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**ASSESSMENT OF QUALITY MANAGEMENT PRACTICES OF
SELECTED FAÇADE MATERIALS**

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ABSTRACT

This research investigates the quality management practices of wall exterior finishing materials in public construction projects in Addis Ababa. The study aims to identify commonly used finishing materials, assess the quality planning, control, and assurance the current practices applied, examine the key factors affecting their performance, and propose a guideline for improvement. To achieve these objectives, a mixed-methods approach was employed, combining qualitative and quantitative data through questionnaires, interviews, site observations, and document reviews. Triangulation was applied to ensure the reliability of findings across projects handled by the Addis Ababa Design and Construction Works Bureau, Addis Ababa Housing Development Corporation, and the Ministry of Health. The spatial scope of the study is limited to public building projects located within Addis Ababa, while the thematic scope centers on quality management practices related to wall exterior finishing materials specifically focusing on quality planning, quality control, and quality assurance. The study covers mid-rise (5-12) story public buildings constructed over the past fifteen years. Key findings reveal that durability, availability, and cost-efficiency dominate material selection, while sustainability, safety, and compatibility with other systems are often overlooked. Gaps were identified in documentation practices, material integration, and design specification clarity. Inadequate quality assurance systems and incomplete design documents prior to material procurement were common across projects. These issues have contributed to delays, increased costs, and reduced durability of exterior finishes. The study mentions strengthening design documentation, enforcing material compatibility assessments during the planning stage, and institutionalizing design review mechanisms before material procurement. These measures are vital for enhancing quality management practices and ensuring more sustainable and resilient public infrastructure in Addis Ababa.

Key words: Exterior finishing materials, Quality management, public building projects, Quality planning, Quality control, Quality assurance, façade defects

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ACRONYMS

AADCWB	Addis Ababa Design and Construction works Bureau
AAHDC	Addis Ababa Housing Development Corporation.
ASTM	American Society for Testing and Materials
BOQ	Bill Of Quantity
CCS	Critical Chain Scheduling
CES	Compulsory Ethiopian Standard
CSFs	Critical Success Factors
EBCS	Ethiopian Building Code of Standard
G+X	Ground plus X floors
B+G+X	Basement plus Ground plus X floors
IES	Institute of Ethiopian standards
IPMA	International Project Management Association
IS	Indian Standard
ISO	International Organization for Standardization
KPI	Key performance indicator
MEP	Mechanical, Electrical and Plumbing
MOH	Ministry of Health
NAHB	National Association of Home Builders
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PPA	Public Procurement Agency
QA	Quality Assurance
QC	Quality Control
SPC	Statistical Process Control
SPSS	Statistical Package for Social Science
TOR	Term of reference
TQM	Total Quality Management
UK	United Kingdom

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1 INTRODUCTION

1.1. Background of the study

Quality is a cornerstone in all sectors, reflecting the excellence of products, services, and processes. In the construction industry, the concept of quality transcends aesthetics and functionality; it encompasses safety, durability, and customer satisfaction. Quality assurance in construction is pivotal, as poor construction practices lead to substantial economic losses and risks to human safety. Because of the complex nature of construction projects, achieving high-quality outcomes necessitates meticulous planning, continuous monitoring, and effective management strategies (Orji et al., 2019).

Quality management in construction is essential to navigate the intricacies of constructing buildings and infrastructure that meet or exceed the required standards. It involves a comprehensive approach that integrates various processes and practices aimed at ensuring the reliability and performance of construction projects. As highlighted in the literature, effective quality management entails detailed quality planning, rigorous quality control, and constant quality assurance activities throughout the project lifecycle. This systematic approach not only helps mitigate defects but also enhances the overall project delivery by fostering efficient resource use, minimizing rework, and ultimately ensuring that projects are fit for purpose (Dabok, 2022).

Quality management of exterior building materials encompasses key processes, including quality planning, quality control, quality assurance, and quality improvement. Quality planning involves preparation, design, and pre-construction phases (Rumane, 2017) ; Quality control ensures compliance with standards, codes, and project specifications (Satterfield). Quality assurance (QA) encompasses systematic activities designed to meet project requirements (Arditi and Gunaydin, 1998) while quality improvement focuses on enhancing processes to fulfill quality expectations (Cianfrani and West, 2009). Studies have emphasized the importance of thorough planning for project success (Berhan and Beshah).

Building envelopes serve essential functions, including structural support, environmental protection, and aesthetic enhancement (Ogunsote and Prucnal-Ogunsote, 2015, Aderibigbe and Ogunmakinde). External wall finishes contribute significantly to these roles by improving

durability, shielding against environmental conditions, and defining the building's appearance. Various types of exterior finishes exist, including metal cladding, curtain walls, paints, and tiles (Herzog et al. (2004).

In developing nations, a large share of government budgets is allocated to public construction projects (Mwesigwa et al., 2018). Research by Jekal 2006 on stakeholders and their relationship with public construction projects, the share of public construction projects' capital budget in Ethiopia is more than 55% of the total annual budget of the country. More than 60-80% of it is on construction materials (Guan and Cheung, 2023) and 20-30% is to be spent on finishing materials (Lynch and Builders, 2023). Additionally, the NAHB reports exterior wall finishes account for approximately 7.2% of total construction costs (Taylor, 2014). This underscores the significant impact of exterior finishes on urban development and visual quality (CHERENET and SEWNET, 2012)

Addis Ababa has been undergoing rapid urbanization, leading to extensive construction projects. However, the focus on quantity over quality has often resulted in substandard finishes (Admassu, 2018). Poor-quality finishes contribute to visual distress in urban areas. Poor finishes can lead to a decline in property values and deter potential investors This includes peeling paint, cracked walls, and other signs of wear and tear that detract from the city's appearance. Conversely High quality finishes can enhance the city's appeal, attract investment, and contribute in improving the quality of life for inhabitants. (BEKELE, 2021, Yacob et al., 2022, CHERENET and SEWNET, 2012).

Since a significant portion of construction budgets is spent on materials, there is often pressure to reduce costs, potentially compromising the quality of exterior finishes. Studies suggest that well-maintained buildings correlate with increased economic activity and social stability, whereas neglected areas may become hubs for crime and social issues (Qi et al., 2024, Hayward et al., 2015, Awasho and Alemu, 2023).

The exterior wall is a critical building component influencing property value, urban aesthetics, and energy efficiency (Alshamrani et al., 2017). Inadequate selection and poor quality management of finishing materials can accelerate building deterioration (Aderibigbe and Ogunmakinde).

This study is focused on assessing the quality management practice of selected exterior finishing materials by asking the questions of which exterior finishing materials are used, and quality

management systems (planning, control, assurance, and improvement) and investigates factors affecting the quality of exterior finishing materials in public projects in Addis Ababa in order to recommend measures to be taken in the long run.

1.2. Problem statement

Ethiopia’s growing construction industry has led to an increasing demand for public buildings. However, many public construction projects in Addis Ababa suffer from defects, poor performance, and failure to meet quality standards (Awasho and Alemu, 2023, Sahelu, 2015, Awol et al., 1948, Bedru, 2015). The estimated cost of repair and rework ranges between 2.4% and 3.15% of the building's total cost (Alomari, 2022). Quality of construction projects in Addis Ababa are highly influenced by management ability, construction materials, funding and stakeholder engagement. (Geletu, 2020). Fisseha (2021) highlighted quality management practices among building construction companies in Addis Ababa require further study (Fisseha, 2021). The table below summarizes key findings from various studies on building management practices:

Table 1.1 Building management practices according to authors.

Quality management in Ethiopia lags behind even other low-performing developing countries in Africa.	(Ayalew et al., 2016)
Defects arise due to poor planning, inadequate quality control, or deviations from design specifications.	(Waziri, 2016)
Poor workmanship, improper contractor management, and lack of control contribute to housing construction defects.	(Zunguzane et al., 2012).
Causes of public sector project failures include resource shortages, weak management (planning, control, coordination), and technical deficiencies (policy, strategy, poor project design).	(Miressa, 2017).
Major causes of defects in Addis Ababa’s construction sector include design quality, material quality, and construction quality management.	(Fisseha, 2021, Yirgalem and Abdulkadir, 2019)

Exterior finishes are mainly affected by their selection factors (quality, cost, aesthetics, durability, environment); environmental factors (rainfall, humidity, solar radiation, and saline); their execution (technology, application and expertise) and post construction characteristic of the materials (moisture absorption, resistance to chemical and physical attach) (Arizzi et al., 2012, Oluwole, 2014, Ho et al., 2004, Folorunso et al., 2017b, Cunningham, 2013). Poor selection and application of materials without considering climatic and environmental stresses have led to

premature deterioration, increased maintenance costs, and diminished urban aesthetics (Folorunso et al., 2017a).

Indiscriminate selection and use of exterior finishing materials without adequate attention to the stresses of its characteristic caused several damages and accelerated degradation of entire building and these results to surface that will eventually lead to defect and a negative impact on urban aesthetics (Folorunso et al., 2017a, Ishak et al., 2007). Studies have identified poor material selection as a key factor contributing to frequent maintenance issues in buildings. External walls, being a crucial structural component, significantly influence a building's energy efficiency, overall value, and visual appeal. Therefore, understanding the properties of exterior materials is essential for ensuring long-term structural performance (Alshamrani et al., 2017). Enhancing the resilience and sustainability of urban construction projects needs well-structured quality management framework shall prioritize failure prevention, material durability, and environmental adaptability.

Beyond durability, exterior finishes provide both functional and aesthetic benefits, preventing the interior against environmental factors including rain, sunlight, temperature variations, and humidity. Poor quality management in selecting and applying these materials not only affects building longevity but also leads to higher maintenance costs and diminished cityscapes (Bala et al., 2012). Given these challenges, it is essential to assess the quality management practices of exterior finishing materials used in public buildings across Addis Ababa.

1.3. Research objective

1.3.1. General objective

Assessing quality management practice of selected exterior finishing materials for improvement, depending on the study result.

1.3.2. Specific objective

- ✓ Identify commonly used exterior finishing materials on buildings in Addis Ababa.
- ✓ To assess the quality planning, quality control, and quality assurance practice of exterior finishing material.
- ✓ To identify factors affecting the quality of exterior finishing materials.
- ✓ To assess exterior building quality issues and defects.

1.4. Research significance

Providing clear information about the causes of quality problems and documents related to quality plans, control and assurance of exterior wall finishing materials for practitioners of the construction industry, especially internal stakeholders (professionals, consultants, clients, and contractors) including material manufacturers and suppliers, and government regulatory parties working in building design permit and standard development serves multiple purposes. It enhances practitioner awareness, informs decision-making, mitigates risks, ensures regulatory compliance, and holds material manufacturers and suppliers accountable. Ultimately, this knowledge contributes to improved construction practices, better project outcomes, and overall building quality.

1.5. Scope of the study

1.5.1. Thematic Scope

This research focuses on the quality management practices of wall exterior finishing materials used in public building projects. The study investigates quality planning, quality control, and quality assurance processes related to exterior wall finishes. It also examines factors influencing the selection of finishing materials, assesses current quality verification methods, identifies challenges affecting material performance, and proposes guidelines for improving quality management practices.

1.5.2. Spatial Scope

The study is geographically limited to mid-rise public buildings located in Addis Ababa, Ethiopia. Specifically, it covers buildings that are more than five to twelve stories tall and have been constructed within the last fifteen years. This selection reflects recent construction trends and challenges faced in the city's public infrastructure development.

1.6. Limitation

In the context of researching exterior finishing materials, several limitations emerge. Firstly, *there is a scarcity of documented data and comprehensive studies specifically focused on exterior finishing materials*. This inadequacy of empirical evidence hinders our understanding of material

characteristics for various contexts. Secondly, the scarcity of literature that investigates into the local context of finishing materials poses a challenge. Without a robust understanding of the regional context, it becomes difficult to study finishing material choices to the specific needs and environmental factors of a given area. Lastly, the processes and application practices related to exterior finishes should be critically assessed from scratch.

2. LITERATURE REVIEW

2.1. Introduction

All building structures are made up of various types of building materials. Professionals and participating stakeholders such as engineers, contractors and architects must have a deeper understanding of these materials. Knowing the different types of materials, their properties, and their specific uses is a valuable asset for builders, helping them achieve cost-effective solutions. Building finish is a non-structural part of a building. The finish can be divided into two according to the place of use; exterior finish (located principally on the outside of the structure) and interior finish (located inside). Exterior building materials significantly influence the quality and safety of the built environment. They affect life safety, building durability, sustainability, housing costs, and aesthetic compatibility with existing and historic building stock (Alread et al., 2014).

Quality problems on exterior buildings can be caused due to design fault, misunderstanding the client's brief to develop the design, using an incorrect or out of date information, misinterpreting client's expectation, Construction faults, not building to drawing or specifications and poor supervision and untrained workers leading to bad workmanship, which might result aesthetic defects it might also lead to collapse (Orji et al., 2019).

Construction projects require effective quality management because it involves a complete project management system to achieve and surpass established standards. A quality management system that includes planning and control and assurance and improvement functions leads to satisfied customers and delivers value for money while producing projects that meet their intended purpose (Orji et al., 2019). The integration of all processes and procedures and structures and products for quality achievement results in production quality elimination which leads to process standardization and waste reduction and rework elimination and work practice improvement and profit increase and worker morale boost and market share expansion (Dabok, 2022).

This research aims to evaluate quality management practices related to exterior finishing materials in the context of public building construction projects in Addis Ababa. The study intents in identifying commonly used exterior finishing materials, assessing quality planning, control, and assurance practices, and identifying factors affecting material quality and Based on the findings,

recommendations will be provided to enhance effective quality management practices in the sector. The study focuses on projects in public building projects, Addis Ababa Design and Construction Works Bureau, Addis Ababa Housing Development Corporation, and the Ministry of Health and participants involved in those projects

2.2. Building materials

Building materials play a vital role in construction engineering, driving industry growth. Ideal materials are lightweight, durable, aesthetically pleasing, and possess properties such as heat insulation, sound absorption, waterproofing, shock proofing, fireproofing, non-toxicity, and efficiency. Understanding these properties is essential for selecting appropriate materials. Construction professionals must have comprehensive knowledge of building materials, their applications, properties, and manufacturing techniques to achieve optimal engineering, economic performance, and efficiency (Duggal, 2007).

2.2.1. Properties of building materials

Various factors influence the choice of materials for a given project, with climate being a key consideration. Different regions use diverse materials and construction methods due to climatic variations. Economic factors also play a role, as advancements in construction techniques, the use of mechanical tools, and changes in the building industry's organization can impact material selection. Important properties include strength at varying temperatures and resistance to water, acids, and alkalis (Kultermann and Spence, 2021).

Building material have physical, mechanical properties as well as characteristic behavior under stress and goes through it in details (Zhang, 2011). However, in this research the author will try to highlight these properties because they have great role in selection and application of quality management of exterior finishing materials.

Under physical property of a building material Density (volume under absolute compact conditions refers to the solid volume. Materials except glass, steel asphalt contain pores in their natural state), **Porosity** (Porosity is indicative of other major properties of material, such as bulk density, heat conductivity, durability... ex, dense materials with low porosity are used for structures that need mechanical strength). **Water absorption** ((characterizing of materials when exposed to water, and are influenced by air temperature and relative humidity; pores their types, number and size, and by the nature of substance involved), weather resistance, water permeability, Frost Resistance)),

Thermal property (consists of heat conductivity, Thermal Capacity, Fire Resistance, Refractoriness) chemical resistance and durability (in this process materials are subjected to physical, chemical, biological and other natural factors besides various kinds of stress) (Duggal, 2017, Zhang, 2011).

As for mechanical property of a building material strength, hardness, elasticity, plasticity, brittleness and toughness are included. The common characteristics of building materials under stress indirectly their mechanical characteristics are ductility (ex- copper and wrought iron), brittleness (have a little or no plasticity, ex- Cast iron, stone, brick and concrete), stiffness (permitting small deformation for a given load), flexibility (low modulus of elasticity and bend considerably without breaking down), toughness, malleability (hammered into sheets without rupture, depends on ductility and softness ex- copper) and hardness (Varghese, 2015, Duggal, 2017).

2.2.2. Buildings and wall exterior finishing materials

Building finishes are the non-structural elements of a building, categorized by their location: exterior finishes on the outside and interior finishes on the inside. These finishes are further divided into *floor, wall, and ceiling finishes* (Aderibigbe and Ogunmakinde).

The primary function of walls is to vertically separate spaces, although they may also bear loads depending on the building's structural system. Walls must protect against water, moisture, heat, noise, light, and fire. They can be analyzed in three layers: interior coating, core, and exterior coating. Some walls consist of a single layer, like exposed concrete, while others, such as brick walls, have three layers (Koca, 2016, Rich and Dean, 2012).

Coatings serve different functions based on their position on the wall. Exterior coatings shape the building's architectural character and must resist atmospheric, mechanical, and chemical effects, as well as be easy to clean. A large group of finishing materials consists of facing materials, which are produced in the form of sheets, slabs, and tiles (for example, asbestos cement sheets, Stem alit, ceramic mosaic slabs and tiles, and decorative render). In modern industrial construction, it is practical to produce finished facing materials during prefabrication and deliver them ready for assembly (Ching, 2019). Some of the finishing materials are discussed below

Natural stone is one of the most ancient traditional finishing materials, which is durable and has an attractive appearance. Façade materials categorized as natural stone include granite, limestone,

syenite, gabbro, marble, and quartzite. Natural stone finishing is mainly used in *public buildings and structures, such as theaters, hotels, and subway stations*. Additionally, decorative stone chips are used to finish concrete and reinforced concrete surfaces (Siegesmund and Török, 2010).

Glass finishing materials, known for their variety of colors, excellent qualities, and durability, are primarily used for the exterior of public buildings. These include window glass, stained glass, stemalit, glass blocks, marbled glass, molded glass, and mosaic glass. Since the 1960s, crystalline ceramics like Sitalls and slag Sitalls, which have excellent mechanical properties and corrosion resistance, have been utilized in construction (Achintha, 2016).

Decorative concretes and mortars are highly effective finishing materials. Their decorative effect is achieved through the use of colored cements and fillers made from crushed natural stones. The front surfaces of these materials are textured during molding or after the concrete has hardened, enhancing their aesthetic appeal. These materials are commonly used for large blocks and panels. Decorative concretes and mortars are used extensively in the factory finishing of structural members for fully prefabricated buildings; the use of decorative mortar mixtures for the exterior and interior finishing (plastering) during construction is limited, since the operation is time-consuming and labor-intensive (Illston and Domone, 2001).

2.3. Project quality management

2.3.1. Quality

Definition of quality has yielded inconsistent results. Nevertheless of the time period or context in which quality is examined, the concept has had multiple and often muddled meanings and has been used to describe a extensive variety of phenomena (Reeves and Bednar, 1994).

