems, like negligence, lack of ownership, and accountability, play a major role in the decline in the caliber of building projects in Gambella town.

Table 4.6 The relative importance index (RII) and the rank of factors workmanship and construction practices

Workmanship and Construction Practices Factors	RII value	Rank
Lack of Responsibility, Ownership and Carelessness of Workers	0.9357	1
Lack of Insufficient Technical Skill Levels of Workers	0.914	2
Deficiency of Contractor's Workers Number for the Project	0.764	9
Lack of Skilled Professionals in Construction Management	0.9	3
Working Trend of Workers	0.889	4
Material Shortages	0.835	6
Inadequate Labor Surveillance	0.875	5
Misunderstanding Between Labor and Superintendents	0.832	7
Ineffective Project Planning	0.7428	10
Delayed Progress Payments for Completed Work	0.792	8

However, In figure 4.9, the statement also notes that, with a percentage of 74.28%, "ineffective project planning" had the least effect on lowering the caliber of building projects. This suggests that problems with craftsmanship and building methods had a greater impact than flaws in project planning procedures. On the other hand, problems with craftsmanship and building methods may have a greater influence on project quality than inadequate project planning, even though it is still crucial.

Effective project planning involves defining project objectives, establishing timelines, allocating resources, and coordinating activities to ensure successful project delivery. While deficiencies in project planning can lead to delays, cost overruns, and other challenges, their direct impact on workmanship and construction practices may be less pronounced.

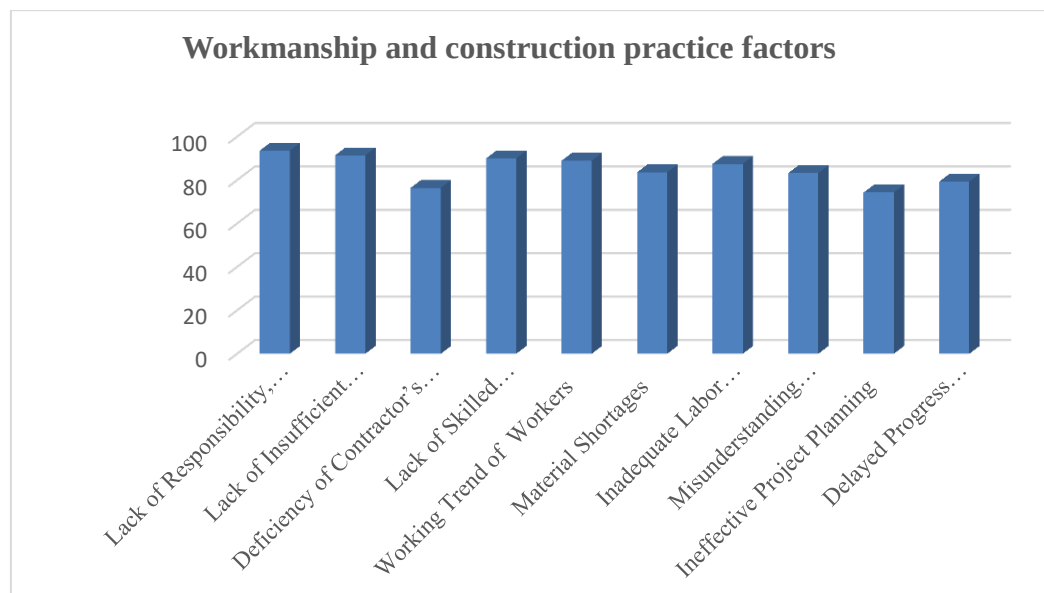


Figure 4.9 Workmanship and construction practice factors

4.3.5 Material Selection and Quality Factors

The statement discusses the findings related to material selection and quality factors and their impact on the quality of construction projects in Gambella town, as presented In Table 4.7. The results indicate that "Using Low Quality Material/Equipment Specification" had the largest impact, with a percentage of 94.29%, in reducing the quality of construction projects. This suggests that choosing

low-quality materials and equipment specifications significantly reduces the quality of construction projects in Gambella town.

Supplies and machinery play a crucial role in guaranteeing the caliber and durability of building projects. The equipment and materials requirements directly impact the structural soundness, functionality, and longevity of built assets. Using subpar tools or materials can result in early deterioration, structural flaws, and a general decrease in the project's quality.

Table 4.7 The relative importance index (RII) and the rank of factors material selection and quality

Material Selection and Quality Factors	RII value	Rank
Low Quality of Selected Material and Equipment	0.925	2
Lack of Availability of Resources and Equipment	0.796	6
Using Low Quality of Material/Equipment Specification	0.9429	1
Local Availability	0.714	9
Durability	0.76	8
Sustainability	0.6964	10
Inspection and Testing	0.91	3
Compliance with Standards	0.764	7
Material Testing Laboratories	0.885	4
Quality Control Plans	0.86	5

In contrast, as illustrated in Figure 4.10, the relatively lowest impact of sustainability issues indicates that, although sustainable practices are gaining recognition as vital components within the construction industry, they may not serve as the principal determinants of quality outcomes in the specific context examined. This observation highlights that the selection of materials and the specifications of equipment utilized during construction processes are pivotal factors influencing the overall quality of building projects.

Consequently, it is imperative for stakeholders—ranging from project managers to architects and builders—to adopt a dual focus that prioritizes both the sustainability of materials and their inherent quality characteristics. By fostering a holistic approach that integrates sustainable practices with stringent quality standards, stakeholders can significantly enhance the performance and structural integrity of construction projects.

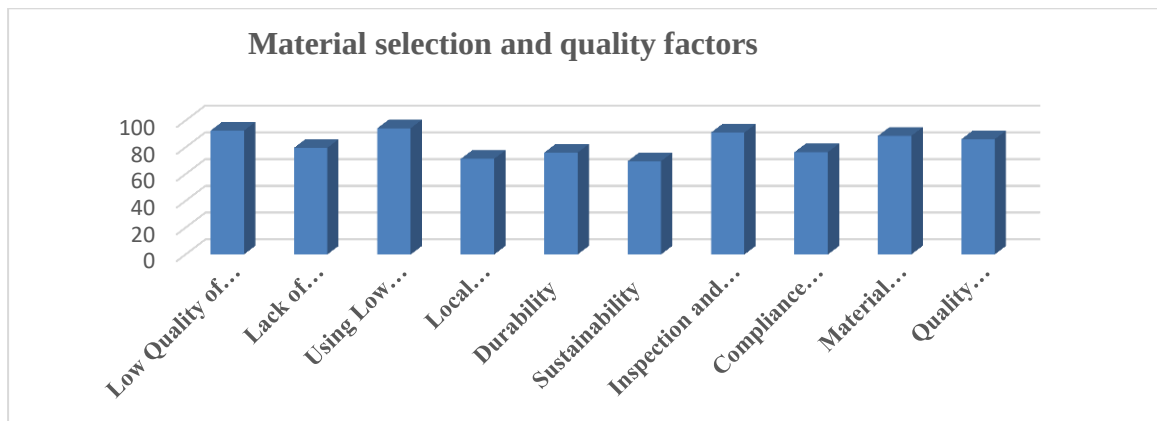


Figure 4.10 Material selection and quality factors

4.3.6 Environmental Factors

The results shown In Table 4.8 provide insight into how environmental elements, particularly the local economy and climate, affect the caliber of building projects in Gambella town. The findings show that, at 96.07%, the climate had the biggest effect on lowering the quality of construction projects, while the economic environment had the least negative effect (72.14%). Climate conditions play a crucial role in shaping the performance and longevity of built infrastructure. Adverse climate conditions, such as extreme temperatures, humidity, precipitation, and wind patterns, can pose significant challenges to construction projects. These factors can lead to accelerated deterioration, structural damage, and reduced overall quality of the constructed assets.