There is an objective and subjective classification of quality. Objective quality is grounded within the precept that the characteristics of a product or service are tangibly *measurable* and *assessable* in absolute terms such as *size, design conformance, durability and performance*. Here each individual's perceptions can vary regarding the very same product or service.

Quality can be classified as *transcendental definition* (abstract properties, evaluated with innate knowledge gained from experience), *Product-based definition* (desired attributes), *User-based*

definition (client/customer Satisfaction), *Manufacturing-based definition* (product), and *Value-based definition* (economic utility) (Garvin, 1987)

Quality as part of project management: Quality as an integral component of project management. Project Management Body of Knowledge (PMBOK Guide) discusses project management as process-based and is accomplished through the processes of, *initiating, planning, executing, monitoring and controlling, closing and rework* in which the negligence of quality has a great role in each process. Further, it assumes quality management as one of the ten knowledge areas, which are *project integration management, project scope management, project time management, project, cost management, project quality management, project resource management, project communications management, project risk management, project stakeholder management, and project procurement management.*

2.3.2. Quality management system.

Quality is a process by which products and services meet or exceed customer expectations. Quality management, related ISO quality Management Standards are based on the following QMPs: *Customer Focus, Leadership, Engagement of People, Process Approach, Improvement, Evidence-Based decision making, Continuous Improvement and Relationship Management* (Fonseca, 2014).

The process approach systematically defines and manages processes and their interactions to achieve desired results according to the organization's *quality policy and strategic direction*. Using the *Plan-Do-Check-Act (PDCA) cycle*, processes and systems are managed with a focus on *risk-based* thinking to seize opportunities and prevent negative outcomes (Hrbáčková and Tuček, 2019)

2.3.3. Quality policy

To establish a Quality Management System, defining the quality policy and its objectives is crucial. The quality policy reflects top management's vision and commitment to quality, both internally and externally. It should align with the industry's purpose and context, providing a framework for quality objectives and emphasizing compliance and continuous improvement (Natarajan, 2017).

The quality policy represents the organization's core values and mission, reinforcing its commitment to quality. It should be well understood and communicated within the organization, made accessible through various channels such as websites, employee handbooks, and office displays. Additionally, it should be part of the onboarding process for new employees and available to external stakeholders like customers and suppliers. Periodic review of the quality policy by top management, during management reviews, ensures it remains relevant to the organization's context (Fonseca, 2015).

2.3.4. Quality planning

Quality management begins with defining quality, guided by the project manager and team. This involves setting relevant quality standards based on the project's specialization and key stakeholders' perspectives. The identification and fulfillment of these standards takes place during project planning which spans *preparation, design and pre-construction phases*. Quality planning needs to be ongoing and run in parallel with other *planning activities* by using information from predecessor processes including the *project scope statement and project management plan* as well as external factors such as *enterprise environmental factors and organizational process assets* (Thisse, 1998). Quality planning requires organizations to create *quality system policies and objectives and requirements*. It explains techniques of executing these policies and reaching targets set and fulfilling requirements through direct defect prevention measures (Harris et al., 2021).

To ensure quality in planning, follow these guidelines: (i) Include all relevant parties, such as consultants, subcontractors, and suppliers, in the quality planning process; (ii) Establish and define the purpose of the quality system; (iii) Minimize the effort required to amend documents; (iv) Set up a quality system development team to create an effective plan; (v) Maintain a constant focus on customer requirements throughout the quality planning task (Mane and Patil, 2015, Nyomek, 2010).

Steps in quality planning are; (1) *establish the project* (2) *Identify the customers/clients.* (3) *Identify the needs of those customers,* (4) *Analyze and prioritize customer needs,* (5) *Develop a product that can respond to customer needs* (6) *Optimize the product features so as to meet the organization's product range as well as customer needs,* (7) *Identify process and goals,* (8) *Develop a process that is able to produce the product,* (9) *Optimize the process features and goals,*

(10) Prove that the process can produce the product under operating conditions, (11) Identify control needs (Juran, 1992).

2.3.5. Quality Control

Quality control means that work is done in accordance with established plans, specifications, standards, codes, and permit conditions.(Satterfield). It is a process of determining whether a *component, system, process, or procedure meets certain predetermined levels of accuracy or performance*. This is done through various techniques such as *dimensional inspections, material testing, non-destructive testing, pressure and leak tests, performance evaluations, and documentation management*. Organizations usually follow their own testing protocols and standards, and also follow the client's requirements. Therefore, a comprehensive quality control system must be implemented to satisfy all these expectations (Benator and Thumann, 2003).

Quality control systems effectively minimize changes and errors and omissions which in turn lower the number of conflicts and disputes that occur during a project. The quality assurance framework contains defined procedures which include *planning and coordination and development and verification and review and scheduling work*. The quality control process follows a specific order which starts with *selecting the work item for regulation and continues through method of measurement determination and performance standard setting and product and process goal or permit requirement definition and actual performance measurement and standard comparison and deviation resolution* (Rumane, 2017).

The ISO defines quality control as the operational techniques and activities used to fulfill quality requirements. The process includes regular inspections and testing of work products and materials and production facilities. The process includes reviewing and approving materials and shop drawings as well as submitting certificates of guarantee and involving third-party laboratories for testing (DASUKI and MALAYSIA, 2015). Quality control works to enhance overall quality through monitoring project outputs which verify they meet stakeholder expectations. The assessment evaluates project performance regarding scope management alongside budget and schedule management (Watt, 2014).

2.3.6. Quality Assurance

Quality Assurance (QA) represents a collection of activities which verify work quality through the implementation of project requirements by developing relevant policies and procedures and standards and training and systems (Arditi et al., 1998). The system provides defense against quality problems by indicating an early cautions, which help prevent both internal and external problems (Huang and Haseeb, 2013).

It encompasses activities from *design and development to construction, installation, servicing and documentation*. It includes *regulating quality of materials, assemblies, products and components; production related services; and management and inspection processes*. In construction projects, A involves efforts by the *design team, contractor, and quality auditors* to ensure the project meets the owner's goals and functions effectively for end-users (Rumane, 2017).

Main activities included in quality assurance are *confirm that owner's briefs are reflected in the scope of works TOR, reviewing and verifying design compliance with TOR, to execute work that complies with the specified standards and codes, ensuring regulatory requirements are met, perform works according to approved shop drawings, install material and equipment as per the preapproved method or manufacturer's suggestion, effective coordination among all trades, consistent inspection during construction or installation as well as identify and correcting deficiencies, rapid submission and review of transmittals in time is critical* (Manghani, 2011).

2.3.7. Quality Improvement

Focuses on increasing the ability to fulfill the quality requirements. Quality improvement represents a philosophy which emphasizes that all members of an organization must maintain quality standards. The process of change management operates as a strategy to boost organizational competitiveness and efficiency and a value system dedicated to continuous pursuit of excellence in products or services (Cianfrani and West, 2009).

Quality improvement is achieved by continuously enhancing an organization's production and execution processes. This involves anticipating client needs, controlling performance with metrics like *scrap and cycle time, and using monitoring tools such as control charts*. Maintaining dissatisfaction with current performance levels, eliminating waste and rework, investigating non-value-added activities, and addressing nonconformities are key practices. Benchmarking,

innovation, and incorporating lessons learned help improve competitive advantage and prevent regression. Technical tools like *statistical process control (SPC)*, *experimental design*, and *benchmarking* are essential for this improvement (Rumane, 2017).

Quality improvement steps involved include *sending the survey form to the stakeholders who involve in the projects management in the organization, the participant should fill in the form, mentioning the causes of the projects delay and non-conformance and how to eliminate the causes from their point of view, the collected data should be analyzed to figure out the most common reasons of problems, the final step is to figure out how to eliminate or mitigate the most common problems behind problematic indications* (www.pmworldjournal.net).

2.4. Construction materials quality management

Quality in construction has gained importance because of *recurrent failures, high-risk factors* and *the need for reliability and maintainability in complex facilities*. The use of substandard materials and *equipment* results in *major expenses* that include *project delays, rework, reduced productivity, and lose of work to international competitors*.

Quality monitoring in construction operates as a permanent system which extends across the entire organization to monitor materials quality beyond basic inspection procedures. The figure demonstrates that *fabrication and pre-shipment confirmation* operate as part of a larger quality program. The supplier's quality assurance program functions as a vital component to stop nonconforming material shipments while handling shop deficiencies. All construction systems require quality assurance and quality control to start with *owner* and progress through the *engineer who sets standards and specifications before reaching the contractor who relies on quality products from vendors and subcontractors*. (O'Brien, 2013)

Construction quality depends on clear and accurate quality control requirements, developed by translating user needs into specifications and quality plans. These guide contractors' and suppliers' control measures. Research, including Best (2008), shows that while nonconformities often occur during fabrication or testing, the root cause is usually in the planning phase. Effective planning prevents quality issues and delays, while poor planning results in changes and weak supplier performance, ultimately compromising quality.

Supplier quality refers to the conformance of engineered, fabricated, and bulk materials to project specifications, including those from vendors and subcontractors, even if formal quality programs cover only certain commodities. While quality managers advise on the program, responsibility lies with engineering, materials management, and construction. Strong supplier relationships are essential, as success is shared (Feigenbaum, 1983). Achieving quality requires checklists, reports, documentation, reviews, training, and close attention to detail.

2.4.1. Quality in organizations (Quality Planning)

The project manager and project materials manager and design engineer and project quality manager and buyer and shop inspector and site materials manager and vendor's quality management personnel are the key personnel involved in materials quality. Even if some of these roles do not formally exist within an organization, their responsibilities must still be clearly assigned to someone.

All these personnel typically report to the project manager in most organizations. Some organizations have a structure where quality function personnel report directly to top management, independent of the project's reporting hierarchy. This approach emphasizes the independence and importance of the quality function.

Each team member has distinct responsibilities. The buyer is tasked with minimizing costs while ensuring compliance with quality standards. The design engineer is responsible for creating error-free, clear, and consistent drawings and specifications. The project quality manager oversees the quality program, provides expert advice, and reports directly to the project manager or other senior officials when issues arise.

Quality shall be prioritized at every stage of materials management. Many deficiencies can be traced to organizational gaps, such as unclear roles or poor coordination between departments. A common issue is the failure to document the quality history of materials. This has been a major problem, particularly in highly regulated industries like nuclear power plant construction, where a lack of documentation has hindered licensing efforts. While strict procedures may not be needed for every project, failing to maintain proper documentation reflects a significant gap in the quality control process.

2.4.2. In designing and specification (Quality planning)

The design engineer transforms owner equipment and material requirements into a buildable product through drawings and specifications. The engineer can use *brand names or performance criteria or physical properties or manufacturing methods to fulfill this requirement*. The chosen method must be clear and understandable and practical for effective implementation.

Engineers maintain consistency and compliance through the use of industry standards from organizations including ISO, IS, ES, ASTM, ASME, SAE, National Bureau of Standards and others. The standards need verification for their relevance and applicability to supplier and client needs and verification that they are not outdated. Engineers should also consider cost-effective and easier-to-fabricate material options and are expected to consult with purchasing, construction, and quality managers, even though they hold final responsibility for design and specifications.

2.4.3. Factors affecting selection of exterior finishing materials (Quality planning)

Selecting suitable facade materials during the design and specification stages of a building minimizes future maintenance requirements. This ensures that the facade system is easy to maintain with less time, cost, and effort. Unfortunately, architects and designers often overlook this crucial factor, potentially complicating future maintenance tasks (Zwikael, 2009).

Durability plays a significant role in selection of façade materials since the material is durable it requires a minimum cost for maintenance and operation (Kanniyapan et al., 2019).

Cleanability relates with meeting aesthetical and functional performance requirements. It emphasizes the frequency, method and operation of materials for longer life span of a building (De silva et al., 2004).

Material sustainability: should address economic, social and environmental aspect addresses energy conservation in manufacturing and performance, health hazards, global environmental hazards, and recyclable of the material (Chaturvedi et al., 2023)

Compatibility and Suitability: material integrate with its adjacent materials in a system with less modification and less conversions. The designer shall consider material properties and design guideline before selecting materials (Kanniyapan et al., 2015)

Health and Safety: is critical issues in quantifying and grading the parameters in the facade material selection process (Chew, 2022) However, nowadays, residential buildings contain a large amount of heavy metals and chemicals that cause several health related problems (Torgal and Jalali, 2011).

Material Economy: Materials which give the maximum performance with minimum initial cost and life costs of materials. Assuming initial cost to specify the economic acceptability of the project; but, it has been proved that the initial cost may not be the most economical solution as low cost materials often require more frequent maintenance (Crosby, 2005, Elmaghraby, 1989)

Material Availability: Locally available materials are preferable for repair and replacement work, as they are easier to obtain and more cost-effective. Long delivery times for materials procured from distant locations can cause delays. Using local materials can help minimize these delays and reduce costs (Das et al., 2010, Briffett, 1995).

Functional performance refers to how well materials perform to their full capability with minimal defects. Documenting the performance of various materials is essential to ensure the use of high-performing materials and avoid those that do not meet standards. However, choosing the best-performing materials alone is insufficient, as the efficiency of construction also depends on the quality of workmanship (Alkhaiat and Fattuhi, 1990, Cohendet et al., 1988).

Thermal Performance: despite of dimensions and location, and characteristics, thermal design is helps in carefully propose and plan envelope to control heat gain and loss and Enhancing thermal performance (Benator and Thumann, 2003, Park, 2009)

An acoustical façade is designed to absorb or control exterior noise, crucial for managing sound pressure levels outside a building and assessing interior acoustics through façade insulation. Key factors in evaluating interior sound include the sound pressure level and façade insulation (Tuhus-Dubrow et al., 2010, Šaparauskas et al., 2011).

2.4.4. Suppliers' quality evaluation (Quality control)

The Business Roundtable Report A6.5 (1983) revealed that supplier reference files used for prequalification were insufficient. The nuclear industry had developed sophisticated supplier evaluation systems yet most owners lacked experience in this field. Quality assurance requires buyers to keep their supplier database current while monitoring performance indicators. A supplier

rating system with a structured format should receive input from the engineering, quality assurance, materials management and construction team (Stukhart, 1989).

The *supplier quality assessment format* evaluates factors such as *experience, technical personnel, facility/housekeeping, observed quality, past performance, delivery schedule, service/parts support, financial status, vicinity, labor relations, cooperation, attitude and overall reputation*. These criteria are to be rated using the organization's *scale* (see *Appendix 3*).

Each rater needs to evaluate suppliers independently through separate assessment forms to maintain objective evaluation. The *weighted average ratings* need to include *quality performance indicators* such as *nonconformance rates, adequacy of testing, submittals, certifications, and audit results*. The sources of nonconformance must be specifically identified, including *fabrication problems, test failures, and inadequate documentation*.

The evaluation process includes assessment of *schedule compliance*, along with *labor relations, safety standards, technical capability, and service performance*. Suppliers providing *engineered equipment with performance specifications* must present their *quality control procedures* during *prequalification*. The use of computerized systems for *supplier performance data management* such as *spreadsheets or database systems* should be implemented for *selection and tracking*.

The communication of design and *quality requirements* to suppliers depends on properly documented *purchase orders or subcontracts*, which include *warranties, testing methods, and acceptance/rejection procedures*. All *supplier interactions* must be *handled professionally by buyers*, who must be informed about technical discussions between *engineers, inspectors, and suppliers*.

2.4.5. Pre and post award phases

For specific procurements especially those related to *equipment* conducting structured supplier quality assessments is crucial. These assessments often involve conducting *surveys and on-site visits* to supplier facilities. Before initiating the evaluation, the owner and engineer must reach an agreement on the criteria that will be used for rating. Suppliers should be informed that their quality program is a key factor in award selection. Senior corporate and project managers need to support the quality emphasis in supplier selection processes. Specialized items often receive inadequate quality attention from the lowest bidder. A supplier with a reliable quality system will deliver

durable high-performing products which provide superior long-term value throughout their life cycle (Widjaja and Darmawan, 2022).

Quality stands as a fundamental factor for both present and future contract possibilities during the pre-award procurement phase. The buyer needs to present clear requirements regarding testing and certifications and submittals to suppliers so they understand what is needed. Suppliers need to submit their information promptly because it directly affects the design of foundations and structures and test coordination. The buyer and supplier need to work together to establish particular details which go beyond the general requirements specified in the specifications. The "Report on Materials Management" A6.5 (Business Roundtable, 1983) shows that about half of surveyed firms operated without a defined system for organizing shop visits through quality checkpoint standards.

2.4.6. The Inspection plan (Quality control)

The inspection planning process extends across design and pre-award and post-award phases with essential steps.

Need Assessment: shop inspection is needed for complex and costly or safety-critical items and for suppliers who lack proven quality history.

Level of inspection: extends from occasional visits to permanent resident inspector positions based on item importance and supplier reliability.

Selection of inspectors: depends on their skills and accessibility and the need for permanent staff and the availability of inspectors and may require either internal or external third-party services. It requires proper funding and logistical support for qualified personnel.

Coordination with Suppliers: to establish test schedules and inspector access and documentation standards and specification compliance. The coordination meetings at supplier sites help ensure understanding and quality alignment.

2.4.7. Pre-shipment quality control

The quality surveillance or inspection process known as pre-shipment quality control functions as a vital system to verify that materials and equipment fulfill necessary standards before shipping.

Quality surveillance and inspection differ slightly in their approach yet they share the same goal of stopping non-conforming products from reaching the project site.

Quality surveillance functions through owner or contractor oversight which depends on the supplier's established internal quality management systems. The process of inspection requires direct hands-on verification of products during manufacturing and before shipping. The majority of projects implement a dual inspection method to achieve better reliability.

Quality requirements assessment of suppliers starts with pre-fabrication audits for essential or intricate equipment to verify their ability to fulfill quality standards. The inspection process extends from the start of production until the time of shipment. The purchase order includes inspection definitions which are established during planning based on item criticality and supplier history and inspection costs and manufacturing site accessibility.

Quality inspectors who are either in-house or contracted monitor compliance but the supplier maintains complete responsibility for product quality. Modern contractors choose to delegate this responsibility to either specialized inspection firms or accredited laboratories for independent testing. Inspectors verify certifications while checking marking and tagging for traceability and proper handling of rejected materials with clear disposition labels.

2.4.8. Onsite quality assurance

The success of material control at construction sites depends on establishing responsibilities beforehand. The site construction or materials manager should take responsibility for deciding what to do with incoming materials through acceptance or return or replacement. The organization or individual responsible for accepting or rejecting materials should be free from influence by factors such as schedule, cost or vendor pressure to accept nonconforming material. The site receives many incoming materials which requires multiple personnel to perform unloading duties and check paperwork and move materials throughout the site. The job requires immediate storage of materials to avoid delays while carriers need immediate notification about exceptions but standard practice dictates that suppliers must be notified about problems before returning shipments. The identification process for non-conforming materials requires future action and separate storage from other materials. A form exists to document nonconformance along with detailed rejection reasons and improvement details and cause descriptions (see appendix 4).