The high impact percentage associated with climate conditions (96.07%) underscores the substantial negative effect that adverse weather patterns and environmental conditions can have on construction projects in Gambella town. It suggests that the local climate poses a significant risk to the quality and durability of construction projects, highlighting the need for careful consideration of climate-related challenges in project planning, design, and material selection.

Table 4.8 The relative importance index (RII) and the rank of factors environmental

Environmental Factors	RII value	Rank
Low Tendency to Teamwork by the Contractor	0.853	5
Project Scope and Size	0.857	4

Weather Conditions During the Construction Period	0.939	2
Wastes Around the Site	0.796	8
Climate Condition	0.9607	1
Air Quality	0.821	6
Stability of Political Environment	0.875	3
Economic Environment	0.7214	9
Physical Environment	0.81	7

Conversely, the lower impact percentage associated with the economic environment (72.14%) In Figure 4.11 suggests that while economic factors are important, they may have a relatively smaller direct impact on project quality compared to climate conditions. Economic considerations, such as market conditions, financial resources, and cost management, are undoubtedly crucial for project viability and success. However, the findings indicate that in the context of Gambella town, climate conditions have a more pronounced and direct influence on the quality of construction projects than economic factors.

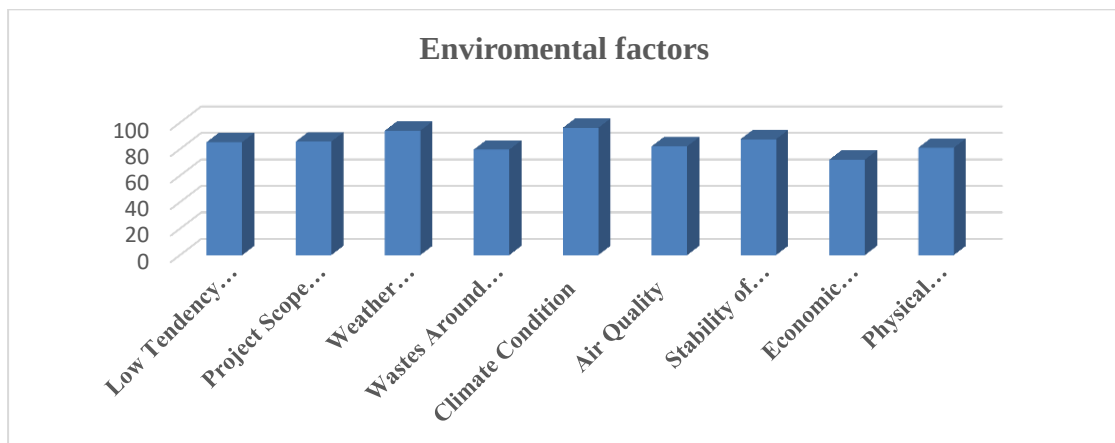


Figure 4.11 Environmental factors

4.3.7 Regulatory Compliance Factors

Table 4.9 results indicate that the communication gap between stakeholders had the largest impact, with a percentage of 95.36%, in reducing the quality of construction projects, while ethical and legal compliance had the smallest impact, with a percentage of 73.57%. It is important to consider the critical role that effective communication and regulatory compliance play in ensuring the successful delivery of construction projects. Effective communication between stakeholders, including

project owners, designers, contractors, subcontractors, and regulatory authorities, is essential for coordinating project activities, resolving issues, and aligning expectations. A breakdown in communication can lead to misunderstandings, delays, and conflicts, ultimately compromising the quality and success of construction projects.

The high effect percentage linked to the lack of communication among stakeholders highlights the serious harm that inadequate communication techniques may do to the quality of a project in Gambella town. It implies that poor communication practices such as insufficient information sharing, unclear expectations, and a lack of teamwork can impede project development, cause mistakes and rework, and eventually provide results that are of inferior quality.

Table 4.9 The relative importance index (RII) and the rank of factors regulatory compliance

Regulatory Compliance Factors	RII value	Rank
Lack of Information Between Team Members and also with Stakeholders	0.907	2
Poor Relationship and Partnering among Project Participant	0.867	3
Communication Gap between Stakeholders	0.9536	1
Conflicts and disputes between project partners	0.839	5
Government Policies and Regulations	0.796	8
Risk Management and Mitigation	0.821	7
Ethical and Legal Compliance	0.7357	9
Quality Assurance and Safety Compliance	0.842	4
Professionalism and Collaboration	0.828	6

Conversely, In Figure 4.12, The comparatively lower impact percentage of 73.57% associated with ethical and legal compliance suggests that while adherence to legal requirements and ethical standards is essential for maintaining project integrity and regulatory compliance, its immediate influence on project quality may be less significant than that of communication gaps among stakeholders. This finding underscores the importance of ethical and legal compliance in ensuring that construction projects operate transparently and accountably, thereby fostering trust and adherence to regulatory frameworks.

However, the results indicate that, particularly in the context of Gambella town, communication gaps between stakeholders exert a more pronounced and direct impact on the quality of construction projects. Effective communication is vital for aligning the objectives and expectations of various parties involved, facilitating timely decision-making, and minimizing misunderstandings that can lead to project delays and quality issues.

The contrast between the roles of ethical/legal compliance and communication highlights the need for project managers to prioritize and enhance communication strategies among stakeholders to improve overall project quality.