Quality management of materials prior to receipt includes;

Planning: Purchase orders must be available so that receiving personnel can identify materials. Purchase orders for material requiring non-routine inspection by QA/QC (or other designate d individuals) should be identified and inspection criteria developed prior to the start of materials deliveries.

Receipt: Materials must be checked against packings lips, purchase orders, and drawings to confirm dimensional compliance. Receipt inspection should be carried out promptly by individuals qualified to determine the compliance of the materials with the purchase order and specifications.

Visual checks: Pre- shipment information must be available. Critical materials must be checked for shipment damage, improper markings, shortages, and overages. Random sampling of routine materials (e.g., ceramic) should be done to check markings, packing, and possible damage in shipment.

Document Review: Documentation required by specification or code should be reviewed to ensure the materials meet the documented requirements.

Report: A materials receiving report (MRR) or a separate over, short, and damage report (OS&D) is generally prepared to indicate that any variance in condition of delivery is noted. Photographs of damage are appropriate. A Non-Conformance report (NCR) may be used to report serious quality deficiencies.

Notification of suppliers: Suppliers must be promptly notified of deficiencies in quality or quantity delivered. An effort should be made to resolve the deficiency at the time of receipt.

Repair or replacement: The site materials manager or construction manager must decide whether to recommend that suppliers repair or replace damaged or other quality deficient items. The limits of the manager's discretion should be spelled out in the specifications to avoid compromising the program.

Handling: Manufacturer's instructions must be available for proper handling of equipment. Such instructions must be used to plan handling and lifting equipment. Slings, spreader bars, and dunnage should be utilized to prevent exterior damage.

Storage: Sensitive material/ equipment must be stored with the environmental protection measures required.

Maintenance: The storage process requires regular rotation and inspection of movable parts and sensitive electrical components including motors and switchgear and instruments and control panels according to manufacturer guidelines.

Installed equipment protection: The construction organization needs to establish plans and procedures for protecting installed equipment during ongoing construction activities which must be strictly followed.

2.4.9. Organization and personnel

According to the report of business roundtable 1983, there are a sizable quality assurance/ control staff. Quality management is part of company's organizational structure, here are some of the main organizational positions and their responsibility. See appendix 8 which shows the conventional organizational structure of a construction project.

Project manager: Overall project policy and monitoring relations with consultant and clients team; Conducting daily meeting with all staff/ subcontractors to point out difficulties in work activities, requirement of resources, order/ direct materials and equipment at site with maximum efficiency, find solutions and taking immediate actions; Review correspondence for proper action; Financial follow-up and control the cost of project duration, execution follow-up monthly payment certificates variation order in coordination with QS planner; Directing to senior project engineer, architectural, engineer, planning engineering, quality control engineer, quantity survey and safety officer.

Senior Project engineer: Overall area activity directing monitoring and controlling the productivity of all staff; will determine possible critical areas and activities have to be improved for successful completion of project in time; find solutions and taking immediate action required to push the work in proper coordination with project manager; will be assisted by site engineer, foreman, safety officer and services/ finishing works engineers and also will be directing subcontractors, site engineer, general Foreman and land surveyor and reporting to the project manager.

Architectural coordination engineer: Overall technical coordination, preparation of architectural drawing, composite drawing; will be responsible for coordination between subcontractors for the preparation of shop drawings; find technical solutions with consultants and subcontractors and taking immediate action required and will be reporting directly to the project manager and will be directing the structural engineer and architectural draftsman.

Planning engineer: Preparation, submission, approval of project schedule, updates, revisions, adjustments and monitor the construction progress, identify/ initiate potential variance and delays, follow-up resource assignment. The planning manager will be reporting directly to project manager and will coordinate with senior project engineer to follow up and monitor construction activities and the Q.S for preparation of CLS, as well the subcontractors.

Will be responsible for preparation, submission, approval of cost loaded schedule in coordination with QS; prepare the monthly/ fortnightly work programs including values of work done Vs planned values; prepare monthly progress reports; follow-up the updates of material/ drawing submittal logs and procurement material and preparation and submittal of pre-meeting submittals.

Quantity surveyor: Preparation of cost load values for all activities as per project construction schedule in coordination with planning engineer; check quantities preparation of payment application under the supervision of the project manager and in co- ordination with the planning engineer/ senior project engineer and also responsible for preparation of subcontractors' payment, analyzing variations claims and all other contractual issues in coordination with planning engineer.

Safety officer: Establish and follow up safety procedures all in accordance with the safety manual prepared by her/him. He will be reporting to project engineer, and will be coordinating with the senior project engineer to ensure safety control at site.

Quality control engineer: All aspects of materials/ quality control of site work and site laboratory functioning; review preparation of all submittals of subcontractors supplier's materials, samples to provide continuous flow of procurement as per the requirement of project program; responsible for all technical aspects regarding shop drawings preparation and coordination between different subcontractors; preparation of method statement statements and follow-up procurement of materials and equipment; supervise quality control procedures and will follow all types of submittals such as subcontractors suppliers shop drawings, materials.

Structural engineer: Structural shop drawing preparation; coordination between the different subcontractors; prepare submit and get approval of structural as built drawings; to coordinate with the project manager/ MEP (Mechanical, Electrical and Plumbing) coordinator for the progress priority of shop drawings submittal and to solve site structural problem on daily basis and he will be assisted by the draftsman.

Civil engineer: Work under the directives of project engineer and will be responsible to carry out the works as site directly, and to arrange laborers, materials, equipment machine; to supervise the work of subcontractors and arrange their responsibility; reporting for any material or other requirements well in time and report to the project engineer in case of expected shortage; supervise the Forman and advise him to carry out the work according to drawings and specification; to get the work inspection of A/E and follow-up with checklists in coordination with QC engineer; and to follow-up the works progress under responsibility of project manager and project engineer and ensure that CCS (Critical Chain Scheduling) is followed.

General foreman: Proper execution of daily work/ weekly work program as provided by civil engineer and proper distribution of resources. He will be reporting to civil engineer and will be managing the labor at site.

Audits represent systematic review processes which evaluate quality programs implemented by owners' contractors and suppliers to verify their alignment with established procedures. Audits exist in two forms which include general assessments and targeted evaluations of supplier performance evaluation and project entity communication and pre-shipment quality control. Quality managers along with designated personnel conduct audits to prevent future deficiencies instead of addressing existing problems. Audits need coordination between suppliers and buyers for effectiveness by providing advance notification about review topics.

2.5. Factors affecting finishing material quality

The building phase construction quality depends on site layout and staff experience and skills and design document clarity and equipment and material usage and quality and labor management and owner decision speed (Amer, 2002).

The common causes of defects to the various types of facades are caused due to ***poor design quality*** (inconsistent, have errors, incomplete, unclear and lack constructability. Insufficient understanding of materials' physical properties, performance and their potential for deterioration as well as the use of incompatible material and poor detail design are few of the main factors that negatively influence construction quality and durability (Alarcon and Mardones, 1998).

Substandard material the contractor or client must inspect all materials at delivery time to verify they fulfill the specified requirements. The verification process requires immediate documentation through the Inspection Checklist before materials can be used in construction work.

Poor workmanship (In Malesia *poor project management, complicated role of subcontractor lack of experience and competency of labors, language barrier to communication and lack of communication, poor weather condition, unsuitability of construction equipment, limited time, and limited cost* and in Minna, Nigeria (Diyana and Kasim, 2009, Moavenzadeh and Rossow, 1975),

Poor construction technique (technical solution, process, testing methods, and arrangements of construction procedures for construction adopted by construction contractors, poor quality management. Insufficient knowledge on the construction/fixing of the cladding elements. Even if the suppliers of these fixing elements have already tested the elements to a certain standard, the actual use of such fixings may still need to be verified by additional tests appropriate to the particular situation. Failure to carry out necessary maintenance or incorrect identification of the cause of defect is also another result due to poor construction technique (Ren et al., 2011).

Poor Quality Management: lack of adequate planning, scheduling, materials management, quality control and quality assurance are chronic problems of construction. The effects of these problems are, low productivity, poor safety, inferior working conditions, and inadequate quality (Koskela, 1997). Construction quality can be affected by internal factors like contractual provisions in planning stage, organizational structure, lack of technical expertise, slow pace of mechanization, lack of training and skills, limited financial capability. While external factors include technological developments in allied industries, globalization, quality certification.

2.6. Stakeholder mapping

Stakeholders are individuals or groups who have an interest in or may be affected by a project's outcomes, even if they are not directly involved in executing the work. They can influence the success of an organization, program, or project by shaping policies, regulations, and decision-making processes (Freeman, 2010). In the context of environmental management, sustainability efforts, and construction projects, stakeholders play a crucial role in shaping project directions and ensuring compliance with various standards and expectations.

Developing a stakeholder map is a strategic approach for construction firms and other industries to identify all parties that have a stake in a project, both *within* and *outside* the organization. This process helps recognize stakeholder interests, address their concerns, and balance competing priorities. Stakeholders can generally be classified into two categories:

Internal stakeholders: are those who have a direct impact on the project. Can be divided in to project owner/client (private and public), project professionals/ management team (Architect, PMC (Project Management Contract), Civil engineer, Building service engineer) supplier (Main contractor Sub-contractor, Laborer, Supplier) and customer/client (Owner, User). The role for each party is discussed on Appendix 5.

External stakeholders are which don't have an in direct impact on the project. It includes external public parties (interests' groups, the media and local national authorities) and external private parties (the public, and trade and industries), their role is attached on Appendix 6.

2.7. Key Performance Indicators

Key Performance Indicators (KPIs) serve as essential tools for assessing project performance by comparing actual outcomes with expected benchmarks in terms of efficiency, effectiveness, and quality (Ogunlana, 2010, Sibiya et al., 2015). A project's success is primarily determined by its ability to meet the needs of end users, where efficiency relates to management structures, adherence to timelines, budgets, and specifications, while effectiveness refers to user satisfaction and the functionality of the completed project (Tishler et al., 1996).

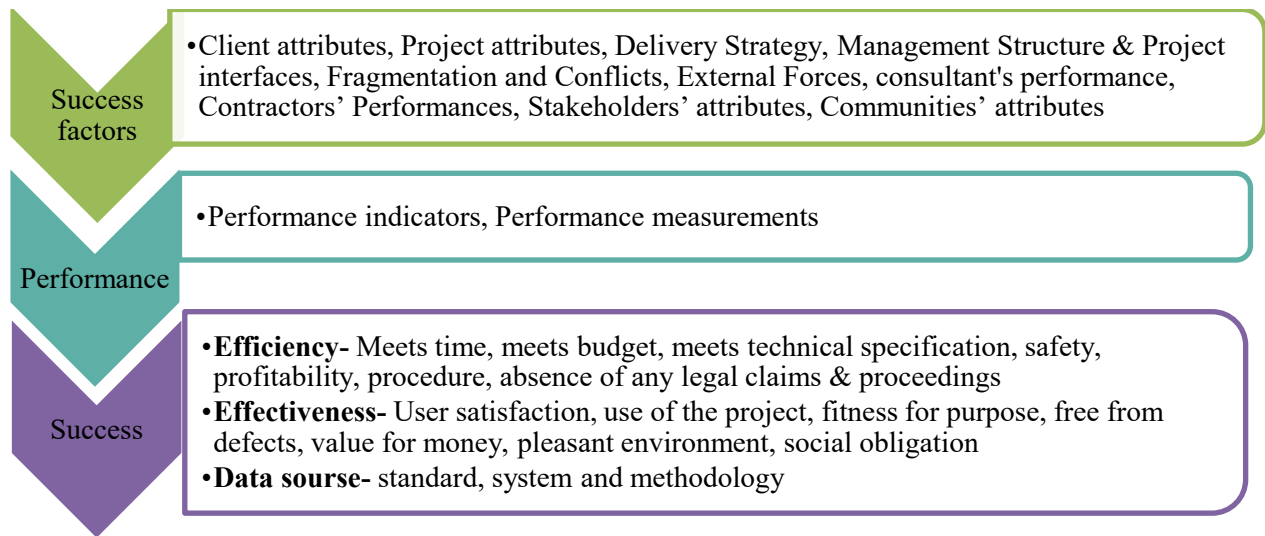


Figure 2.1 Relationship between success factors, performance and success, developed by the author

Source: TAKIM, R. & AKINTOYE, A. Performance indicators for successful construction project performance. 18th Annual ARCOM Conference, 2002.

Atkinson et al. (1997) highlight that project stakeholders including clients, consultants, contractors, and suppliers must achieve satisfactory performance for sustainable collaboration. As shown on *figure 2.2* Clients expect projects to meet cost, quality, and schedule requirements, while consultants require fair employment terms to maintain expertise. Similarly, contractors and suppliers need profitable returns to continue delivering quality resources, and end-users expect a functional and high-quality final product. Measuring and managing these stakeholder performances is crucial for ensuring long-term cooperation in construction projects (Takim and Akintoye, 2002). Refer **appendix 7**

The UK construction sector identifies ten core KPIs for benchmarking project performance as shown on *table 2.1* are categorized under the "5-6-10" model introduced in the "Rethinking Construction" initiative (Egan, 1998). These KPIs include construction *cost, time, predictability (in cost and time), client satisfaction (product and service), defects, productivity, profitability, and safety*. They encourage a results-oriented approach, ensuring performance assessment across *economic, environmental, and workforce-related* aspects (Board, 2016).

Table 2.1 KPIs of construction performance

Source: BOARD, C. I. T. 2016. UK industry performance report based on the UK construction industry KPIs. Watford, UK: Construction Industry Training Board.

Economic KPI	Respect for people	Environmental
✓ Predictability cost (project, design, construction)	✓ Employee Satisfaction	✓ Impact on the Environment
✓ Predictability time (project, design, construction)	✓ Staff Turnover	✓ Energy Use (Designed)-Product
✓ Client satisfaction (product)	✓ Sickness/Absence	✓ Energy Use, Construction Process
✓ Client satisfaction (service)	✓ Safety (accidents, time lost due to accidents and fatality)	✓ Mains Water Use (Designed), Product
✓ Contractor satisfaction	✓ Working Hours	✓ Mains Water Use, Construction Process
✓ Defects (Quality)	✓ Qualifications & Skills	✓ Waste
✓ Productivity	✓ Equality & Diversity	✓ Commercial Vehicle Movements
✓ Profitability	✓ Training	✓ Impact on Biodiversity
✓ Construction cost	✓ Pay	✓ Area of Habitat Created/Retained
✓ Construction time	Investors in People	✓ Whole Life Performance

As discussed in the KPI report for minister for construction of UK, KPI framework consists of seven main groups namely, **time, cost, quality, client’s satisfaction, client changes, business performance, health and safety**. In order to define KPI throughout the lifetime of a project, five stages have been identified (Qi et al., 2024).

Construction Key Performance Indicators in case of **South Africa**, according to (Sibiya et al., 2015) the most significant performance indicators are ranked as *construction time, profitability, Project management, Material (ordering, handling and management), Risk management, Quality assurance, Client satisfaction (product), Safety, Time predictability (project, design, construction), Productivity, Client satisfaction (service), Cost predictability (project, design, construction), Procurement, Construction cost, Defects, and Human resource management*.

On the other side (Song et al., 2004) classify quality performance pointers in three organization levels:

Strategic Level (S): Assesses overall quality policies and department-wide performance.

Project Level (P): Reviews quality assurance actions, objectives, and action strategies although monitoring site quality through data analysis.

Operational Level (O): Works on inspections, resource apportionment, and decision-making for quality control and problem resolution.

2.8. Construction Quality Standards/Documents of finishing materials

2.8.1. Building heights

Understanding the classification of buildings by their height and number of stories is essential for contextualizing construction practices and quality management in different building categories. According to the International Building Code (IBC, 2021) and the National Fire Protection Association (NFPA 101, 2018), buildings are generally categorized as low-rise, mid-rise, high-rise, and skyscrapers based on their height and story count. Low-rise buildings typically consist of 1 to 4 stories with heights up to 15 meters, while mid-rise buildings range from 5 to 12 stories, approximately 15 to 45 meters in height. High-rise buildings are defined as those exceeding 12 stories and 45 meters in height, and skyscrapers generally refer to buildings over 40 stories or taller than 150 meters (IBC, 2021; NFPA 101, 2018).

In the Ethiopian context, the Ethiopian Building Code Standards (EBCS, 2017) adopt a similar classification, defining mid-rise buildings as those between 4 and 12 stories, with high-rise buildings extending beyond 12 stories. These classifications have direct implications for the structural design, material selection, safety requirements, and quality management processes involved in construction projects (EBCS, 2017). The adherence to these standards ensures that buildings meet appropriate performance and safety criteria tailored to their scale and complexity.

2.8.2. Finishing materials quality Standards.

Effective quality management in construction ensures that building projects meet required standards. According to Pyzdek, as cited in Rumane (2017), quality standards serve as documented criteria that define acceptable conditions and provide a benchmark for ensuring compliance. These standards can be mandatory or voluntary, written or unwritten; however, unwritten standards are generally not acceptable.

Quality standards are defined as documents that provide requirements, specifications, guidelines, or characteristics that can be used consistently to ensure that materials, products, processes, and services are fit for their purpose. The author included *ISO (International Organization for Standardization)*, *ASTM (American Society for Testing and Materials)*, *CES (Compulsory Ethiopian Standard)*, *EBCS (Ethiopian Building Code Standard)*, *IS (Indian Standard)* as a

reference to identify and study the factors and requirements of earth based, stone based, steel, glass based, mortar in order to be used as an exterior building material. See *Appendix 7*

2.8.3. Building envelope construction and management in Ethiopia (EBCS)

Exterior walls play a crucial role in creating a weather-resistant building envelope. According to the Ethiopian Building Code Standard (EBCS), exterior walls must be designed to prevent water accumulation by incorporating water-resistant barriers and drainage systems. Moisture protection measures, including flashing, should be implemented to redirect water and prevent structural damage. Additionally, safeguards against condensation must be integrated to maintain durability (EBCS, 2017).

Walls shall be constructed by materials with the appropriate fire resistance rating for the intended occupancy type, in accordance with EBCS 13 standards. Parapet walls must be capped with non-combustible, weatherproof materials of a width at least equal to the wall thickness. External finishes must be securely attached following manufacturer specifications and should not have excessive reflectivity that could pose health risks. Flashing should be installed around windows, doors, chimneys, balconies, and other structural intersections to prevent moisture infiltration. Furthermore, design measures such as sills, trims, and gutters must be used to prevent water damage by directing moisture away from building elements (EBCS, 2017).