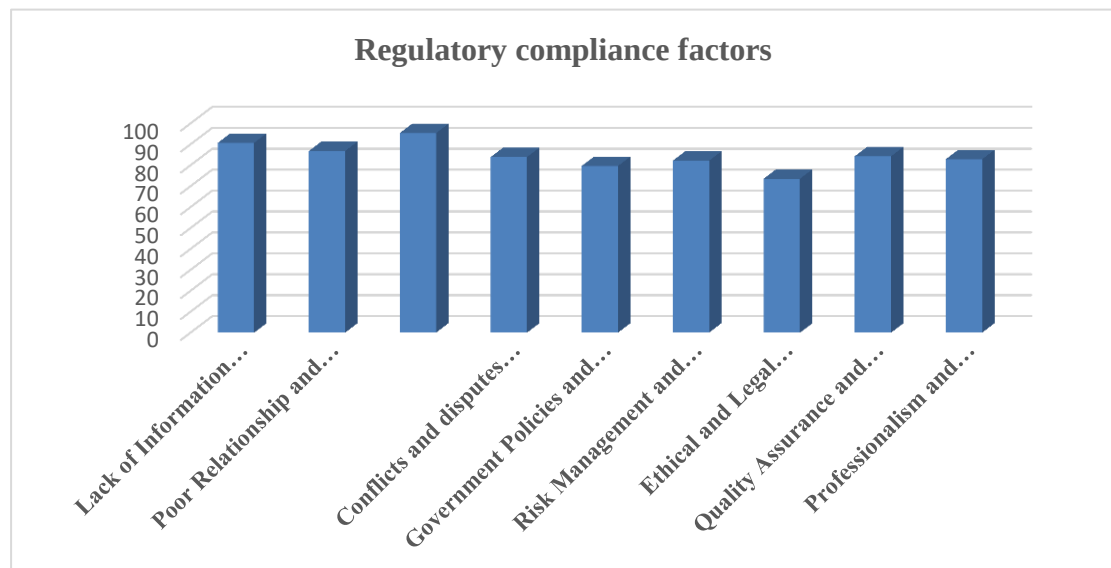


Figure 4.12 Regulatory compliance factors

4.3.8 Quality Control and Assurance Processes Factors

The results In Table 4.10 demonstrate the noteworthy influence of quality control and assurance procedures, with a particular emphasis on project overruns and the conduct of contracting firms, on the caliber of construction projects in Gambella town. The findings show that, at 92.5%, project overruns had the biggest effect on lowering the quality of construction projects, while the practices of contracting businesses had the least effect (71.93%). It is essential to delve into the factors contributing to project overruns and contracting companies' practices and their implications for project quality in construction projects.

Project overruns can arise due to various factors such as poor planning, inaccurate cost estimation, scope changes, delays in material delivery, labor shortages, adverse weather conditions, and unforeseen site conditions. When projects experience overruns, it can lead to budget constraints, schedule delays, resource reallocation, and quality compromises, ultimately impacting the overall quality of the construction project. The high impact percentage associated with project overruns in reducing the quality of construction projects in Gambella town underscores the critical importance of effective project management, planning, monitoring, and control to mitigate risks and prevent overruns. Project overruns can disrupt project progress, lead to cost escalations, schedule delays, rework, and compromise the quality of construction outcomes. Therefore, addressing factors contributing to project overruns through proactive risk management, accurate cost estimation, effective scheduling, and contingency planning is essential to maintaining project quality.

Table 4.10 The relative importance index (RII) and the rank of factors quality control and assurance processes

Quality Control and Assurance Processes Factors	RII value	Rank
Project Overruns	0.925	1
Poor Quality	0.889	2
Inappropriate Procurement Systems	0.757	6
Lack of Skilled Professionals	0.875	3
Contracting Companies Practices	0.7193	8
Fluctuating Labor Availability	0.846	5
Proper Planning	0.742	7
Continuous Monitoring	0.867	4

Conversely, In Figure 4.13, the practices of contracting organizations cover a wide range of aspects pertaining to the capabilities, performance, and methods of construction firms that are engaged in project management. Knowledge, experience, resources, quality control procedures, adherence to standards, workforce competency, subcontractor management, and dedication to providing high-quality results are some of the ways that contracting organizations' activities can affect the quality of projects. The quality of construction projects can be jeopardized by the actions of poor contracting businesses, which can lead to poor workmanship, material faults, safety concerns, non-compliance with specifications, delays, and communication breakdowns.

The findings indicate that, although contracting companies' practices have a significant impact on project quality, their direct impact may be smaller than that of project overruns, as evidenced by the comparatively lower impact percentage (71.93%) associated with their practices in Gambella Town's construction projects. Enhancing the prequalification procedures, performance reviews, training plans, quality control procedures, and contractual agreements of contracting organizations can improve their practices and reduce the risk of subpar work and noncompliance.

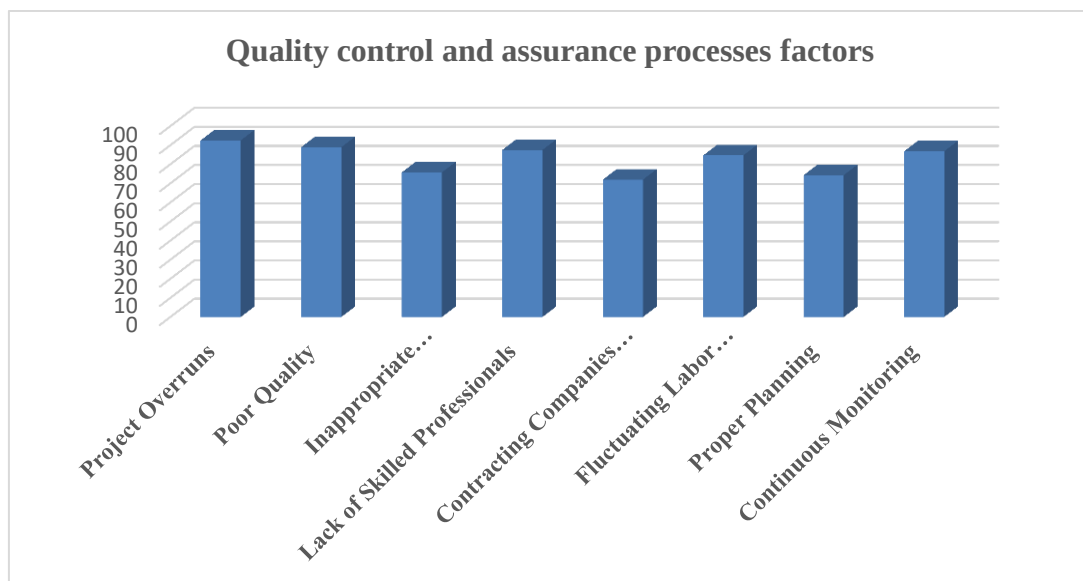


Figure 4.13 Quality control and assurance process factors

4.4 Effects Due to Quality Reduction in the Public Building Construction Project in Gambella Town

The findings In Table 4.11 and Figure 4.14 showed the significant impact of time waste and non-conformity to requirements on the quality of construction projects in Gambella town. According to the results, time wastage had the highest effect, with a percentage of 94.64%, in reducing the quality of construction projects, while non-conformity to requirements had the smallest effect, with a percentage of 72.5%.

A number of things can lead to time wastage, including insufficient preparation, insufficient coordination, a breakdown in communication, scope modifications and design flaws, shortages of materials, inefficient labor, inclement weather, and equipment failures. Time waste in projects can result in schedule delays, cost

increases, rework, lost productivity, resource reallocation, and eventually affect the construction project's overall quality. In order to avoid delays and maximize resource utilization, effective project management, scheduling, coordination, and monitoring are crucial. This is demonstrated by the high impact of time waste on the quality of construction projects in Gambella town. To ensure timely project delivery and improve project quality, it is imperative to address time-wasting problems through efficient project planning, scheduling tools, resource allocation techniques, risk management, and performance monitoring. The relatively lower impact percentage associated with non-conformity to requirements (72.5%) in reducing the quality of construction projects in Gambella town suggests that while non-conformity is a significant factor affecting project quality, it may have a smaller direct impact compared to time waste. Mitigating non-conformity risks through rigorous quality assurance processes, inspections, testing protocols, compliance checks, subcontractor oversight, and continuous monitoring can help prevent quality deviations and ensure adherence to project requirements.