2.9. Quality Management and its implementation in Ethiopia

Quality is a key determinant of construction project success, alongside time and cost. Effective quality management across all project phases significantly influences the final outcome, with the execution (construction) stage being particularly crucial (Wawak et al., 2020).

For developing economies like Ethiopia, the construction sector plays a vital role in economic growth and employment. The industry has attracted foreign investors, making quality improvement essential for maintaining competitiveness (Shahraki et al., 2018) also pointed, “The construction industry is considered as the wealth of any country. The Ethiopian Building Proclamation No. 624/2009 outlines regulatory requirements for construction quality, covering aspects such as project approval, material compliance, inspection processes, professional

qualifications, and fire safety measures. The proclamation also includes provisions for land use, energy efficiency, sanitation, and accessibility considerations.

Part three of the proclamation outlines the formation, powers, and duties of the appellate board. Part four covers service fees, including planning consent, review, approval, inspection fees, and refunds. Part five addresses land use studies, building design, construction precautions, site operations, and considerations for master plans, energy efficiency, and accessibility. Parts six and seven focus on water supply, sanitation, fire protection, and firefighting systems. Part eight includes miscellaneous provisions on administrative fines, directives, and the effective date.

The Ethiopian industries operate at a standstill while showing poor competitiveness which restricts their access to contemporary quality control methods needed for operational performance enhancement (Berhe and Gidey, 2016). The study included 44 companies across different sectors showed that quality departments lack proper understanding and application of quality control tools. The survey results showed that 62% of participants had not received any training about these tools which indicates a major deficiency in top management awareness and commitment.

2.10. Gaps in literature

Although quality management is a well-studied area in construction, there is a significant gap in the literature concerning the integrated assessment of quality management practices and specific defects in exterior building works. Most existing studies tend to address either the general quality assurance processes or the identification of defects in isolation. This lack of a combined approach limits the understanding of how quality planning, control, and assurance directly relate to on-site defects and long-term material performance, particularly in the context of exterior wall finishes. Furthermore, the literature reveals a shortage of diverse case studies that examine multiple types of wall finishing materials across different building types and urban contexts. The few existing case-based studies often focus on limited material categories or project types, leaving a knowledge gap in how various external factors such as environment, design complexity, and material integration impact quality outcomes. Another underexplored area is the impact of emerging materials and construction technologies on exterior finishing quality. As construction methods evolve, there is insufficient research evaluating how these innovations are managed in real-world projects, especially in relation to defect prevention and quality control. In addition, current

research is predominantly concentrated on specific regions or regulatory frameworks, with limited comparative studies that consider varied policy environments and geographic conditions. Lastly, there is a lack of longitudinal studies that assess the long-term durability and performance of exterior finishes, which are crucial for identifying recurring quality failures and informing maintenance strategies. This research seeks to address these gaps by conducting a comprehensive assessment of quality management practices related to exterior wall finishing materials in public construction projects in Addis Ababa. By combining defect analysis, quality management evaluation, and case-based field data, the study aims to provide a more integrated understanding of the issues and contribute practical recommendations for improving construction quality and sustainability.

3. METHODOLOGY

3.1. Introduction

The chapter summarizes the research design and methodology used to conduct the study for obtaining data that answers the research questions. The chapter outlines research instruments while explaining research approach and techniques and defines the target population and sampling techniques through sample size and selection and validity and reliability of the research and data collection methods and data analysis methods (Kothari, 2004).

3.2. Research design

During research design the researcher should consider philosophical assumptions, *general procedures*¹ (Creswell and Creswell, 1994). The main function of developing research design is as discussed by Creswell is to explain how an answer is found to our research questions. All research inquiries must be included precisely and designed properly. As a result, the study adopted the following research design² to conduct the whole research to reach conclusion. Different research categories are used to classify the research under study. And are presented as follows.

3.2.1. Research approach: Mixed method, triangulation

Of the three research approaches qualitative³, quantitative⁴ and mixed research. The author chose to use mixed method⁵, to conduct the research observation, in depth case analysis from quantitative data source followed by interview and questionnaire survey is conducted.

The first phase involved an extensive literature search on quality management practices and exterior finishing materials. The focus was on assessing specific management factors that contribute to defects. Secondly, Formal and informal interviews, along with questionnaires, were developed and administered towards internal stakeholders⁶ directly involved in the projects. These stakeholders included clients, contractors, consultants and designers. The third phase consisted of

1 strategies of inquiry, application, reasoning, and detailed procedures of data collection, analysis, and writing, called methods

2 Research design is a conceptual framework within which research would be conducted.

3 Quantitative study is a study where purely quantitative data (measured with number) and analysis techniques.

4 Qualitative research makes use of solely qualitative data and analysis

5 adopts the combination of both quantitative and qualitative approaches

⁶ residents/ building users, manufacturers, Sub city, municipality

case studies on selected constructed projects. Data were gathered through site observations, supported by photography and a structured checklist. Finally, discussions then conclusions and recommendations were drawn based on the research findings.

3.3. Source of Data and Research Instrument

The most commonly used study design to conduct a scientific inquiry are *primary and secondary data collection* (Kabir, 2016). It includes Questionnaire, focus group interview, survey, case studies, archival analysis, process analysis, link analysis and past studies, Books, records, internet articles, database (Zegeye et al., 2009).

Based on the research questions, the author has used both methods in consideration with the advantage it gives in terms of triangulation and validation of the information given. This assisted the author to get access to a wider perspective of participants and activities involved as well as to know most common exterior finishing materials used in buildings in Addis Ababa, quality management practice of exterior finishing materials used, factors affect quality of exterior finishing materials/ finishes and pinpointing the problem to propose an improvement strategy.

3.3.1. Primary data

Primary data also known as field work is involved with the collection of empirical data (Naoum, 2012). There are four types to which data is collected. Three out of the four types are used except participation of the researcher. Initially the researcher selected survey, which obtains information from a sample of projects from the selected case institutes. The researcher used surveys because according to (Creswell and Creswell, 1994). Surveys are used for relatively large number of respondents selected in a technical way.

3.3.1.1. Case study

In this research, public building projects in Addis Ababa were taken as case study. These projects are governed by organizations such as the AADCW, AAHDC, and MoH. As clients and employers, these organizations play a crucial role in large-scale construction and project management. Primary data was collected from various documents, including contract details, design specifications, purchase orders, inspection results, quality certifications from material suppliers, standards, acceptance letters, variation orders, progress payment certificates, approval

letters, and reports related to project completion. These documents contributed to the dataset used for analysis.

- ✓ Projects that are taken by Grade- 1 contractors- In order to focus on large building projects that are larger than five story and to assess the causes and quality management process of wall exterior finishing materials.
- ✓ Projects that have a wall exterior building material/finish defect and are constructed and under operation the past fifteen years (1999 - 2014 EC) since the project focuses on wall exterior finish and the causes of defects with respect to its quality management practice.

The case study was done on two projects, total of six were chosen by purposive sampling selection from each institute that fulfil the above requirements. This data is obtained using measurement, observation, questionnaire and interview described as follows.

3.3.1.2. Measurement

In this mixed-method research, measurement plays a crucial role in gathering data related to various parameters. It directly assesses factors such as nonconformance, rework, and long-term durability. Measurement is essential for evaluating performance in quality planning, control, and assurance of exterior wall finishing materials. Notably, the measurement focuses on the exterior wall including top slab and coping work. and are measured according to *Appendix 8*



Figure 3.1 Measurement sample image of exterior finishing of case projects

3.3.1.3.Observation

Assessment of management practices include planning, control, assessment and improvement of quality of projects. Observation starts with preparing check lists of what should be seen during site observation.

Every aspect of the project will be recorded which includes building orientation, material use in each plane of the wall, sun radiation exposure, material type and quality, assembling/construction technique, adhesives used and standards, condition of building (under construction, operation, maintenance) and life cycle assessment record of the project should be taken under consideration).

3.3.1.4.Questionnaire

The questionnaires were developed based on literature reviews, desk studies, and input from local experts. They were distributed to stakeholders, including clients, contractors, and consultants involved in Addis Ababa's public building construction projects. Specifically, personnel with experience in building project quality management related to exterior finishing materials participated.

Part of the structured questionnaire uses a Likert scale for respondents to express their agreement with each statement (ranging from 1 to 5). This method simplifies responses, allows for nuanced opinions, and facilitates statistical analysis. The questionnaire comprises four sections:

The *questionnaire* consists of four sections; Respondents' professional and educational background assessment; Materials used for wall exterior finish and factors affecting selection; Application of quality management practices and defects observed on projects and General assessment, recommendations, and feedback from professionals respectively.

3.3.1.5.Interview

According to (Kabir, 2016) questionnaires consist of open-ended questions and close ended questions aiming to find out the processes of quality management and gap in interpretation and execution of documents.

The Interview involves conducting two distinct groups: employers/clients (team leaders and top-level management) and experts from contractor/consultant organizations.

For employer/client interviews, Interviews with team leaders and top-level management focus on their background, professional experience, organization overview, existing quality management practices, material selection, impact of exterior materials on buildings, and recommendations for improvement. Key questions cover policies, processes, challenges, and personnel involvement.

Contractor/consultant experts, Interviews with experts delve into their background, involvement in quality management, preferred materials and design processes, supplier relations, quality evaluations, control and assurance procedures, and recommendations for enhancing quality management. Practical aspects, standards, and common flaws are addressed.

semi-structured interviews were conducted with building users, employees not directly related to the projects, and professionals not involved in executing the specific case projects, treating the case project sites as a laboratory for data collection.

3.3.2. Secondary data

Comprehensive literature reviews on the subject areas were the main secondary sources of data. Literature and archival documents were reviewed to evaluate the current practice and detect the gaps of those documents with execution procedure. Also helped to identify the, barriers of application, CSFs (Critical Success Factors), potential factors to be taken under consideration in every stage of quality management. Sources of literature were identified and collected in books, articles, technical journals, standards, construction plans and contracts, conference proceedings, and academic reports, etc.

3.3.2.1. Internal secondary sources.

These are published within companies or organizations (Johnson and Turner, 2003) such as annual reports, nonconformance reports information booklets, brochures, magazines, operation and maintenance history record financial information memoranda, financial reports, plant and equipment registers. This type of internal secondary source of information for the research was collected from the selected consultancy and contractor firms.

3.3.2.2. External Secondary Sources

External secondary source of data gathering was described by (Erzberger et al., 2003) as a primary literature source. Accordingly, it is the most accurate source of information as it contains the

original research. Alternative sources of external secondary sources of information include standards, textbooks, technical journals, newspapers, magazines and internet sources.

3.4. Research Population and Sampling

Sampling is a process involving special methods to select a group of subjects of research study from its parent population enabling the researcher through its study to draw inference about the characteristics (Dhivyadeepa, 2015). In this research *non probabilistic sampling* technique because of the nature the data to be collected (that focuses on assessment of quality management of exterior finishing materials as well as the causes of defects appearing on exteriors). From the types of non-probabilistic sampling method *convenience sampling* is used is widely used.

Subsequently the entire population cannot be studied due to available resource the research has. The population must precisely be defined and samples shall be taken. The results from the sample were used as an input for the framework development. According to (Som, 1995) defining and framing the population are the main parts of starting the sample framework.

3.4.1. Target population

As discussed by (Mugo, 2002) a population is defined as a group sharing specific common characteristics. For this research, the target population consists of public building projects managed by the Addis Ababa Design and Construction Works Bureau, Addis Ababa Housing Development Corporation, and the Ministry of Health. These projects include all public buildings constructed and currently in operation within the last fifteen years, regardless of their location within Addis Ababa. Additionally, the study focuses on exterior finishing materials used in these publicly owned buildings. The population also encompasses key stakeholders directly involved in the construction sector, including professionals, clients/owners, manufacturers, suppliers, standards developers, facility managers, and other internal parties engaged in the planning, execution, and maintenance of these projects.

3.4.2. Sampling technique

The most efficient way of getting across to professionals involved in exterior building materials quality management process in Addis Ababa public building projects, was the concept of *snowball and purposive sampling*.

Snowball sampling is utilized when it is challenging to directly access individuals with the desired characteristics (Som, 1995, Kabir, 2016). The researcher first asked few samples (who had a wide range of experience and knowledge in façade design and project management) These initial participants acted as “seeds” and provided referrals to other relevant professionals, creating a snowball effect. The method ensured representation of diverse perspectives within the target population.

Purposive Sampling: the researcher employed purposive sampling as an efficient data collection method. Rather than surveying the entire population this simple random sampling was used to obtain the necessary data (Mugo, 2002). specific building materials were targeted specifically; the top five defective exterior finishing materials used in the city. The focus extended to public buildings governed by the Addis Ababa design and construction works bureau, Addis Ababa housing development corporation and the ministry of health. These buildings, characterized by heights exceeding 5 stories or mid-high-rise structures, had been operational for at least 15 years. The comprehensive data collection process covered aspects such as design, construction, post-construction evaluations, material quality assessments, laboratory test results of finishing materials, and insights from professionals actively involved in these projects.

Their size is determined by using formulas for sample size determination in qualitative research, adjusting for the non-probability nature the study. This formula is more suited for probability sampling but can provide a rough estimate to guide the initial purposive sample size.

3.5. Data collection, analysis and interpretation technique.

The amount of data needed depends on the type of generalization which the study will make at the end. Since the research made both a statistical and analytical generalization, a method of snowball and purposive sampling was used to determine the study’s data source size (Findlay and Li, 1999).

Several approaches are used for sample size determination. However, in the case of purposive sampling, the concept of data saturation was used to determine the appropriate sample size.

In this study a mixed method (combining qualitative and quantitative research data approach) was used, emphasizing “data triangulation”. This involved document review, measurement, interrogation, and observation to capture different aspects of the phenomenon and enhance

confidence in the results obtained. Researchers must also be mindful of potential biases, such as interviewer bias and response bias, and take steps to mitigate them. (Findlay and Li, 1999) (Desta, 2015) Kabir (2016).

The study covered criteria for selecting exterior façade finishing materials, factors affecting quality management, and quality standards (ISO, IS, EN, ESA, and CES) through document reviews. Semi structured interviews with top-level management and experts complemented these findings, enhancing rigor. Additionally as Yin (2003), open and closed-ended questionnaires were used, and cross-referencing interview results with other sources strengthened the study.

The study employed semi-structured questionnaires in English to assess bias, educational background, current practices, execution barriers, and quality assessment stages related to exterior finishing materials. A closed questionnaire with a Likert scale was used, supplemented by a few open-ended questions. After a pilot test, data collection occurred through hard copy and an e-survey using Google Forms, which were then triangulated with interview and document review results. The study also utilized a closed questionnaire with a five-point Likert scale, refining it based on valuable input from volunteers during the pilot test. The combination of these methods enhanced the study's rigor and validity.

3.5.1. Qualitative data

Document analysis is a structured method used to examine and interpret both printed and digital materials, including computer-based and online sources (Bowen, 2009).

In this study both thematic and content analysis was used for reviewing published articles related to exterior finishing material's selection criteria. Based on the method used by (Levy 2006) a three-stage method will be carried out to extract, analyze and report the literature-based findings.

The first stage involved identifying relevant articles from construction and building materials journals, reviewing previously studied researches, books and framing a questionnaire based on their title, abstract and literature. In the second stage, detailed rules of conduct were designed for data collection, including grouping companies based on the required data and thematic areas. Questionnaire surveys, observation checklists, and envelope measurements were developed and conducted. Finally, the third stage focused on synthesizing and analyzing the collected data using tools such as Google Forms, SPSS, Pandas, and Microsoft. The study aimed to identify commonly

used exterior finishing materials in Addis Ababa, evaluate the current quality management (planning, control and assurance) practices, and provide recommendations for improvement.

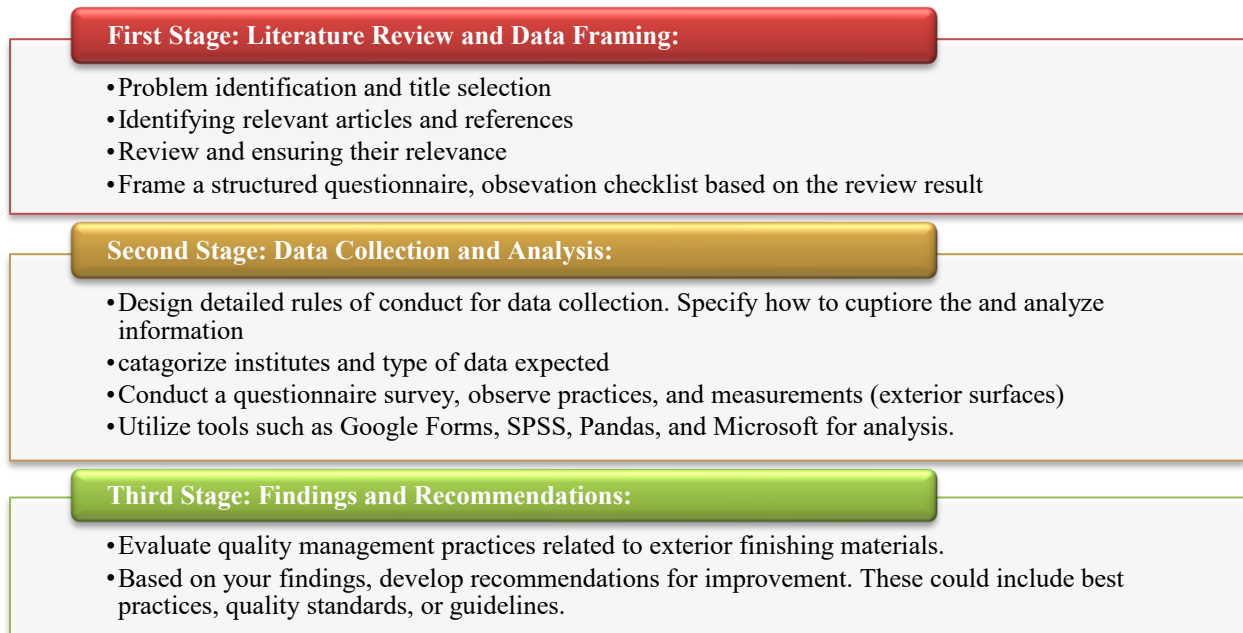


Figure 3.2 Structure of the research developed by the author

3.5.2. Quantitative data

Character of the research implements quantitative data, SPSS was used to analyze data obtained from questionnaires. The qualitative amount of data of exterior finishing materials, usage of materials in meter squares of the exterior, and percentage of defective area from the whole, documents of operation and maintenance through years of operation were analyzed with chart, and will be cross analyzed with used quantity of materials for construction (from specifications) were cross analyzed.

The raw data from primary sources: observation results, site measurements and questionnaire results were transformed and analyzes using various software tools, such as Google Earth, SketchUp, Revit, AutoCAD, SPSS Statistics, and Microsoft excel.

3.6. Research quality assurance technique

The evaluation of research design quality relies on logical tests which examine *trustworthiness* alongside *credibility and confirmability and data dependability or reliability*. (Kothari, 2004).

Ensuring validity and reliability of qualitative research involves several steps. First, interview instruments must pass reliability and validity tests to be considered reliable tools. The interview questions were aligned with research objectives and refined through expert feedback and pilot testing. Additionally, professionals with extensive quality management experience reviewed the questions and research approach. The questions and research methods were piloted with other researchers with experience of more than 10 years, from three different universities who are familiar with exterior finishes and quality management.

The use of scientific analysis software during observation serves as a method to enhance the rigor of qualitative research (Photographs naked eye observation and videos) and modeling process and crosschecking the result of observations, current plan, construction and post-construction. And to increase reliability the researcher used in modeling software (ArchiCAD, Echotect and sketchup) in site analysis of factors affecting quality, SPSS for questionnaire. Interview (NVivo) and observations were also done by a volunteer professional working in the sector for the past 10 years.

3.7. Conceptual framework and it's validation

The research team created a complete quality management framework for exterior finishing materials through the combination of existing guidelines and standards and past models and current practice assessments and quality factors identified through qualitative and quantitative methods. The framework will be validated through focus group discussions with experts from contractors, consultants, manufacturers, the Quality and Standards Authority of Ethiopia, and facility managers, using purposive sampling similar to the original data collection approach.

4. RESULT AND DISCUSSION

4.1. Introduction

In this chapter, the study presents the analysis results and discusses the collected data to address the main and derived objectives of the study. In this study, a questionnaire to key organizations involved in large-scale projects within Addis Ababa that include AADCB, AAHDC, and MoH was distributed. The questionnaire covered various aspects, including professional backgrounds, types of exterior finishes, quality management practices, and improvement guidelines. The study focused on professionals like project managers, architects, civil engineers, mechanical engineers, electrical engineers, material and water supply engineers, sanitary engineers, foremen, and quantity surveyors. The questionnaires were distributed for two projects from each organization, which are completed and/or in the finishing stage in the past fifteen years. Projects constructed in the past fifteen years were selected due to a lack of documented project history for projects completed previously and to lessen the difficulty of getting professionals who participated in the projects. The author distributed two distinct questionnaires: one to government professionals overseeing large-scale public projects (clients) and another to consultants and contractors engaged in the case projects. The questionnaire comprised of their professional background and gathering information about participants' expertise. Identification and selection of wall exterior finishing materials; examining collaboration among quality-related departments during material selection. Quality management practice and defects; investigating specific quality issues and defects related to exterior building work and general assessment and feedback; Capturing professionals' overall perspectives and professional feedback.

The author distributed two distinct questionnaires: one to government professionals overseeing large-scale public projects (clients) and another to consultants and contractors engaged in the case projects. The questionnaire comprised of their *professional background*; Gathering information about participants' expertise. *Identification and selection of wall exterior finishing materials*; examining collaboration among quality-related departments during material selection. *Quality management practice and defects*; investigating specific quality issues and defects related to exterior building work and *general assessment and feedback*; Capturing professionals' overall perspectives and professional feedback.

Table 4.1 Questionnaire response rate

No	Institutes	Case blocks	Distributed questionnaires	Returned		Incomplete questionnaires		Analyzed	
		Num	Num	Num	%	Num	%	Num	%
1	AADCWB	2	30	22	73.3	1	4.54	21	70
2	AAHDC	528	18	13	72.2	2	15.38	11	61.11
3	MoH	2	8	6	75	1	16.67	5	62.5
	Total/ sum	532	56	41		4		37	

As shown on table 4.1, out of the total 56 questionnaires distributed, 41 were returned, yielding an overall response rate of 73.2%. The AADCWB accounted for the largest number of distributed questionnaires (30), with a response rate of 73.3%. Of these, one questionnaire was incomplete, resulting in 21 analyzed responses, representing 70% of the distributed questionnaires. The AAHDC, which oversees 528 case blocks, distributed 18 questionnaires and achieved a response rate of 72.2%. However, two questionnaires were incomplete, leaving 11 (61.11%) for analysis. Similarly, the MoH distributed 8 questionnaires, with a response rate of 75%. One questionnaire was incomplete, resulting in 5 responses (62.5%) included in the analysis. The variation in response rates and analyzed questionnaires across the three organizations highlights the level of engagement and data completeness achieved in this study. Despite some incomplete responses, the analyzed data provides a robust foundation for evaluating diverse institutional contexts.

Normalizing Percentages:

$$\text{Normalized Returned \%} = \left(\frac{\text{Number of Returned Questionnaires}}{\text{Total Number of Distributed Questionnaires}} \right) \times 100$$

$$\text{Normalized Analyzed \%} = \left(\frac{\text{Number of Analyzed Questionnaires}}{\text{Total Number of Distributed Questionnaires}} \right) \times 100$$

$$\text{Normalized Incomplete \%} = \left(\frac{\text{Number of Incomplete Questionnaires}}{\text{Total Number of Distributed Questionnaires}} \right) \times 100$$

The questionnaire results were normalized to account for varying population sizes across the institutes. For each institute, the percentage of returned, incomplete, and analyzed questionnaires was calculated relative to the total number of distributed questionnaires. AADCWB had a 73.33% return rate, with 70% of questionnaires analyzed. AAHDC showed a return rate of 72.22% and an

analyzed percentage of 61.11%. MoH had the highest return rate at 75%, with 62.5% of responses analyzed. These normalized percentages allow for meaningful comparison across the institutes despite differences in sample sizes, providing a clearer picture of response quality and data integrity.

As shown in Table 4.2, the respondents represented diverse professional backgrounds, with civil engineers (57.1%) forming the majority, followed by architects (14.3%), sanitary engineers (9.5%), electrical engineers (4.8%), and project managers (4.8%). Most participants (61.9%) held graduate degrees, while 38.1% had postgraduate qualifications, reflecting a well-educated group. The respondents were drawn from government bureaus (66.7%), contractor firms (19%), and consulting or research institutes (14.3%), with experience levels ranging from 0 to 20 years: 57.1% with 6–10 years, 28.6% with 11–15 years, 9.5% with 0–5 years, and 4.8% with 16–20 years.

Table 4.2 Demographic and Professional Background of Respondents

Category	Subcategory	Percentage (%)
Profession	Civil Engineers	57.1
	Architects	14.3
	Sanitary Engineers	9.5
	Electrical Engineers	4.8
	Project Managers	4.8
Education Qualification	Graduate Degree Holders	61.9
	Postgraduate Holders	38.1
Experience (Years)	0–5	9.5
	6–10	57.1
	11–15	28.6
	16–20	4.8
Organization	Government Bureaus	66.7
	Contractor Firms	19.0
	Consulting Institutes	14.3

4.2. Types of exterior finishing materials

Respondents were asked to rank the widely used of exterior finishing material in case of selected organizations. Since the researcher shall identifying the top 5 materials, as shown on table 4.3 from the most used to the least used exterior finishing materials, *marble and quartz* with a mean value of 5 and standard deviation of 0.00, *granite and aluminum* with mean value of 4.83 and standard deviation of 0.39, *enamel paint* with mean value of 4.09 and standard deviation of 0.900, *mortar render* mean value of 4.04 and standard deviation of 0.82 with, *oil paint* with mean value of 4.00

and standard deviation of 0.603, Brick of mean value 3.96 and standard deviation of 0.56, limestone 3.96 mean value and standard deviation 0.88, emulsion paint 3.69 mean value and 0.87 standard deviation, and lastly steel with mean value of 3.48 and standard deviation of 1.08165.

Table 4.3 Respondent answer on which exterior finishing material is used the most

No	Exterior finishing material	N	Minimum	Maximum	Mean	Std. Deviation	Rank
1.	Ceramic	41	1.00	3.00	1.78	.85048	13
2.	Porcelain	23	1.00	3.00	1.78	.90235	14
3.	Brick	41	3.00	5.00	3.96	.56232	7
4.	Granite	41	4.00	5.00	4.83	.38755	3
5.	Marble	41	5.00	5.00	5.00	.00000	1
6.	Limestone	41	2.00	5.00	3.96	.87792	8
7.	Mortar render	41	3.00	5.00	4.04	.82453	6
8.	Acrylic rendering	41	2.00	4.00	2.96	.56232	13
9.	Quartz	41	5.00	5.00	5.00	.00000	1
10.	Emulsion paint	41	2.00	5.00	3.69	.87567	9
11.	Oil paint	41	3.00	5.00	4.00	.60302	7
12.	Enamel Paint	41	2.00	5.00	4.09	.90015	5
13.	Cast iron	41	2.00	4.00	3.00	.60302	12
14.	Wrought iron	41	2.00	4.00	3.09	.79275	11
15.	Steel	41	2.00	5.00	3.48	1.08165	10
16.	Aluminum	41	4.00	5.00	4.83	.38755	3
	Valid N (list wise)	41					

The questionnaire responses highlighted marble, quartz paint, granite, aluminum cladding, and enamel paint as the top five exterior finishing materials. Quartz paint and enamel paint emerged as particularly used for large-scale applications. Respondents indicated quartz paint's cost efficiency, durability, ease of maintenance, and wide range of aesthetic options as key explanations for its preference in mass housing and public projects. In the same way, enamel paint was praised for its hard, glossy finish and resistance to environmental factors, making it ideal for high-traffic areas like corridors, balconies, and external surfaces in public and mass housing projects.

Interviews with consultants, contractors, clients as well as stakeholders confirmed the deliberate selection of these materials originated on their functional and aesthetic features. Quartz paint was widely regarded as a practical selection for its affordability and resilience, especially in developments requiring longevity and less preservation. Marble, on the other hand, was emphasized for its symbolic and practical value in public constructions, linking traditional and modern design while providing durability, cooling characteristic, and design flexibility. Granite cladding was ideal for its natural beauty, richness in color, and low maintenance, although

aluminum cladding's lightweight nature, weather resistance, and the aesthetics made it a current choice among designers. Enamel paint is highly resistant to moisture, which is critical for balconies and exterior surfaces exposed to rain and humidity. Its ability to resist fading from sun exposure ensures that the variety of its vibrant colors remain intact over time, maintaining the aesthetic appeal of the painted surfaces.

An assessment of design documents, contracts, and specifications further verified these preferences. Quartz is frequently specified in projects for its economic and performance benefits, specifically in high-traffic and large-scale applications. Marble was identified in documents for administrative and nation interrelated projects, emphasizing its role in presenting heritage and architectural implication. Granite and aluminum claddings were emphasized in design specifications for their combination of esthetics and durability. Enamel paint was constantly recommended for areas exposed to environmental wear, such as corridors, balconies, and exteriors, ensuring long-lasting finishes in public and mass-housing projects.

Overall data sources questionnaires, interviews, and document reviews highlight a clear agreement among stakeholders on the practicality, aesthetic value, and performance of these materials. Their choices replicate a balance of cost-efficiency, durability, and cultural or project specific requirements.

4.3. Quality management of exterior finishing materials

Quality management of exterior finishing materials is essential for confirming their durability, performance, and aesthetic appeal in construction projects. Consisting of quality planning, quality assurance, quality control, and quality assessment, all aimed at ensuring materials meet required standards and resistance to environmental conditions. This study assesses the quality management practices applied to projects under AAHDC, MOH, and AADCWB.

As drawn on fig 4.1 the analysis will start with **Quality Planning**, examining how standards, materials, and methods were defined, Awareness, Level of commitment and resources; selection of contractors and consultants; Materials selection, design, specification and contract document and whether they aligned with project requirements. Next, **Quality Control** will be assessed by examining inspection records, testing processes, and how well construction practices adhered to prearranged specifications. The **Quality Assurance** stage focuses on the effectiveness of process

oversight, ensuring QC measures were properly executed and that the overall management system supported constant quality. Finally, **Quality Assessment** evaluates the long-term performance of the exterior finishes, causes of quality issues, evaluating durability, weather resistance, and maintenance requirements of completed projects, and impacts of quality issues. This intensive approach will help identify gaps, strengths, and areas for improvement in the quality management practices applied.

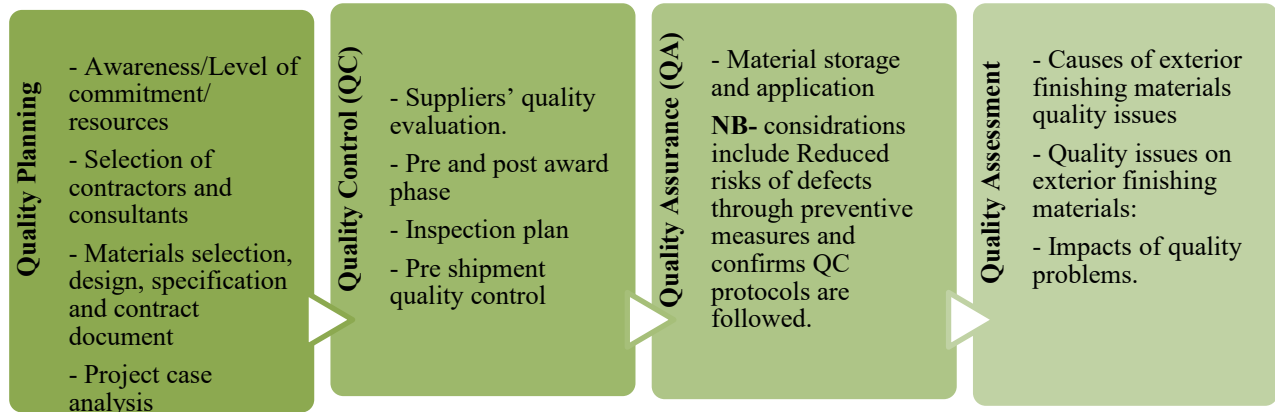


Figure 4.1 Sub titles and key points included under each phase in the quality management.

4.3.1. Quality planning

Quality planning is the first step in managing exterior finishing materials, involving the establishment of performance objectives, material selection, and setting usage standards. Focuses on ensuring requirements of materials durability, aesthetics, and environmental resistance are met. During this phase, design teams determine selection criteria and outline installation and maintenance processes. Effective quality planning lays the foundation for the overall quality management process contribute to the project's long-term success.

4.3.1.1. The case of AADCWB

AADCWB is a government agency responsible for managing and overlooking the planning, design, and construction of infrastructure projects within Addis Ababa owned by the government. The institute handles a wide range of projects, including hospitals, schools, administrative, and public building projects, from small to large scale. Projects under this institute were evaluated based on interviews, questionnaire survey, site observations, and document reviews. This section of analysis assesses main factors affecting quality planning in exterior finish quality and includes

the level of awareness, commitment and organizational resources; selection of consultant and contractors and contract documents compliance and reviews as well as case projects analysis.

A. Awareness/Level of commitment/resources

The results from questionnaires survey from AADCWB's on table 4.4 quality management practices reveal a mix of strengths and areas for improvement. While the organization surpasses in ensuring the free flow of quality management information (81%), it faces substantial challenges in formalizing its quality structure and empowering employees (57.1%). The absence of a strong quality management system and leadership involvement in quality initiatives (47.6%) deteriorates its ability to consistently apply effective quality methods. Different literature highlights a strong leadership and clear policies are important for nurturing a culture of quality, and the lack of formal quality structure may lead to unpredictable results, particularly exterior finishes, which demand precise standards. Additionally, lower score for top management's awareness and control of quality (57.1%) indicates a gap in leadership commitment, which is essential for addressing expectations to quality standards. To improve performance, AADCWB must strengthen its quality management framework, enhance leadership involvement, and empower employees to maintain a better standard.

Table 4.4 Quality management awareness and commitment in AADCWB questionnaire result

Assessment Points	Respondents (%)
Top managers have awareness and sound control of quality	57.1
Managers in your organization play a leadership role in quality management initiatives	47.6
Executes a proper quality management technique	47.6
Existence of formal quality management structure	38.1
Empowered employees on quality management perspectives	57.1
Free flow of information related to quality management	81
Quality policies and mission exists	38

Interviews with key stakeholders highlighted that AADCWB is in the process of restructuring its internal framework to improve operational efficiency. The institute focuses on managing contracts for government owned projects, employing both in-house experts and external consultants. Leadership involvement in quality initiatives was reported to be moderate, with management parties being aware and included in quality control, but there is a potential for improvement in leadership engagement in driving quality initiatives.

The document review confirmed that AACDCWB follows Standard Bidding Documents (SBD) for procurement, which include methodology, schedules, and contracts. Documents showed that training and awareness programs were produced to improve employees' understanding of workflow, methodologies and the quality management system. The formal quality management structure was found to be well-established, although there is room for improvement.

Table 4.5 Compliance of quality management documents in each case institutes (AACDCWB)

Data on specification	AACDCWB	
	Case 1	Case 2
Clear quality management /control manuals	√	√
Easily available quality management manuals	X	X
Construction material specifications are clearly defined in the project documents.	X	X
Complete and clear construction designs	X	X
Clearly stated specification of works	X	X
Clear supervision check lists for construction works	X	X
Production check lists for building exterior work	X	X
Clearly stated site book or resident Engineer observation records	√	√
Contract document which clarifies quality management techniques	X	X
Properly endorsed quality control test results by the Engineer	X	X

As shown on table 4.5 The document review data from AACDCWB reveals significant deficiencies in quality management documentation for exterior finishing materials. While documents such as quality control manuals and site books are in place key elements like clear material specifications, supervision checklists, and production checklists are missing. Literature underlines comprehensive documentation, including clear specifications and endorsed quality control results, is crucial for maintaining consistent quality. The lack of these documents hinders the organization's ability to enforce standards, potentially compromising the quality of exterior finishes.

Triangulation of data coming from the questionnaire survey, interviews, and document review shows that AACDCB possesses well established quality management, vertical and horizontal communication, and formalisms. However, there is a need for more consistent application of quality techniques, better leadership involvement, and stronger employee empowerment in quality-related decisions. These findings suggest that while AACDCWB is undergoing in quality

management, further improvements are required to ensure a more effective and consistent approach across the organization.

B. Selection of contractors and consultants

Based on review of literature evaluation in table 4.6 AADCWB showed high compliance concerning selection of consultants with respect to communication on construction materials and personnel of importance (90.5%). These included the ability to read and interpret designs (85.7%) and manage works under construction (81%). On the other hand, consultants at AADCWB displayed lower competence, with only 61.9% fulfilling the requirement for experienced personnel in this area. The power to reject inferior materials was also moderately rated at 66.7%. While Contractors excelled in their ability to read and interpret designs (95.2%) and maintain key personnel throughout the project lifecycle (81%).