Table 4.11 The relative importance index (RII) and the rank of effect due to quality reduction

Effect Due to Quality Reduction	RII value	Rank
Time waste	0.9464	1
Increased Errors and Defects	0.925	2
Non-Conformity to Requirements	0.725	11
Re-testing, Re-inspection, Re designing and Re-working	0.871	4
Dispute Between Stakeholders	0.796	8
Safety Problems	0.896	3
Aesthetics Reduction	0.846	6
Durability and Strength Problems	0.803	7
Legal and Contractual Issues	0.778	9
Reduced Lifespan and Maintenance Challenges	0.85	5
Environmental Impact	0.76	10

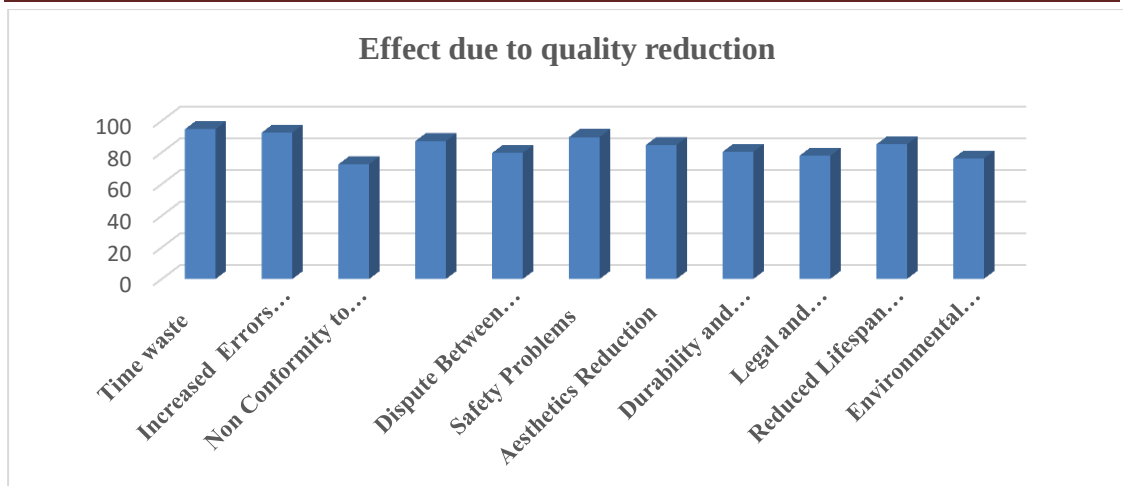


Figure 4.14 Effect due to quality reduction

4.5 Strategies for Addressing Recognized Factors

The following strategies are proposed to address the key factors contributing to quality reduction in public building construction projects in Gambella Town. These strategies are developed based on the findings discussed in earlier sections and are informed by the feedback gathered from stakeholders during interviews.

4.5.1 Employing Skilled and Competent Contractors, Subcontractors, and Suppliers

The data analysis, particularly from the qualitative interviews, revealed that engaging experienced contractors, subcontractors, and suppliers is crucial for maintaining high construction quality. The interviews highlighted that nearly all instances where experienced entities were involved led to successful project outcomes with fewer defects and delays. To operationalize this, it is recommended that public building projects in Gambella Town implement a rigorous contractor certification process. This process would ensure that only those with verified experience and a track record of delivering high-quality work are engaged in public projects. The data indicated that projects involving certified contractors significantly reduced quality-related issues, with one respondent noting that “the use of experienced contractors and suppliers resulted in a 95.71% success rate in maintaining construction quality”.

4.5.2 Implementing Comprehensive Pre-Project Planning

The research highlighted the significant impact of ineffective project planning on the quality of construction projects. Interview responses consistently pointed out that inadequate planning leads to delays, cost overruns, and compromises in quality. To mitigate these issues, it is essential to implement detailed and thorough pre-project planning processes. For instance, several respondents emphasized incorporating stakeholder input early in the planning phase as a way to align expectations and reduce misunderstandings. One respondent noted that "ensuring that detailed designs are completed and all stakeholders are engaged early in the process significantly improves project outcomes by preventing issues that typically arise during construction." This approach aligns with best practices in project management, where adopting advanced planning tools and methodologies, such as risk assessment and resource allocation, can facilitate real-time adjustments and keep the project on track.

4.5.3 Enhancing Communication and Collaboration Among Stakeholders

Communication gaps were identified as a critical issue leading to project delays and quality reduction, with a high Relative Importance Index (RII) of 0.953, indicating its significance. The qualitative interviews further emphasized the need for structured and regular communication among all project stakeholders, including contractors, project managers, architects, and government officials. To address this, it is recommended to establish a communication plan that includes regular meetings and the use of collaborative platforms for real-time information sharing. One interviewee noted that "projects with established communication protocols had significantly fewer instances of rework and misunderstandings, which improved overall project quality." This strategy ensures that all stakeholders are informed and aligned on project goals and quality standards.

4.5.4 Continuous Training and Capacity Building

The lack of ongoing training and capacity building among workers was frequently cited as a factor contributing to quality reduction. Respondents in the interviews and surveys highlighted the need for regular training programs to keep workers up to date with the latest construction technologies and quality control practices. It was suggested that continuous education is crucial for maintaining high standards of

workmanship throughout the project lifecycle. For example, respondents mentioned that "regular workshops and training sessions focusing on construction best practices and quality assurance have led to noticeable improvements in project outcomes." Implementing these programs will ensure all personnel have the skills to deliver high-quality construction.

By implementing these strategies, stakeholders in public building construction projects in Gambella Town can address the key factors contributing to quality reduction. These strategies, supported by data and real-world examples from earlier sections of this document, offer practical solutions that can be tailored to the specific needs of each project.

4.6 Summary of Key Findings

This section summarizes the key findings from the data analysis collected in this study, highlighting how they address the specific research objectives outlined at the beginning of the thesis.

Identification of Key Factors Contributing to Quality Reduction

The study identified several critical factors that contribute to quality reduction in public building construction projects in Gambella Town. These factors include inadequate contractor skills and experience, poor pre-project planning and scheduling, ineffective stakeholder communication, and insufficient quality control measures. The analysis presented in Section 4.3 highlighted that these factors significantly contribute to the overall decline in construction quality.

Assessment of the Impact of Identified Factors

The impact of these factors was assessed using both quantitative and qualitative methods. The study found that projects with experienced contractors had significantly fewer defects, as discussed in Section 4.3.5. Similarly, the importance of thorough pre-project planning and effective communication was emphasized through stakeholder interviews and supported by quantitative data, as detailed in Sections 4.3.2 and 4.3.7. The findings demonstrated that addressing these factors could substantially improve construction quality.