Table 4.6 Selected consultants’ compliance to contract according to survey result (AADCWB)

Assessment Points	Rate (%)
Construction materials	90.5
Key personnel to communicate (verbal or in writing)	90.5
Works under construction	81
Required skill to read, interpret designs and specifications	85.7
Production quality control engineers fulfilling minimum requirements	76.2
Supervisors follow clearly stated acceptance criteria for installed finishing materials	76.2
Experienced and competent key personnel in quality management	61.9
Motivated personnel to ensure conformance/compliance of works	57.1
Power/practice to reject inferior quality materials delivered by the client	66.7
Free flow of quality management information	38.1
Committed supervisors to reject inferior quality materials/works ethically	47.6
Trained key personnel in quality management	52.4
Qualified quality control personnel to perform their assigned duties	52.4
Favorable organizational structure for quality management	47.6

However, AADCWB contractors had low compliance in implementing quality management practices, such as favorable organizational structures (47.6%) and the ability to reject inferior materials (52.4%). This indicates systemic gaps in quality assurance processes within AADCWB.

Table 4.7 Selected contractors’ firm compliance to contract according to survey data (AADCWB)

Assessment Points	(%)
The required skill to read	90.5

The contract agreement requires contractors to employ key personnel for compliance	76.2
Presence of key personnel from commencement to provisional acceptance	76.2
Trained employees in quality management	66.7
Experienced key personnel in quality management	66.7
Employees can communicate verbally or in writing	66.7
Has an appropriate structure which supports quality management activities	47.6
Supervisor has the commitment to remove inferior quality materials/works	38.1
Authority to reject inferior quality materials	52.4
Motivated personnel to ensure conformance/compliance of works	52.4
Qualified quality control personnel, to perform their assigned duties	61.9

During its consulting firm selection process, AADCWB prioritizes construction material knowledge as well as the communication skills of the firm’s personnel. A cardinal overlooks current construction activities as well as firms with basic design comprehension and schematic reading skills. However, less importance is given to the presence of experienced personnel in quality management and the authority to reject substandard materials. Similarly, for contractors, the bureau prioritizes technical proficiency in reading and interpreting designs and ensures the retention of key personnel throughout the project lifecycle. Less emphasis is given to the existence of experienced quality management personnel and the right of rejection of noncompliant materials. As for the bureau, less emphasis is placed on the existence of clean work procedures, quality management methodologies, communication competencies, and the authority to reject inappropriate materials. Such a focus on technical capability enables effective project completion while raising questions about whether the bureau can sustain enduring quality management.

On the other hand, interviews and document reviews provided additional insights into the selection and quality management process at AADCWB. During the evaluation stage, legal, professional, experience, technical, and financial qualifications are considered. However, projects open for public occupancy are often awarded to the lowest price bidder, which can compromise quality. The involvement of clients, consultants, subcontractors, and suppliers in the quality planning stage is minimal because bids are awarded based on client-developed requirements. Procurement is segmented, with consultancy, construction, and material supply handled separately, which can lead to gaps in quality integration.

Contract documents, including special conditions and specifications, outline the project scope, drawings, work methodology, schedule, cost breakdown (BOQ), and quality certification requirements. Despite this, issues such as incomplete designs, insufficient clarity, and discrepancies between designs and specifications hinder effective quality control and project execution.

The questionnaire findings align with the challenges identified through interviews and document review. While AADCWB emphasizes technical capabilities and personnel retention in both consulting firms and contractors, the reliance on the lowest price bidder undermines efforts to maintain quality. The minimal involvement of key stakeholders during the quality planning stage further exacerbates these challenges, as it leads to fragmented procurement processes and inconsistencies in material and design standards. Additionally, while contract documents provide a framework for guiding project execution, the lack of detailed and accurate designs and specifications introduces discrepancies and delays. This highlights a critical gap between AADCWB's technical priorities in the selection process and the practical issues arising during project implementation.

C. Materials selection, design, specification and contract document

The questionnaire results show key priorities in the material selection process for AADCWB. Respondents highlighted *durability*, *material availability*, and *material economy (initial and lifetime cost)*, with durability being very critical factors in choosing exterior finishing materials. Other important factors include *functional performance*, *cleanability*, and *acoustic performance*. Lesser prominence is placed on *material sustainability*, *compatibility with other materials*, and *health and safety*. These priorities are focused on materials that ensure longevity and cost-effectiveness but rises concerns about the institution's commitment to *sustainability* and *safety*. Aesthetics and physical characteristics were also taken as main factors in the material selection, indicating middle ground functionality and design.

Interviews revealed material selection is mainly driven by *cost-effectiveness* and *availability*. Designers emphasized the ease of obtaining materials and their initial cost as essential for meeting project budgets. However, it was recognized that *sustainability* and *functional performance* should be given more consideration. This output is similar with questionnaire results, where respondents indicate these factors were less prioritized. Furthermore, the lack of emphasis on *compatibility*

between materials during selection indicating a gap in the integration of materials performance in construction projects

D. Case Project analysis

- **Case 1- Bole Sub-City Administration Building**

As discussed in seen on figure 4.2 Bole Sub-City Administration Building project utilized *marble cladding* and *quartz paint* for the exterior finishing. Although the materials tested in laboratory indicating to meet standards, there was an obvious problem with *compatibility* and *suitability* when combined/attached with other exterior wall elements. This discrepancy wasn't obvious in the initial design but was seen during and post construction, indicating the importance of considering material integration early in the design phase. In addition, the documentations lacked detailed descriptions, such as cladding size and fixing techniques, which led to challenges in coordinating the work. organized site books and insufficient documentation of lab test results further impacted the quality management process.



Figure 4.2 Image of Bole sub city building project

- **Case 2- Children and Youth Theatre (Basement + G + 11):**

Children and Youth Theatre project exterior finish is a combination of *granite and aluminum cladding* and *curtain walls* additionally *exterior paint* was used. However, the project documentation did not include these materials in the contract specifications, although they appeared in the elevation drawings. The omission of detailed specifications led to issues during assembly where dimensions and fixing methods had to be altered onsite due to compatibility

problems. This showed a lack of integration between design and specification which is a critical in ensuring quality and consistency in construction. The failing to address materials requirements during the planning led to increased onsite modifications, cost overrun and delays.

The findings from AADCWB’s material selection process underscore the tension between practical considerations, such as durability, cost-cost efficiency, and material availability, neglecting sustainability, safety, and material compatibility. Literatures also highlight the importance of functionality and cost but also inclusive approach oversees sustainability, health, and safety into the decision-making process. The case of the Bole Sub City Administration Building indicates a common gap in the application of these priorities, where lack of unattended material integration and insufficient documentation leading to construction challenges. This highlights the importance of clear, detailed design documentation and the early evaluation of material compatibility to make sure selected materials perform effectively in construction projects. The findings recommend AADCWB should strengthen its quality management practices by prioritizing detailed documentation and integrating sustainability and material compatibility into quality planning to improve long-term performance and reduce project risks.




Figure 4.3 Image of children and youth theatre (basement +G+11) building project

Table 4.8 Description listed on *specifications* of exterior finishing materials (Marked “√” indicates described, “O” not described and Proficiency levels E- Entry, I- Intermediate, P- Proficient.)

Data on design and specification	AADCWB	
	Case 1	Case 2
Cladding		
Size	√	√
Color and/or pattern	O	√
Attachment detail	O	√
Laboratory (characteristic test)	O	O
Proficiency level of the cladding installer	I	P
Paint		
Color/ label		
Standard lab tests		
Mix ratio		
Proficiency level of the painter		
Plastering		
Layers	O	O
Mix ratio	√	√
Layers of plastering (thickness)	O	O
Heavy equipment used	√	√
Manual tools	√	√
Proficiency level of the plasterer	I	I
Glazing		
Size	√	√
Material type	√	√
Thickness	√	√
Frame	√	√
Sealant type and size	√	√
Proficiency level of the glazer	I	I

Table 4.8 indicates the design and specification details as well as the proficiency of labor used for exterior finishing materials for the two case projects. Both projects provide size specifications for cladding, but only Case 2 includes details on color, pattern, and attachment. Both lack lab tests results for cladding, with proficiency level of worker as intermediate for Case 1 and proficient for Case 2. Paint specifications are incomplete, with missing details on color/label and lab tests, and undefined painter proficiency. For *plastering* specifications includes mix ratios, but coat counts and thickness are not mentioned. Both cases list tools are mentioned, and plasterers' proficiency is intermediate. Glazing specifications are more complete, including size, material type, thickness, frame, and sealant, combined with intermediate proficiency for the glazer during construction. Overall, the data shows a mix of clear specifications and ones that need more details, particularly for finishing materials and worker proficiency.

The analysis from the questionnaire, interview results, and observations showed significant challenges in AADCWB. The selection process prioritizes durability and cost-effectiveness, factors like sustainability, functionality, and material compatibility are neglected. Compilation and integration between design drawings and specifications further contribute to onsite adjustments and quality assurance problems. The findings suggested improved documentation practices, thorough material compatibility assessments and long-term performance factors in material selection to enhance the overall efficiency and quality of future projects.




Awareness/Compliance

Challenges

- Inconsistent application of quality management techniques.
- Moderate leadership involvement in quality initiatives.
- Limited employee empowerment in quality decisions.

Key Insights

- Improve leadership engagement in quality initiatives.
- Enhance consistency in applying quality techniques.
- Strengthen employee involvement in quality decisions



Selection of Contractors and Consultants

Challenges

- Reliance on the lowest price bidder, compromising quality.
- Minimal involvement of stakeholders in quality planning.
- Limited focus on quality management experience in contractor and consultant selection.

Key Insights

- Focus on quality management experience when selecting contractors and consultants.
- Involve stakeholders more in the quality planning process.
- Prioritize quality-based procurement over cost..



Materials Selection, Design, Specification, and Contract Documents

Challenges

- Incomplete designs and insufficient material specification documentation.
- Discrepancies between design documents and contract specifications.
- Minimal attention to sustainability, material compatibility, and health/safety during selection.

Key Insights

- Ensure comprehensive and clear design and specification documentation.
- Improve coordination across procurement stages.
- Consider sustainability, material compatibility, and health/safety in material selection.

Figure 4.4 Challenges and key insights in quality planning, the case of AADCWB

4.3.1.2. The case of the AAHDC project

Addis Ababa Housing Development Corporation has categorized its projects into two types: 40/60 and 20/80 housing projects. Initially, there were 18 projects under the 20/80 category, which were merged into 9, while the 4 projects under the 40/60 category remained unchanged. This brought the total number of projects to 13. In 2014 EC, 5 new projects were established, which later merged into 3 projects by April of the same year. As a result, there are currently 10 projects, of which 3 are still in the foundation stage, while the remaining 7 are 95% complete and ready for handover. In total, 500 professionals are involved in these projects.

Table 4.9 List of Projects Under Addis Ababa Housing Development Corporation

Project Name	Type of Housing (Condominium)	Number of Sites	No of Blocks	Site Locations
Project 1	40/60	5	89	Asko, Megenagna (tourist district), Megenagna (Ehil Nigd), Gerji Imperial, Bole Bulbula site (Project office)
Project 2	40/60	7	207	Meri, Bole Hayat 1 (Site 1, Site 2, Site 3, Site 4), Bole Hayat 2, Summit
Project 3	40/60	1	58	Bole Beshale
Project 4	20/80	1	148	Hayat roundabout
Project 5	20/80	1	439	Bole arabas
Project 6	20/80	1	210	Haile garment
Project 7	20/80	1	1071	Koye feche (former project 8, 9, 10, and 11)

A. Awareness/Level of commitment/resources

Based on the questionnaire survey result on table 4.11 a weak commitment to quality management, with low percentages in key areas such as quality mission policies (38%) and the presence of a formal quality management structure (38.1%). Reviews from literature indicates the importance of strong leadership and structured quality management processes in construction projects. The low ratings in empowering employees (47.6%) and managerial leadership (42%) indicates that it is important to have effective communication and involvement in quality practices. These findings show importance of clear frameworks and better engagement at all organizational levels to support effective decision-making, particularly for exterior finishing materials quality management. And the lack of it raises concerns about the ability to maintain high standards in material selection and implementation.

Table 4.10 Quality management awareness and commitment in AAHDC questionnaire result

Assessment Points	Rate (%)
Top managers have awareness and sound control of quality	42
Managers in your organization play a leadership role in quality management initiatives	47.6
Executes a proper quality management technique	47.6
Existence of formal quality management structure	38.1
Empowered employees on quality management perspectives	47.6
Free flow of information related to quality management	57.1
Quality policies and mission exists	38

The interview result revealed that AAHDC follows a standardized approach to housing design and specifications, with the federal government handling need assessment, selection of contractor and consultants. The design and specifications reviewed by in-house professionals to maximize housing output within budget. Construction material supply for 20/80 condominiums is managed by the corporation, while contractors handle supply for 40/60 projects. Additionally, the corporation involves small enterprises in subcontracted works to create job opportunities. Despite a laid-out organizational structure, there are noticeable communication gaps between the execution teams and the management, which hinders the achievement of quality standards, particularly considering the mismatch between the number of sites and the limited professionals available.

Document review conformed AAHDC's organizational structure, with two branches: the Contract Administration and Construction Monitoring and Control Directorate, and the Management Directorate. Which are dedicated to contract administration, infrastructure, finance, and human resources. Although responsibilities in the divisions are clear, a gap has been identified in the number of professionals assigned, particularly in the infrastructure department, which affects the corporation's ability to meet the required quality standards.

Table 4.11 Compliance of quality management documents in each case projects (AAHDC)

Data on specification	AAHDC	
	Case 3	Case 4
Clear quality management /control manuals	X	X
Easily available quality management manuals	X	X
Construction material specifications are clearly defined in the project documents.	X	X
Complete and clear construction designs	X	X
Clearly stated specification of works	X	X
Clear supervision check lists for construction works	X	X

Data on specification	AAHDC	
	Case 3	Case 4
Production check lists for building exterior work	X	X
Clearly stated site book or resident Engineer observation records	X	X
Contract document which clarifies quality management techniques	X	X
Properly endorsed quality control test results by the Engineer	X	X

As shown in table 4.11 The lack of key quality management documentation at AAHDC, such as quality control manuals, clear material specifications, and construction designs, highlights significant gaps in their quality management system. Published documents boldly indicated the importance of detailed and accessible documentation such as clear specifications, site books, and endorsed lab test results for maintaining quality standards of exterior finishing materials. Lacking these documentations may challenge consistent material quality and effective monitoring process.

Questionnaire survey, interviews, and document review illustrate AAHDC’s challenges in quality management. The results highlight gaps in leadership, structure, and employee empowerment, which are resonated in the interview findings, where communication gaps and resource constraints are noted. The document review also confirms these problems, by detailing the organizational structure, job description and execution is not enough, quality planning is also affected by resource limitations and inadequate communication between management and execution teams.

B. Selection of contractors and consultants

AAHDC gives priority to communication skills and design interpretation ability in consultants. While consultants showed positive ratings in communication (85.7%) and design interpretation (81%), their expertise in quality management was lacking, with only 52.4% meeting the experience requirements. The authority to reject substandard materials was similarly low, at 52.4% as shown on table 4.12.

Table 4.12 Selected consultants’ compliance to contract according to survey result (AAHDC)

Assessment Points	Rate (%)
Construction materials	90.5
Key personnel to communicate (verbal or in writing)	90.5
Works under construction	81
Required skill to read, interpret designs and specifications	85.7
Production quality control engineers fulfilling minimum requirements	76.2

Assessment Points	Rate (%)
Supervisors follow clearly stated acceptance criteria for installed finishing materials	76.2
Experienced and competent key personnel in quality management	61.9
Motivated personnel to ensure conformance/compliance of works	57.1
Power/practice to reject inferior quality materials delivered by the client	66.7
Free flow of quality management information	38.1
Committed supervisors to reject inferior quality materials/works ethically	47.6
Trained key personnel in quality management	52.4
Qualified quality control personnel to perform their assigned duties	52.4
Favorable organizational structure for quality management	47.6

Contractors have achieved the highest in design interpretation (90.5%) and maintaining key personnel (76.2%), but exhibited significant downside in quality management structures (42.9%) and material rejection authority (38.1%) as shown on table 4.13. This lack of emphasis on structured quality management and material enforcement mechanisms inflicts risks to the consistency of quality in the large-scale housing projects.

Table 4.13 Selected contractors' compliance to contract according to survey result (AAHDC)

Assessment Points	Rate (%)
The required skill to read	90.5
The contract agreement requires contractors to employ key personnel for compliance	76.2
Presence of key personnel from commencement to provisional acceptance	76.2
Trained employees in quality management	66.7
Experienced key personnel in quality management	66.7
Employees can communicate verbally or in writing	66.7
Has an appropriate structure which supports quality management activities	42.9
Supervisor has the commitment to remove inferior quality materials/works	38.1
Authority to reject inferior quality materials	42.9
Motivated personnel to ensure conformance/compliance of works	52.4
Qualified quality control personnel, to perform their assigned duties	61.9

Interview findings showed that when it comes to hiring consultants and contractors, for projects at AAHDC and under direction is largely influenced by criteria set by the organization and authorities involved in the process of selecting bids based solely on these criteria alone. The lack of involvement from stakeholders in the initial project phases was emphasized as a key issue hindering effective collaborative quality planning efforts. Interviewees pointed out that inadequate

participation of stakeholders during the quality planning phase results in incorporation of quality aspects, in project design and specifications.

Upon reviewing the documents again, it became evident that the contract papers. Including conditions specifications and schedules. Lay down the necessary scope, work procedures, cost breakdown (BOQ) and quality benchmarks. Nevertheless, these papers are often found to be incomplete ambiguous and lacking in information. This leads to mistakes and differences, between the design and stipulated requirements. The lack of clarity, in the design papers makes it challenging for both contractors and consultants to fully grasp the quality standards expected potentially resulting in quality issues during implementation.

The results, from the survey questionnaire and interviews align with the document review in highlighting a concern; AAHDCs emphasis on cost, in selecting and acquiring consultants and contractors could potentially impact the quality of work delivered. The results indicate that the institute should enhance their purchasing procedures and contract records to ensure incorporation of quality planning, from the beginning and minimize the chances of mistakes and inconsistencies, during project implementation.

C. Materials selection, design, specification and contract document

The findings from the questionnaire survey on table 4.3 align with key principles in quality management for exterior finishing materials, where durability, material availability, and cost-effectiveness are prioritized, as supported by literature on material selection in construction. Durability, as the most important factor, reflects industry standards emphasizing longevity and minimal lifecycle costs. However, the lesser emphasis on health and safety raises concerns, as literature advocates for integrating safety and sustainability in material choices to ensure long-term performance and occupant well-being. Additionally, the high importance placed on architectural and physical properties highlights the role of aesthetics and functionality, which are crucial in ensuring that materials meet both structural and design standards. The findings suggest a need for a more balanced approach, incorporating comprehensive quality management practices that prioritize not only cost and durability but also sustainability, safety, and performance integration.