Development of Practical Strategies for Improvement

Based on the findings, practical strategies were developed to mitigate the identified factors contributing to quality reduction. These strategies, discussed in Section 4.5, include implementing rigorous contractor selection and training processes, adopting advanced project management tools for better planning and scheduling, establishing structured communication plans, and enhancing quality control through regular inspections and digital tools. These strategies are grounded in the data collected and the insights gained from stakeholder feedback, ensuring their relevance and applicability to the context of Gambella Town.

The findings of this study provide a comprehensive understanding of the key factors affecting construction quality in public building projects in Gambella Town. By addressing these factors through the proposed strategies, stakeholders can significantly improve the quality of future construction projects, ensuring that they meet the required standards and deliver lasting value.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the conclusions drawn from analyzing factors contributing to quality reduction in public building construction projects in Gambella Town. It synthesizes the key findings from the study and discusses their implications for construction practices in similar contexts. Based on these conclusions, the chapter also provides actionable recommendations to improve construction quality. These recommendations are designed to address the specific challenges identified in the study and offer practical strategies for stakeholders involved in public building projects.

5.1 Conclusions

This study aimed to assess the key factors contributing to quality reduction in public building construction projects in Gambella Town and to develop practical strategies for addressing these issues. Through a thorough analysis combining quantitative data and qualitative insights from stakeholders, the research has provided meaningful conclusions that inform both theory and practice.

The findings reveal that inadequate contractor skills, poor pre-project planning, ineffective communication, and insufficient quality control significantly contribute to the reduction in construction quality. These factors emerged consistently across both the quantitative analysis and stakeholder feedback, highlighting their critical importance in determining the overall success of construction projects.

Further analysis demonstrated the substantial impact of contractor competence and pre-project planning on the quality of construction. A clear correlation was found between these elements and the incidence of defects and delays. Additionally, the role of communication and quality control was underscored, with improvements in these areas likely to yield significant enhancements in construction outcomes.

Building on these insights, the study proposed a set of actionable strategies tailored to the context of public building projects in Gambella Town. These include implementing rigorous contractor certification processes, adopting advanced project

management tools, establishing structured communication protocols, and enhancing quality control through regular inspections and digital monitoring. The proposed strategies are designed to be both practical and directly applicable, offering a clear pathway for improving construction quality.

In conclusion, this research has successfully identified the key factors affecting construction quality in Gambella Town, assessed their impact, and developed practical strategies to address them. By applying these strategies, stakeholders can significantly improve construction quality, ensuring that projects meet the required standards and deliver lasting value. The findings offer a deeper understanding of the challenges faced in Gambella and provide a framework that could be applied to similar construction contexts elsewhere.

5.2 Recommendations

Based on the analysis and conclusions of this research, the following recommendations are presented to tackle the critical factors identified as contributing to quality reduction in public building construction projects in Gambella Town:

Enhancing Contractor Skills and Competence

Given the significant impact of contractor skills on construction quality, it is recommended that a formal certification and accreditation process be established for contractors, subcontractors, and suppliers involved in public building projects. This process should evaluate their experience, technical expertise, and adherence to industry standards. Furthermore, continuous professional development programs should be implemented to ensure that contractors are kept up-to-date with the latest construction techniques and technologies. This will help to mitigate the risk of defects and improve overall project outcomes.

Improving Pre-project Planning and Scheduling

To address the issues related to poor pre-project planning and scheduling, it is recommended that public building projects in Gambella Town adopt comprehensive project management practices. This includes the use of advanced project management tools that allow for real-time tracking of project timelines, resources, and progress. A phased planning approach is also advised, where an initial pilot phase is used to identify potential challenges before the full-scale implementation of the project. This

will enable better anticipation and management of risks, reducing the likelihood of delays and cost overruns.

Strengthening Communication Among Stakeholders

Effective communication is essential to the success of construction projects. To overcome the challenges of miscommunication identified in the study, it is recommended that a structured communication plan be developed for each project. This plan should include regular progress meetings, the use of collaborative tools for real-time information sharing, and the appointment of a dedicated communication officer to ensure that all stakeholders are aligned. This will help to minimize misunderstandings, reduce errors, and ensure that all parties are working towards the same project goals.

Enhancing Quality Control and Assurance

Given the importance of rigorous quality control in maintaining construction standards, it is recommended that a comprehensive quality assurance framework be established for public building projects in Gambella Town. This framework should include regular inspections at key project milestones, the use of digital tools for quality monitoring, and the involvement of independent third-party auditors to verify compliance with established standards. By implementing these measures, the quality of construction projects can be significantly improved, leading to more durable and reliable public buildings.

Overall Recommendation

The recommendations outlined above are designed to address the specific challenges identified in this study and are tailored to the context of public building construction in Gambella Town. By implementing these recommendations, stakeholders can improve construction quality, reduce the incidence of defects and delays, and ensure that public building projects meet the required standards and deliver lasting value to the community. It is also recommended that future research continue to explore these areas, particularly the long-term impact of these strategies on construction quality and project outcomes.

REFERENCES

- Ababa, A. and Minch, A. (2013) 'Loss and damage from flooding in the Gambela region , Ethiopia Alemseged Tamiru Haile * Koen Kusters Negash Wagesho', 5(4), pp. 483–497.
- Al-tmeemy, S.M.H.M., Abdul-rahman, H. and Harun, Z. (2010) 'Author ' s personal copy Future criteria for success of building projects in Malaysia'. Available at: <https://doi.org/10.1016/j.ijproman.2010.03.003>.
- And, A.L.Y. and Yadeta, F.T. (2021) 'ABC Research Alert', 4(2), pp. 1–56.
- Andersson, R. and Eriksson, H. (2006) 'Similarities and differences between TQM , six sigma and lean'. Available at: <https://doi.org/10.1108/09544780610660004>.
- Ayegun, O.A., Abiola-falemu, J.O. and Olawumi, T.O. (2018) 'Assessment of Clients' Perception and Satisfaction with Project Quality Delivery in Nigeria', *Journal of Sustainable Construction Engineering and Project Management*, 1(1), pp. 27–44. Available at: <https://doi.org/10.6084/m9.figshare.19726483>.
- Baccarini, D., Salm, G. and Love, P.E.D. (2004) 'Management of risks in information technology projects', *Industrial Management and Data Systems*, 104(3), pp. 286–295. Available at: <https://doi.org/10.1108/02635570410530702>.
- Butler, J. a., Seigel, R. a. and Mealey, B.K. (2006) 'Malaclemys terrapin - Diamondback Terrapin', *Chelonian Research and Monographs*, (3), pp. 279–295. Available at: <https://doi.org/10.2305/IUCN.UK.2019-1.RLTS.T12695A507698.en.CITATIONS>.
- Chan, A.P.C. and Tam, C.M. (2006) 'building projects in Hong Kong'.
- Choy, S. (2015) *Planning for project*, Griffith University CI 8252EDN.
- Collins, A. and Baccarini, D. (1987) 'Project Success – A Survey'.
- Cook, D.J., Augusto, J.C. and Jakkula, V.R. (2009) 'Ambient intelligence: Technologies, applications, and opportunities', *Pervasive and Mobile Computing*, 5(4), pp. 277–298. Available at: <https://doi.org/10.1016/j.pmcj.2009.04.001>.
- Dawood, N. (2010) 'Construction Management and Economics Estimating project and activity duration : a risk management approach using network analysis Estimating project and activity duration : a risk management approach using network analysis', (April 2013), pp. 37–41.
- Dorcas, B., Elkanah, O. and John, O. (2019) 'Most Critical Factors Responsible For Poor Project Quality Performance in Building Construction Industry (A Case Study of Three Major Cities in Nigeria)', *European International Journal of Science and Technology*, 8(2), pp. 1–14.
- Ede, A.N. (2011) 'Journal of Sustainable Development in Africa (Volume 13, No.1, 2011)', 13(1), pp. 153–161.
- El-sokhn, N.H. and Othman, A.A.E. (2014) '10 th International Conference on Civil

and Architecture Engineering PROJECT FAILURE FACTORS AND THEIR IMPACTS ON THE CONSTRUCTION INDUSTRY : A LITERATURE REVIEW’, *Proceedings of the 10th ICCAE-10 Conference*, 27-29 May, 2014, pp. 27–29.

Enshassi, A. and Ayyash, A. (2014) ‘Factors affecting cost contingency in the construction industry - Contractors’ perspective’, *International Journal of Construction Management*, 14(3), pp. 191–208. Available at: <https://doi.org/10.1080/15623599.2014.922729>.

Estimates, C.O.F. (2001) ‘Predicting a Ccuracy of E Arly C Ost Estimates Based on Estimate Quality’, 127(June), pp. 173–182.

Fahmy, H. (2001) ‘A Review of “Quality Engineering Handbook“ Thomas Pyzdek Marcel Dekker, 1999, 680 pp.’, *IIE Transactions*, 33(6), pp. 531–531. Available at: <https://doi.org/10.1080/07408170108936851>.

Gong, K. *et al.* (2009) ‘Nitrogen-doped carbon nanotube arrays with high electrocatalytic activity for oxygen reduction’, *Science*, 323(5915), pp. 760–764. Available at: <https://doi.org/10.1126/science.1168049>.

Grandgirard, J. *et al.* (2002) ‘Costs of secondary parasitism in the facultative hyperparasitoid *Pachycrepoideus dubius*: Does host size matter?’, *Entomologia Experimentalis et Applicata*, 103(3), pp. 239–248. Available at: <https://doi.org/10.1023/A>.

Gupta, S., Ahmadi, M.A. and Kumar, L. (2020) ‘Identification of the Barriers of Lean Construction Implementation in Construction Projects- a Review’, *International Journal of Innovative Research in Computer Science & Technology*, 8(3). Available at: <https://doi.org/10.21276/ijircst.2020.8.3.27>.

Hammad, S.A., Jusoh, R. and Ghozali, I. (2013) ‘Decentralization, perceived environmental uncertainty, managerial performance and management accounting system information in Egyptian hospitals’, *International Journal of Accounting and Information Management*, 21(4), pp. 314–330. Available at: <https://doi.org/10.1108/IJAIM-02-2012-0005>.

Harvey, W.S. (2010) ‘Methodological approaches for interviewing elites’, *Geography Compass*, 4(3), pp. 193–205. Available at: <https://doi.org/10.1111/j.1749-8198.2009.00313.x>.

Iyer, K. C. and Jha, K. N. (2017) ‘Critical Factors Affecting Schedule Performance: Evidence from Indian Construction Projects’, *Engineering, Construction and Architectural Management*, 24(5), pp. 757–773.

Jamaludin, S.Z.H.S., Mohammad, M.F. and Ahmad, K. (2014) ‘Enhancing the Quality of Construction Environment by Minimizing the Cost Variance’, *Procedia - Social and Behavioral Sciences*, 153, pp. 70–78. Available at: <https://doi.org/10.1016/j.sbspro.2014.10.042>.

Jha, S. *et al.* (2006) ‘UBVRI Light Curves of 44 Type Ia Supernovae ’, *The Astronomical Journal*, 131(1), pp. 527–554. Available at: <https://doi.org/10.1086/497989>.

Josephson, P.-E. and Hammarlund, Y. (1999) 'The causes and costs of defects in construction', *Automation in Construction*, 8(6), pp. 681–687. Available at: [https://doi.org/10.1016/s0926-5805\(98\)00114-9](https://doi.org/10.1016/s0926-5805(98)00114-9).

Kazemi, N. *et al.* (2018) 'Economic order quantity models for items with imperfect quality and emission considerations', *International Journal of Systems Science: Operations and Logistics*, 5(2), pp. 99–115. Available at: <https://doi.org/10.1080/23302674.2016.1240254>.

kothari, 2010 (2010) 'Department of Management Studies Lachoo Memorial College of Science & Technology, Jodhpur', 1(1).

Lenk, A. *et al.* (2009) 'What's inside the cloud? An architectural map of the cloud landscape', *Proceedings of the 2009 ICSE Workshop on Software Engineering Challenges of Cloud Computing, CLOUD 2009*, pp. 23–31. Available at: <https://doi.org/10.1109/CLOUD.2009.5071529>.

Ling, R. and Baron, N.S. (2007) 'Text messaging and IM: Linguistic comparison of American college data', *Journal of Language and Social Psychology*, 26(3), pp. 291–298. Available at: <https://doi.org/10.1177/0261927X06303480>.

Liu, D. *et al.* (2019) 'Hierarchical task network approach for time and budget constrained construction project planning', *Technological and Economic Development of Economy*, 25(3), pp. 472–495. Available at: <https://doi.org/10.3846/tede.2019.9384>.

Malmqvist, J. *et al.* (2019) 'Conducting the Pilot Study: A Neglected Part of the Research Process? Methodological Findings Supporting the Importance of Piloting in Qualitative Research Studies', *International Journal of Qualitative Methods*, 18, pp. 1–11. Available at: <https://doi.org/10.1177/1609406919878341>.

Mane, P.P. and Patil, J.R. (2017) 'Quality Management System at Construction Projects', (April 2015).

Mishra, S.K. *et al.* (2009) 'Telemedicine in India : Current Scenario and the Future', pp. 568–575.

Muhumuza, J. *et al.* (2016) 'Article information : To cite this document ':

Oke, A., Aigbavboa, C. and Dlamini, E. (2017) 'Factors Affecting Quality of Construction Projects in Swaziland', *The Ninth International Conference on Construction in the 21st Century (CITC-9)*, (March 5th-7th), pp. 1–6.