Interviews highlighted that the selection of exterior finishing materials primarily focuses on factors like durability and material economy, with less emphasis placed on material sustainability, acoustics, and cleanability. Contractors were found to be involved in the procurement and

management of construction materials according to project specifications, but there were instances of misalignment between the design specifications and the final materials used. This misalignment, particularly in the Arabsa 20/80 project, was linked to unclear color specifications, leading to discrepancies in material availability.

Document reviews and site observation substantiated that the materials selection process is guided by specifications outlined in project contracts. Quality conformance manuals, checklists, certifications and test results, standards and manuals are available on site for professionals onsite for reference. *lack of integrations between construction design drawing and specification, descriptive drawing* (detail drawing of own pipe fittings on exteriors). *Undocumented site book/ observation record* and *test result* are observed since the corporation was undergoing through reorganizing organizational structure.

The quality of all materials, including window and door frames, was selected and purchased under the main office for both 20/80 and 40/60 condominium projects. The contractor was involved in construction material, resource, and time management according to specification and schedule technical proposal submitted by his/her company. If there is a design change during construction comments will be forwarded to the central (main office) and will be commented and given approval to the design and specification

D. Case project Analysis:

- **Case 3- Arabsa 20/80 project**

In the Arabsa 20/80 project, quartz paint was used for exterior walls, and plastic paint was applied to balconies as shown on figure 4.5, PVC profile frame windows with 4mm thick glass were installed. **Observations** indicated misalignment in design and procurement due to unclear material standards, particularly regarding color specifications. Procurement challenges led to variations in material availability. The wall finishing work involved three coats of external wall plastering with a cement mortar mix, followed by primer and final coats of approved quartz paint. Balcony walls received a gypsum first coat and two coats of plastic paint. Glazing work included PVC frames with clear and figured glass panes. Site observations revealed discrepancies in color uniformity and finishing quality. Missing site documentation and test results further complicated quality control efforts rather than enhance clarity in material specifications, especially for aesthetic details, and strengthen integration between design drawings and specifications.



Figure 4.5 20/80 condominium housing project, Arabsa site, Addis Ababa

- **Case project 4: Bole Bulbula 40/60 Project**

In the Bole Bulbula 40/60 project seen on figure 4.6, aluminum window frames were introduced, reflecting the larger unit sizes and higher payment installments by residents. Differences in material quantities were observed compared to the Arabsa 20/80 project, aligning with the higher payment structure and expectations for quality. The project specifications emphasized durability and economy, with better integration of design changes and procurement approvals. Aluminum frames replaced PVC for windows, and higher-quality finishes were applied to walls and balconies. Site observations indicated enhanced finishing standards and alignment between design and procurement. Documentation practices, including the maintenance of site records and test results, were more consistent in this project. These gaps emphasize the need for clearer communication and more detailed material specifications and conducting regular reviews to ensure alignment between design, procurement, and construction.



Figure 4.6 Bole Bulbula 40/60 condominium housing project

Table 4.14 Description listed on specifications of exterior finishing materials
(Marked “√” indicates described, “O” not described and Proficiency levels E- Entry, I- Intermediate, P- Proficient.)

Data on design and specification	AAHDC	
	Case 3	Case 4
Cladding		
Size		
Color and/or pattern		
Attachment detail		
Laboratory (characteristic test)		
Proficiency level of the cladding installer		
Paint		
Color/ label	√	√
Standard lab tests	O	O
Mix ratio	√	√
Proficiency level of the painter	E	I
Plastering		
Layers	O	O
Mix ratio	O	O
Layers of plastering (thickness)	√	√
Heavy equipment used	O	O
Manual tools	√	√
Proficiency level of the plasterer	E	E
Glazing		
Size	√	√
Material type	√	√
Thickness	√	√
Frame	√	√
Sealant type and size	√	√
Proficiency level of the glazer	E	E

As shown on table 4.15 findings from the specifications of exterior finishing materials underscore critical gaps in the detail and comprehensiveness of material documentation, which directly impacts quality in projects. The absence of detailed descriptions for cladding size, attachment details, and laboratory tests in both Case 3 and Case 4 highlights a significant lack of clarity in the material selection and installation process, which could compromise the quality of the finished product. Literature on quality management emphasizes the importance of providing clear, standardized specifications for all materials to ensure consistency and quality control throughout construction. Furthermore, the proficiency levels of installers and painters, recorded as Entry (E) or Intermediate (I) levels, indicate potential risks in achieving optimal quality outcomes. According to industry standards, skilled professionals with higher proficiency levels are essential

to ensure proper material application, minimizing defects and ensuring long-term durability. The findings suggest that more detailed specifications and higher training standards for personnel are necessary to enhance quality assurance and overall project success in exterior finishing materials.

Triangulation of data from the questionnaire survey, interviews, document reviews, and site observations highlights key insights into the materials selection and procurement processes for the Arabsa 20/80 and Bole Bulbula 40/60 condominium projects. Durability, material availability, and material economy were consistently identified as the most critical factors in material selection, with architectural appearance and physical properties also playing significant roles. However, the Arabsa 20/80 project faced significant procurement challenges due to unclear material specifications, gaps in documentation, and misalignments between design and procurement, particularly regarding color specifications and plastering work. In contrast, the Bole Bulbula 40/60 project benefited from better integration of design changes, improved documentation practices, and more consistent quality control, resulting in fewer discrepancies. The findings suggest that clear and detailed material specifications, including plastering work procedures, are crucial to ensuring consistency between design and procurement. Regular stakeholder engagement, enhanced documentation, and reviews of procurement approvals are essential to addressing these issues and ensuring the successful execution of future projects, maintaining a focus on durability, economy, and quality in exterior finishing.

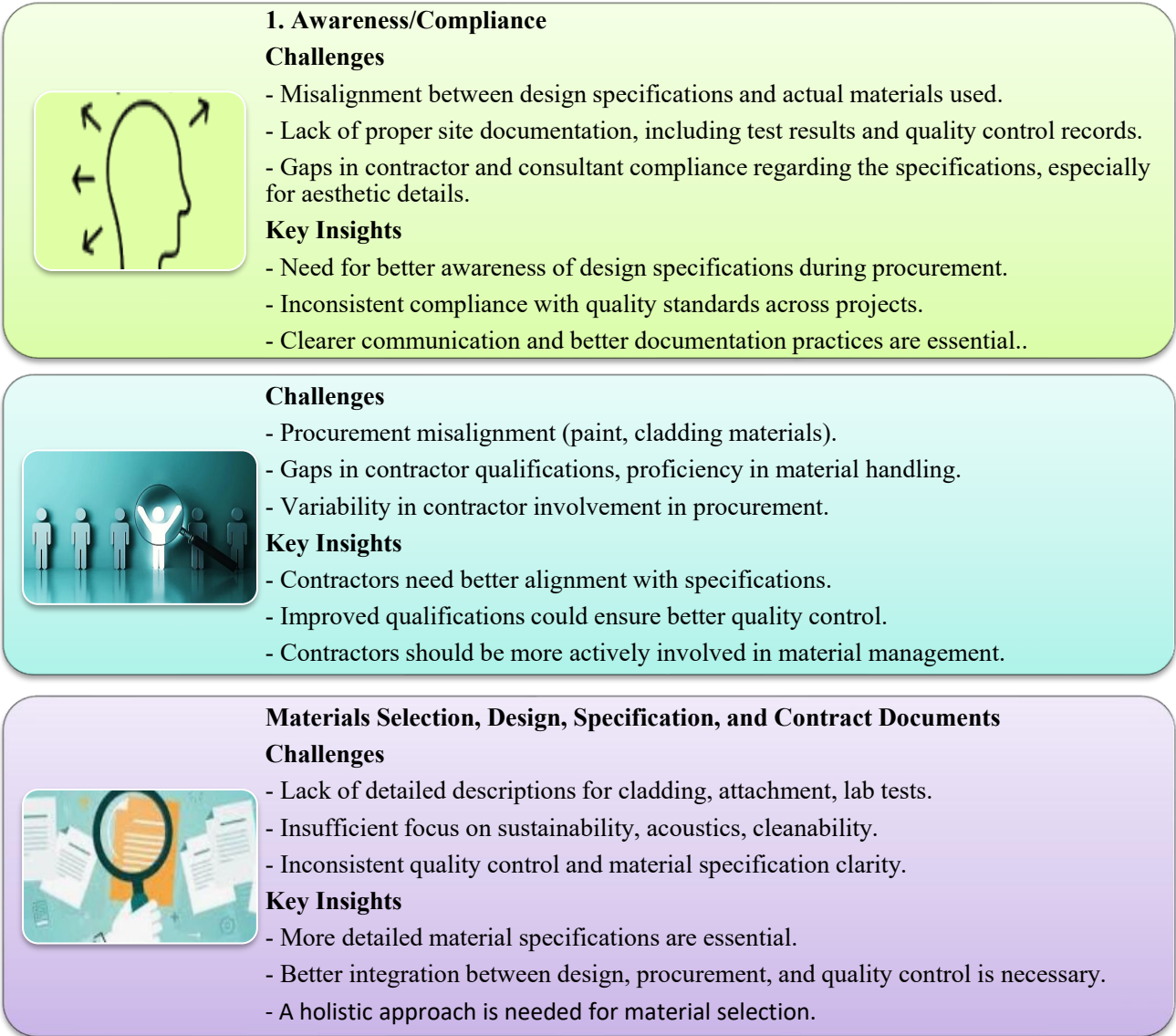


Figure 4.7 Challenges and key insights in quality planning, the case of AAHDC

4.3.1.3. The case of the MOH project

As the Ministry of Health's (MoH) capacity grows, the need for additional hospitals arises, requiring secure land and careful project planning. Projects are classified by size, with small-scale (under 50 million) managed in-house, medium-scale (50-150 million) handled by in-house or external consultants, and large-scale (over 150 million) typically managed by external consultants. Professionals in this organization are mainly active in contract administration and are aware of their responsibilities in maintaining quality throughout the project construction. Contracts are awarded based on financial and technical proposals, along with the bidder's capacity and experience, while fast-track projects are directly awarded to the Ethiopian Construction Works Corporation.

A. Awareness/ Level of commitment/ resources

The findings from the Ministry of Health (MOH) on quality management aspects reflect several critical areas of concern that could affect the quality of exterior finishing materials in construction projects. See on table 4.16 that low percentage (47.6%) of respondents reporting the presence of a quality mission, free flow of quality information, and employee empowerment highlights a gap in fostering a robust quality culture within the organization. According to literature on quality management, a strong organizational commitment to quality, alongside clear communication channels and staff involvement, is important in order to ensure consistent and effective implementation. The (57.1%) formal quality management structure suggests organizational commitment exists but weak leadership involvement and limited control of top management over quality with (42%) points is evidence for the weaknesses in leadership and oversight. These findings suggest that effective quality management in construction, especially regarding exterior finishing materials, requires not only a clear structure but also active leadership and engagement from top management, improved communication, empowerment programs for employees on quality to enforce standards and ensure the proper implementation of quality planning and control measures strengthening to achieve better consistency in quality management practices for exterior finishing materials as well as throughout the project lifecycle.

Table 4.15 Quality management awareness and commitment in MOH questionnaire result

Assessment Points	Rate (%)
Top managers have awareness and sound control of quality	42

Managers play a leadership role in quality management initiatives	47.6
Executes a proper quality management technique	47.6
Existence of formal quality management structure	57.1
Empowered employees on quality management perspectives	47.6
Free flow of information related to quality management	47.6
Quality policies and mission exists	47.6

The Ministry of Health operates at present to fulfill its mission of expanding health service delivery capacity due to growing demand. The organization assigns internal management to small projects yet requires external consultant support for projects exceeding 50 million. The interview participants indicated that leadership involvement for quality management needs improvement within the construction project development team which conducts proposal reviews.

The document reviews verified both survey and interview results by confirming the project classification framework as well as the contract allocation process which uses technical and financial proposal evaluations. The findings show that leadership and top management lack active participation in quality management despite their responsibility to maintain consistent quality standards across the organization.

Table 4.16 Compliance of quality management documents in each case projects (MOH)

Data on specification	MOH	
	Case 5	Case 6
Clear quality management /control manuals	X	X
Easily available quality management manuals	X	X
Construction material specifications are clearly defined in the project documents.	X	X
Complete and clear construction designs	X	X
Clearly stated specification of works	X	X
Clear supervision check lists for construction works	X	X
Production check lists for building exterior work	X	X
Clearly stated site book or resident Engineer observation records	√	√
Contract document which clarifies quality management techniques	X	X
Properly endorsed quality control test results by the Engineer	X	X

The result from document review on table 4.17 reveals gaps in quality management for exterior finishing materials, with no clear quality control manuals or detailed construction material specifications. The absence of supervision and production checklists for exterior work limits effective quality monitoring. The absence of detailed documentation together with insufficient

guidelines prevents strong quality assurance practices at the site. Quality management literature requires specific processes and easy documentation access for controlling material selection and application so MOH should enhance these areas to achieve better quality outcomes.

The results from both the questionnaire and interview and document assessment reveal the MoH has quality management structures yet needs better communication and leadership involvement alongside enhanced quality management implementation. Better leadership involvement together with empowered employees would create substantial improvements to quality management initiatives at the MoH.

B. Selection of contractors and consultants

The data collected from the Ministry of Health (MOH) shown on table 4.17, consultants reveal key insights into the quality planning (selection and compliance of consultants) processes. Consultants at MOH showed a high priority for communication (78.5%) and works under construction (71.9%), with an ability to read and interpret designs rated at (71.9%). However, only 57.1% of respondents have an opinion that MoH consultants possessed adequate experience in quality management, indicating shortcoming about their ability to uphold construction standards. Furthermore, the power to reject inferior materials was only accepted by 61.9% of respondents, suggesting room for improvement in decision-making authority regarding material quality.

Table 4.17 Selected consultants' compliance to contract according to survey result (AAHDC)

Assessment Points	Rate (%)
Construction materials	78.5
Key personnel to communicate (verbal or in writing)	78.5
Works under construction	71.9
Required skill to read, interpret designs and specifications	71.9
Production quality control engineers fulfilling minimum requirements	66.7
Supervisors follow clearly stated acceptance criteria for installed finishing materials	66.7
Experienced and competent key personnel in quality management	57.1
Motivated personnel to ensure conformance/compliance of works	57.1
Power/practice to reject inferior quality materials delivered by the client	61.9
Free flow of quality management information	42.9
Committed supervisors to reject inferior quality materials/works ethically	52.4
Trained key personnel in quality management	52.4

Assessment Points	Rate (%)
Qualified quality control personnel to perform their assigned duties	52.4
Favorable organizational structure for quality management	42.9

According to the assessment pointed developed from different literatures seen on table 4.18, contractors at MOH exhibited strong skills in design interpretation (95.2%) and retention of key personnel (81%). However, quality management practices were poorly rated, with only 42.9% of respondents rated a favorable organizational structure is in place to supporting quality. The authority to reject inferior materials in the contractor’s quality personnel was 42.9%, highlighting the need for enhanced quality management mechanisms within MOH projects.

Table 4.18 Selected contractors’ compliance to contract according to survey result (MOH)

Assessment Points	(%)
The required skill to read	95.2
The contract agreement requires contractors to employ key personnel for compliance	81.0
Presence of key personnel from commencement to provisional acceptance	81.0
Trained employees in quality management	66.7
Experienced key personnel in quality management	66.7
Employees can communicate verbally or in writing	66.7
Has an appropriate structure which supports quality management activities	42.9
Supervisor has the commitment to remove inferior quality materials/works	42.9
Authority to reject inferior quality materials	42.9
Motivated personnel to ensure conformance/compliance of works	52.4
Qualified quality control personnel, to perform their assigned duties	61.9

According to interview and document review findings show he MOH follows a structured process for selecting consultants and contractors. The bidding process includes specific eligibility criteria such as required experience, financial stability, and compliance with Ethiopian regulations. Bidders must submit documentation addressing technical and financial qualifications, with the most suitable consultant or contractor selected based on these evaluations. However, challenges arise due to unclear and incomplete design specifications, which result in discrepancies during project execution, especially in applying exterior finishing materials. Consultants generally comply with contract requirements, particularly in terms of key personnel and design interpretation, but struggle with the flow of quality management information and ensuring the rejection of substandard materials. Contractors typically meet basic contract obligations, but face challenges in creating strong quality management structures and ensuring the removal of inferior materials when needed.

The results from questionnaire, interviews, and document reviews underscores several key insights regarding the quality planning of exterior finishing materials. While consultants demonstrate strong technical competence and communicate well, there is a gap in their experience with quality management practices. The moderate authority granted to reject inferior materials also suggests a lack of enforcement mechanisms in place for maintaining quality standards. Contractors, although proficient in design interpretation, face challenges in organizing quality control and ensuring the rejection of subpar materials. The organizational structure for quality management is often insufficient, which could lead to compromised material quality and project execution. The findings highlight the importance of strengthening quality management systems for both consultants and contractors. The lack of clarity in design and specifications further exacerbates challenges in maintaining material quality. Recommendations include improving the quality management information flow, establishing clearer guidelines for the rejection of inferior materials, and enhancing training for personnel on quality control measures. Additionally, improving the organizational structure for quality management and ensuring the specifications are comprehensive and clear will help in better managing the application of exterior finishing materials in construction projects.

C. Materials selection, design, specification and contract document

The questionnaire results on table 4.3 revealed that durability was the most critical factor in material selection, followed by material availability and material economy. Other considerations included functional performance, cleanability, and acoustics. Lower emphasis was placed on thermal performance, material sustainability, and compatibility, with health and safety receiving the least focus. These results emphasize the prioritization of durability and availability over aspects like sustainability and safety.

The selection of exterior finishing materials for Ministry of Health (MoH) projects was evaluated based on interviews, site observations, and document reviews. *Durability* is again the foremost concern in material selection, reflecting a universal emphasis on materials that endure in health facilities. *Material availability* and *economy* follow closely, underscoring practicality and cost-efficiency in decision-making. Moderate attention is given to *functional performance* and *cleanability*, critical for hygiene and maintenance in healthcare settings. However, *health and safety* are surprisingly ranked lower, which is a notable oversight for an institution centered on

public health. *Aesthetic appearance* is considered, but *physical and mechanical properties* are regarded as equally important, ensuring materials meet both design and operational standards.

Interviews revealed that designers and project managers primarily focused on factors such as *aesthetic appeal* and *functional performance* during material selection, often constrained by project timelines and budget limitations. Key challenges, including *political interference* and *cost inflation*, were identified as recurring issues that disrupted the procurement and implementation processes. The interviewees acknowledged that aspects like *compatibility* and *sustainability* were often overlooked due to insufficient time and resources for thorough analysis.