Oyedele, L.O. *et al.* (2015) 'Critical factors affecting construction quality in Nigeria: evidence from industry professionals', *International Journal of Sustainable Building Technology and Urban Development*, 6(2), pp. 103–113. Available at: <https://doi.org/10.1080/2093761X.2015.1033662>.

Rabinowitz, J.E. *et al.* (2002) 'Cross-Packaging of a Single Adeno-Associated Virus (AAV) Type 2 Vector Genome into Multiple AAV Serotypes Enables Transduction with Broad Specificity', *Journal of Virology*, 76(2), pp. 791–801. Available at: <https://doi.org/10.1128/jvi.76.2.791-801.2002>.

Shebob, A., Dawood, N. and Shah, R.K. (2012) 'Development of a methodology for

analysing and quantifying the impact of delay factors affecting construction projects’, pp. 17–29.

Smith, D.B. *et al.* (2009) ‘Applied Geochemistry Pilot studies for the North American Soil Geochemical Landscapes Project – Site selection , sampling protocols , analytical methods , and quality control protocols’, 24, pp. 1357–1368. Available at: <https://doi.org/10.1016/j.apgeochem.2009.04.008>.

Stevens, D. (2010) ‘Osama or the Georges: Shifting threats and state policy towards civil society in Uzbekistan’, *Development and Change*, 41(2), pp. 355–374. Available at: <https://doi.org/10.1111/j.1467-7660.2010.01638.x>.

Vadivel, T.S. *et al.* (2016) ‘Analyzing the Factors Affecting Quality in Construction’, *International Journal of Engineering Research & Technology (Ijert)*, 4(33), pp. 1–6.

Watson, M.A. and Gryna, F.M. (2001) ‘Quality culture in small business: Four case studies how to determine the quality culture at a small company’, *Quality Progress*, 34(1), pp. 41–48.

Yates, J.K. and Lockley, E.E. (2002) ‘Documenting and Analyzing Construction Failures’, *Journal of Construction Engineering and Management*, 128(1), pp. 8–17. Available at: [https://doi.org/10.1061/\(asce\)0733-9364\(2002\)128:1\(8\)](https://doi.org/10.1061/(asce)0733-9364(2002)128:1(8)).

Zwetsloot, G.I.J.M. and Ashford, N.A. (2003) ‘The feasibility of encouraging inherently safer production in industrial firms’, *Safety Science*, 41(2–3), pp. 219–240. Available at: [https://doi.org/10.1016/S0925-7535\(02\)00003-6](https://doi.org/10.1016/S0925-7535(02)00003-6).

APPENDIXS

APPENDIX A

QUESTIONNAIRE FOR ACADEMIC RESEARCH

JIMMA UNIVERSITY

JIMMA INSTITUTION OF TECHNOLOGY

SCHOOL OF GRADUATE STUDIES

FACULTY OF CIVIL AND ENVIRONMENTAL ENGINEERING

Dear Respondents!

The purpose of this questionnaire and format is to obtain information and data for the specified research conducted as partial fulfillment of the requirements for a master's degree in science in Civil Engineering (CEM stream) at Jimma University, Jimma Institute of Technology (JIT).

Research Title: Assessment of Key Factors Contributing to Quality Reduction in Public Building Construction Projects: A Case of Gambella Town.

Objective: The main objective of the study is to assess and analyze the factors that influence a quality reduction in public building construction projects, with the goal of suggesting effective strategies for enhancement in Gambella Town.

Instruction Please answer, rate, and tick (✓) the questionnaire by choosing the appropriate choices. The questionnaire and data collection contain four parts. Part one contains personal information and professional skills; part two deals with the main factors that influence quality reduction in the public building construction project; part three discusses the effects due to quality reduction in the public building construction project in Gambella Town; and part four proposes to develop strategies for addressing recognized factors that contribute to quality reduction in the public building construction project. I realize that there are numerous demands on your time. However, your involvement is a vital requisite for this study. I appreciate your anticipated cooperation in answering this questionnaire, which may take less than 10 minutes of your valuable time. Thank you for your earnest cooperation in advance.

Best Regards

Sincerely yours.

Muluken Azanaw Asre

Postgraduate Student in Civil Engineering, (CEM Stream)

Cell phone: +251920327045

Email address: - mulukenazanawasre@gmail.com

PART 1: GENERAL INFORMATION:

RESPONDENT'S AND PROJECT DEMOGRAPHIC PROFILES.

Please give your response for the following questions by putting “(√)” marks at your choice rectangle shown for questions having choice.

1. Gently indicate the type of organization.

I. Owner ☐ II. Consultant ☐ III. Contractor ☐

2. Gently indicate you're professional.

I. Architect ☐ II. Project manager ☐ III. Site Engineer ☐ V. Office Engineer ☐

VI. Others ☐ VIII. Quantity Surveyor ☐ Please specify_____

3. Gently indicate number your experience in the construction field.

I. Less than 5 years ☐ III. From 11 to 15 years ☐

II. From 5 to 10 years ☐ V. above 15 years ☐

4. Gently indicate your educational level.

I. Diploma ☐ II. Degree ☐ III. Masters ☐ V. Ph.D. Graduate ☐

5. What is your (Respondents) field of specialization?

I. Civil Engineering ☐ II. Surveying Engineering ☐ III. Construction technology and management ☐ V. If other, please specify_____

PART 2: MAIN FACTORS CONTRIBUTING TO QUALITY REDUCTION IN PUBLIC BUILDING CONSTRUCTION PROJECTS.

Lists of influencing factors for quality reduction in public building construction projects for the study are mentioned below. From your experience in the sector, please tick the appropriate cell by indicating how much you rate the listed factors that influence quality reduction in the public building construction project in Gambella town, Gambella region, Ethiopia. (Please indicate your opinion by putting (✓) in the 1 to 5 rating scale.)

Agreement: 1-VERY LOW, 2 - LOW, 3 - AVERAGE, 4 - HIGH, 5 - VERY HIGH.

No	Main Factors Contributing to Quality Reduction in Public Building Construction Projects in Gambella Town.	5	4	3	2	1
	A. Project Management and Planning Factors					
1	Lack of Quality Department by the Contractor					
2	Poor Training System by the Contractor					
3	Lack of Quality Policy by the Contractor					
4	Lack of Management Commitment by the Contractor					
5	Low Effective Project Management system by the Contractor					
6	Low Quality of Supplier and Sub-Contractor Selection					
7	Effective Decision-Making					
8	Project Delivery System					
9	Contractor's Cash Flow Management					
10	Leadership Skills of Project Manager					
11	Adequacy of Fund Allocation					
	If any other, please specify which is not listed on the above					

	table.					
a						
b						
c						
	B. Budgetary and Time Constraints Factors					
12	Contractors' Financial Incapability for the Project					
13	Unsettled and Lack of Sufficient Project Fund					
14	Difficulties in Financing					
15	Materials Price Escalation					
16	Ineffective Project Planning					
17	Resource Management and Scheduling					
18	Delayed Progress Payments					
19	Skilled Professionals Shortage					
20	Fluctuating Labor Availability					
	If any other, please specify which is not listed on the above table.					
a						
b						
c						
	C. Design and Specification Factors					
21	Poor Quality Procedure by the Contractor					
22	Poor Performance of Working Tools, Techniques & Methodology					

23	Changing of Actual Inspection and Test Results					
24	Poor Checking, Inspecting and Testing by the Consultant					
25	Low Quality of Drawing and Specification					
26	Unclear or Incomplete Construction Drawings and Specification					
27	Poor Document Control by the Consultant					
28	Lack of Contractor's Performance Supervision by Consultants					
29	Inefficiently Use of Quality Control Inspection Checklists					
30	Design and Project Complexity					
31	Regulatory Framework					
32	Tender Duration					
33	Technology and Innovation Consideration					
34	Stakeholder Engagement					
	If any other, please specify which is not listed on the above table.					
a						
b						
c						
	D. Workmanship and Construction Practices Factors					
35	Lack of Responsibility, Ownership and Carelessness of Workers					
36	Lack of Insufficient Technical Skill Levels of Workers					
37	Deficiency of Contractor's Workers Number for the Project					
38	Deficiency of the Consultant Staff Number for the Project					

39	Lack of Skilled Professionals in Construction Management					
40	Working Trend of Workers					
41	Material Shortages					
42	Inadequate Labor Surveillance					
43	Misunderstanding Between Labor and Superintendents					
44	Alterations to Drawings and Specifications During Execution					
45	Escalation of Material Prices					
46	Ineffective Project Planning					
47	Scheduling or Resource Management Challenges					
48	Delayed Progress Payments for Completed Work					
	If any other, please specify which is not listed on the above table.					
a						
b						
c						
	E. Material Selection and Quality Factors					
49	Low Quality of Selected Material and Equipment					
50	Lack of Availability of Resources and Equipment					
51	Using of Un calibrated(defective) Equipment					
52	Using Low Quality of Material/Equipment Specification					
53	Local Availability					
54	Cost-Effectiveness					

55	Durability					
56	Sustainability					
57	Inspection and Testing					
58	Compliance with Standards					
59	Material Testing Laboratories					
60	Quality Control Plans					
	If any other, please specify which is not listed on the above table.					
a						
b						
c						
	F. Environmental Factors					
61	Low Tendency to Teamwork by the Contractor					
62	Project Scope and Size					
63	Weather Conditions During the Construction Period					
64	Wastes Around the Site					
65	Climate Condition					
66	Air Quality					
67	Stability of Political Environment					
68	Economic Environment					
69	Physical Environment					
	If any other, please specify which is not listed on the above table.					

a						
b						
C						
	G. Regulatory Compliance factors					
70	Lack of Information Between Team Members and also with Stakeholders					
71	Poor Relationship and Partnering among Project Participant					
72	Communication Gap between Stakeholders					
73	Conflicts and disputes between project partners					
74	Government Policies and Regulations					
75	Risk Management and Mitigation					
76	Ethical and Legal Compliance					
77	Quality Assurance and Safety Compliance					
78	Professionalism and Collaboration					
	If any other, please specify which is not listed on the above table.					
a						
b						
c						
	H. Quality Control and Assurance Processes Factors					
79	Project Overruns					
80	Poor Quality					
81	Inappropriate Procurement Systems					

82	Lack of Skilled Professionals					
83	Contracting Companies Practices					
84	Fluctuating Labor Availability					
85	Proper Planning					
86	Continuous Monitoring					
	If any other, please specify which is not listed on the above table.					
a						
b						
c						

PART 3: THE MAGNITUDE OF INFLUENCE CAUSED BY THE FACTORS IDENTIFIED ON THE PUBLIC BUILDING CONSTRUCTION PROJECTS IN GAMBELLA TOWN.

Lists of the effects of quality reduction in building construction for the study are mentioned below. From your experience in the sector, please tick the appropriate cell by indicating how much you rate the list of effects due to quality reduction in the public building construction project in Gambella town, Gambella region, Ethiopia. Please indicate your opinion by putting (✓) in the 1 to 5 rating scale.

Agreement: 1-VERY LOW, 2 - LOW, 3 - AVERAGE, 4 - HIGH, 5 - VERY HIGH.

No	Effects Due to Quality Reduction in the Public Building Construction Project in Gambella Town.	5	4	3	2	1
1	Time waste					
2	Increased Errors and Defects					

3	Re-testing, Re-inspection, Re designing and Re-working						
4	Dispute Between Stakeholders						
5	Safety Problems						
6	Aesthetics Reduction						
7	Durability and Strength Problems						
8	Legal and Contractual Issues						
9	Reduced Lifespan and Maintenance Challenges						
10	Environmental Impact						
	If any other, please specify which is not listed on the above table.						
a							
b							
c							

PART 4: TO DEVELOP STRATEGIES FOR ADDRESSING RECOGNIZED FACTORS THAT CONTRIBUTES TO QUALITY REDUCTION FACTORS ON THE PUBLIC BUILDING CONSTRUCTION PROJECT IN GAMBELLA TOWN.

1.What are the Proposes strategies for addressing recognized factors that contribute to quality reduction in the public building construction project?

APPENDIX B

INTERVIEW

Project Name: _____

Name of the organization:

Respondent's Name (optional): _____

Position/role:

Date and time: _____

The interviewee is a member of the organization and has previously been or is still involved in the project.

Introduction

Good morning or good afternoon, Mr. or Mrs. (name of respondent). My name is Muluken Azanaw. Before starting my question, I would like to thank you for your volunteer participation in this research. The interview will be divided into two sections and will last approximately 10 to 20 minutes.

This semi-closed interview, which is forwarded to the client, contractor, consultants, or regulatory bodies and organizations that use the public building projects, is part of academic research that aims to assess and analyze the factors that influence a quality reduction of public building construction projects with the goal of suggesting effective strategies for enhancement in Gambella town. With this survey, I would like to identify the main factors that influence the quality of public building construction in order to improve building construction to meet quality standards. In the long term, this research helps the contract parties complete the project on time, within budget, with the desired quality, and with less risk. All information you provide will be kept strictly confidential and only used for academic research. Please feel free to answer the questions with what you know and what you think in your mind. I value your participation and thank you for your commitment of time, energy, and effort.

INTERVIEW QUESTIONERS FOR ORGANIZATIONS

1. How do you define and measure the quality of construction projects?
2. What are the key factors that you believe contribute to quality reduction in these projects?
3. What measures or strategies are currently in place to address quality issues in construction projects?
4. How do you ensure that contractors and other stakeholders adhere to quality standards and specifications?
5. How do you prioritize quality in your construction projects?
6. How do you ensure that the materials and workmanship meet the required quality standards?
7. What role do you think the government or other stakeholders can play in improving the quality of construction projects?
8. What recommendations do you have to enhance the quality of public building construction projects in Gambella Town?
9. How can the collaboration between architects, contractors, and government officials be improved to achieve better quality outcomes?

APPENDIX C

Some of public building construction projects in Gambella town under construction