D. Case Project Analysis 1:

- **Case 5- St. Paul Hospital Cardiac Building (G+8)**

From document reviews and site observations, the St. Paul Hospital cardiac building encountered significant challenges, including *scope expansion* and *contract changes*, resulting in cost and time overruns. The shortage of marble coping led to changes in material specifications, confirmed by site observations, which introduced further delays. Unforeseen risks, such as material unavailability within the contractor's capacity and political interference, aggravated the situation. Changes in specifications necessitated additional time and costs, leading to significant *cost escalation* over the 18-month construction period.



Figure 4.8 St Paul hospital, cardiac building

- **Case 6: St. Peter's General Hospital Expansion Project**

Document reviews and site observations of the St. Peter’s General Hospital revealed a lack of comprehensive design and specification documentation, which posed challenges for facility management. Observations showed that the external walls were finished with three coats of cement mortar plastering (1:3 mix ratio) and approved quartz paint. Interviews with stakeholders highlighted that the project was prematurely handed over to the Ministry during construction due to tight timelines. This early transfer left little room for reviewing and refining design and specification documents, causing inefficiencies in operational readiness.



Figure 4.9 St peter hospital building, MOH

Table 4.19 Description listed on specifications of exterior finishing materials (Marked “√” indicates described, “O” not described and Proficiency levels E- Entry, I- Intermediate, P- Proficient.)

Data on design and specification	MOH	
	Case 5	Case 6
Cladding		
Size		
Color and/or pattern		
Attachment detail		
Laboratory (characteristic test)		
Proficiency level of the cladding installer		
Paint		
Color/ label		
Standard lab tests		
Mix ratio		
Proficiency level of the painter		
Plastering		
Layers	O	O
Mix ratio	√	√

Data on design and specification	MOH	
	Case 5	Case 6
Layers of plastering (thickness)	O	O
Heavy equipment used	O	O
Manual tools	√	√
Proficiency level of the plasterer	I	I
Glazing		
Size	√	√
Material type	√	√
Thickness	√	√
Frame	√	√
Sealant type and size	√	√
Proficiency level of the glazer	I	I

As shown on table 4.18 the result form document review highlights several deficiencies in the specification of exterior finishing materials shown on table 4.20, such as the lack of attachment details, laboratory tests, and proficiency levels of installers. While certain aspects, like paint mix ratios and glazing details, are specified, others, such as heavy equipment use and test results, are missing. According to quality management literature, thorough specifications and skilled labor are essential for ensuring material quality. Thus, MOH should focus on enhancing documentation and training to uphold consistent quality control standards.

The questionnaire results highlighted the prioritization of durability and aesthetic appeal during material selection. These findings were supported by interviews, which indicated a strong focus on these factors by designers and project managers, albeit at the expense of *compatibility*, *sustainability*, and *health and safety*. Observations and document reviews from the case projects validated these claims, showcasing how inadequate material planning and external pressures, such as political interference and cost inflation, impacted project timelines and budgets.

Triangulating the data, it is evident that while key priorities like *durability* and *material economy* drive decision-making, limited attention to holistic factors such as *compatibility* and *health and safety* undermines the long-term sustainability and efficiency of the projects. Future projects must address these gaps through more comprehensive design reviews, improved documentation practices, and stakeholder collaboration to ensure well-rounded material selection and specification processes.

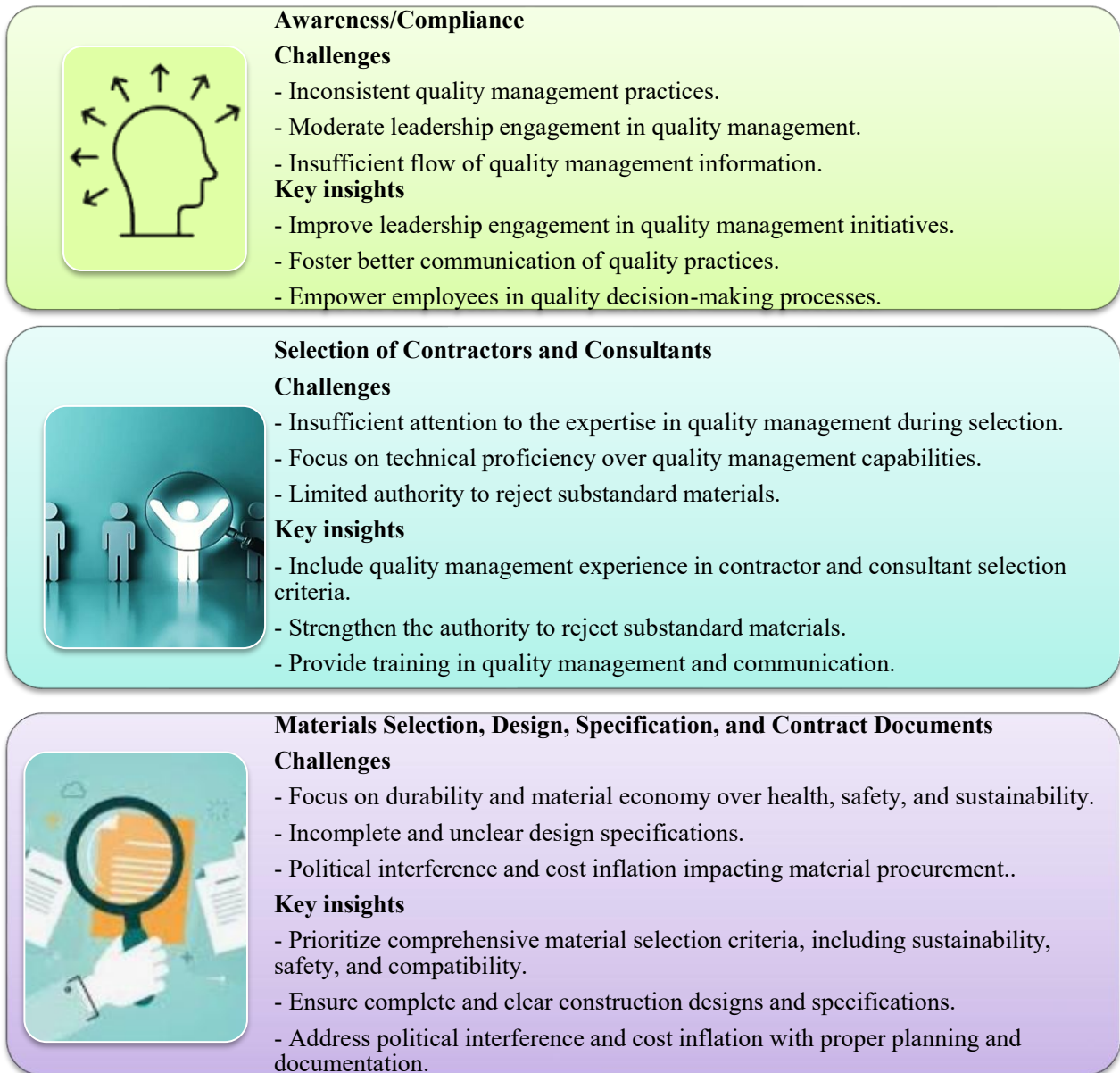


Figure 4.10 Challenges and key insights in quality planning, the case of AAHDC

4.3.2. Quality planning Summary

In AADCWB, the selection of consultants and contractors is primarily based on legal, professional, technical, and financial qualifications. However, the lowest bidder frequently wins, which can lead to compromised quality. Key stakeholders, such as clients, consultants, subcontractors, and suppliers, are rarely involved in the quality planning stage. In the selection of exterior finishing materials, factors like economy, durability, availability, sustainability, and thermal performance are considered, but important aspects such as functional performance, acoustics, and material

compatibility were overlooked. The integration of construction design drawings with specifications is also lacking, leading to designs and specifications that are incomplete and unclear. These gaps in design and the practice of selecting the lowest bidder resulting in a misalignment between project requirements and the final deliverables, negatively impacting overall quality.

At the Addis Ababa Housing Development Corporation (AAHDC), the selection of consultants and contractors similarly hinges on technical and financial qualifications, though the practice of awarding contracts to the lowest bidder poses a risk to quality. Stakeholders such as clients, consultants, subcontractors, and suppliers are rarely engaged during the quality planning process. The selection of exterior finishing materials is influenced by factors like economy, durability, availability, and functional performance, but considerations such as sustainability, cleanability, acoustics, and suitability receive minimal attention. There is a noted lack of integration between construction design drawings and specifications. This results in designs and specifications that are often incomplete and prone to errors, contributing to a potential disconnect between the project's goals and the quality of the final deliverables.

In the Ministry of Health (MOH), the selection of consultants and contractors is based on legal, professional, technical, and financial criteria. However, the quality of the deliverables is sometimes compromised by insufficient attention to certain factors. In the selection of exterior finishing materials, the ministry focuses on durability, aesthetics, availability, environmental impact, and economy, but aspects like material compatibility, suitability, and acoustics are often overlooked. The designs and specifications frequently lack detailed analysis, clarity, and specificity, leading to discrepancies between the design and the specified requirements. These shortcomings, combined with the tendency to select the lowest bidder, result in potential misalignment between the intended project quality and the actual outcomes, particularly when key stakeholders are not involved in the quality planning stage.

4.3.3. Quality Control

Quality control of building exterior finishing materials is a critical process that ensures durability, aesthetic appeal, and resistance to environmental factors. Effective quality control begins with rigorous material selection and sourcing, emphasizing compliance with industry standards and certifications. Proper handling and on-site storage are equally vital to prevent damage or

deterioration, as controlled environments help maintain material integrity. Precise installation practices, guided by skilled labor and detailed inspection protocols, are also necessary to achieve long-term performance and minimize maintenance needs. These processes collectively ensure the quality and reliability of exterior finishes in building projects. This section examines the quality control measures applied to exterior finishing materials in government building projects in Addis Ababa, focusing on case studies from the Addis Ababa Design and Construction Works Bureau, the Addis Ababa Housing Development Corporation, and the Ministry of Health. The analysis evaluates critical parameters, including material sourcing and supply chain management, on-site handling and storage practices, and installation techniques, using data collected from project records, site inspections, and professional feedback. By assessing these aspects, the study identifies challenges and proposes improvements to ensure the durability, safety, and performance of exterior finishes in public buildings.

4.3.3.1. The case of the AADCWB project

4.3.3.1.1. Suppliers' quality evaluation

Interview result showed AADCWB prioritizes supplier evaluation parameters such as experience, capacity, quality, history, schedule/delivery, financial stability, location, attitude/cooperation, and overall reputation. However, critical aspects like technical personnel, facility/housekeeping, and service organization/parts are entirely neglected, while labor relations receive only occasional attention. This selective approach limits the effectiveness of supplier management, resulting in insufficient on-site support and substandard material quality. The lack of consistent quality control measures, such as fabrication tests, further increases the risk of defects, negatively affecting the durability and aesthetics of exterior finishes.

The document review revealed that rejection of substandard materials is infrequent due to time constraints in managing large-scale projects, as delays caused by re-sourcing materials can significantly impact timelines. Additionally, documentation regarding quality control processes, such as fabrication test reports and material inspection formats, is either inadequate or inconsistently utilized. This lack of robust quality assurance processes contributes to insufficient durability and higher risks of defects in construction materials.

Table 4.20 Parameters of evaluating suppliers AADCWB (“√”- Will be checked, “O”- are not applicable.)

Description	AADCWB (contractor)
Experience	√
Capacity	√
Technical personnel	O
Facility/ housekeeping	O
Quality	√
History	√
Schedule/ delivery	√
Service organization/parts	O
Financial	√
Location	√
Labor relations	√
Attitude, cooperation	√
Overall reputation	√

Both observation and document review at AADCWB highlight a selective focus on key supplier evaluation parameters such as experience, capacity, quality, and schedule/delivery, while neglecting technical personnel, facility/housekeeping, and service organization/parts. This leads to inadequate supplier oversight and substandard material quality. The document review further confirms that rejection of substandard materials is rare due to project timelines, and quality control documentation is often inconsistent. These combined findings emphasize the need for improved supplier evaluation and quality control to enhance the durability and aesthetics of exterior finishes.

Neglecting technical personnel and quality control processes can lead to substandard outcomes, as supported by industry research (Christopher and Peck, 2004a). Studies also highlight that effective supplier management, including quality control and technical support, is essential for minimizing defects and ensuring long-term performance ((Monczka, (2016)). By prioritizing these factors, construction projects can enhance exterior finishes and reduce costs associated with rework and maintenance.

4.3.3.1.2. Pre and post award phase

The data for AADCWB was collected through interviews and document review. In the pre- and post-award phases, suppliers and both external and internal professionals are briefed about the

importance of quality in supplier selection. The contractor, who is responsible for the selection and supply of construction materials, focuses on finding materials that are affordable and of acceptable quality. The purchasing team submits specifications to different suppliers, including required stock capacity, and briefs them on requirements for testing, certifications, and schedules for shop visits and submittals.

4.3.3.1.3. Inspection plan

Document review in the AADCWB, the inspection plan for exterior finishing materials includes visual checks of specifications, laboratory tests, quantities, dimensions, packing requirements, and shipping marks. Inspections are conducted by an in-house laboratory that tests the physical and mechanical properties of materials. The architectural appearance is first inspected by the contractor and then approved by the consultant. The selection of quality inspection service providers is based on their previous experience, plant location, accessibility, availability and quality of inspectors for the specific procurement, as well as funding and payment considerations. In coordination with inspections, processes such as notifying the scope of tests, scheduling, determining attendees and participants, arranging logistical support for inspectors, and reaching agreements on certifications are undertaken. The scope of quality tests for materials, including earth-based materials (brick and ceramic), stone-based materials (marble, granite, and limestone), metals (ferrous and nonferrous), paint, and glass, is outlined. However, limitations were observed in the scope of quality testing compared to what is typically expected for these materials.

Table 4.21 Wall exterior finishing material quality management description checklist
 “C”- Conditional, “√”- Will be checked, “O”- are not applicable.

Assessment Points	AADCWB
Construction material’s test results and samples are presented to the consulting engineer for approval before bulk purchase	√
Your organization contract agreement contains specific quality tests obligations for conformation.	O
The consulting engineer receives material samples for approval before the project site receives bulk deliveries.	√
Your organization performs material tests at the beginning of each project.	√
The resident Engineer supervises and approves all tests that take place in your organizations.	O
The materials supplied to construction sites must meet both contract specifications and quality standards.	C

Assessment Points	AADCWB
Construction material's test results and samples are presented to the consulting engineer for approval before bulk purchase	C

Interviews revealed that the AADCWB emphasizes the importance of quality in supplier selection. The contractor focuses on finding materials that are both affordable and of acceptable quality. The purchasing team submits detailed specifications to various suppliers, including required stock capacity, and briefs them on requirements for testing, certifications, and schedules for shop visits and submittals. This approach ensures that while cost-effectiveness is a priority, the quality of materials remains a key consideration for AADCWB.

Table 4.22 Scope of testes done on earth, stone and metals-based material, paint and glass
 The once marked “√” are tested at Institute of Ethiopian standards (IES) and AADCWB laboratory, marked “X” are labeled on
packaging boxes and included in certification documents.

Properties	Earth based		Stone based			Metals		Cement	Paint	Glass
	Brick	Ceramic	Marble	Granite	Limestone	(Ferrous) e.g. Steel Custom	(Nonferrous) e.g. Aluminum Custom			
Dimension (length)	√	√								√
Dimension (Width)	√	√								
Dimension (Thickness)	√	√								
Texture	√									
Straightness of sides		√								
Rectangularity		√								
Flatness of central curving		√								
Color	√	√							X	
Grade/ type	√									
Specific Gravity										
Fire resistance										X
Thermal property (expansion)		√								
Thermal Conductivity										
Water absorption	√	√	√	√	√					
Chemical resistance		√								
Crazing resistance		√								
Abrasion resistance		√								
Efflorescence Rate	√									
Porosity										
Crushing strength		√								
Modulus of rapture		√								
Tensile strength						√	√			
Elongation						√	√			

Properties	Earth based		Stone based			Metals		Cement	Paint	Glass
	Brick	Ceramic	Marble	Granite	Limestone	(Ferrous) e.g. Steel	(Nonferrous) e.g. Aluminum			
Proof stress						√	√			
Impact resistance		√								X
Setting time								√		
compressive strength	√		√	√	√			√		
Warpage										
Flatness of warpage curving		√								
Toughness										
Hardness and soundness								√		X
Resistance to Wear										
Bulk Density										
Seasoning										
Adhesion test									X	
Chem composition						√	√		X	
Water Retention										X
Time to dry								√		
Workability										
Viscosity									X	
Consistency of volume		√								
Pencil hardness test									X	
Elasticity										
Malleability										
Ductility										
Brittleness										
Resistance to Corrosion										
Resistance to Weathering									X	
Light (Absorption, Reflection, and Transmittance)										X
Acoustical Property										X

Table 4.21 provides a complete overview of various tests conducted under the Ethiopian Standards Institute (IES) to identify the properties of different construction materials. These materials include earth-based (brick, ceramic), stone-based (marble, granite, limestone), metals (ferrous e.g., steel, non-ferrous e.g., aluminum), cement, paint, and glass.

Tests to be done during inspection of materials are according to ISO, ASTM, CES (Compulsory Ethiopian Standard), EBCS, IS are present on (Appendix 9 and their summary on appendix 10).

4.3.3.1.4. Pre shipment quality control

The data gathered through document review reveals that pre-shipment quality control at AADCWB involves ensuring that the bulk quantity to be manufactured or imported matches the samples provided. Documentation, including certificates of quality, is maintained, and orders are placed according to the sizes specified in the project specifications. After manufacturing or import, monitoring is carried out to identify any non-conforming materials, which are then addressed and prepared for delivery accordingly.

From the interview data, it was confirmed that the pre-shipment quality control process at AADCWB focuses on verifying that the materials meet the required specifications. Any non-conforming materials are identified and corrected before they are shipped for delivery.

For the AADCWB, construction material tests and sample approvals were confirmed by 91% of respondents before bulk purchases. About 70% of participants noted clear obligations for quality tests in contract agreements, and 92% agreed that consulting engineers approve samples before bulk delivery. However, 37% highlighted tests conducted at the material commencement stage. Meanwhile, 62% of respondents stated that tests are supervised and approved by the Resident Engineer, with 63% affirming materials meet contract specifications and quality requirements, and 45% noting that tests are conducted when material sources change.

Table 4.23 Procedures of quality control of exterior wall finishing materials (AADCWB)

Quality Control Procedure (Assessment Points)	Rate (%)
Construction material's test results and samples presented to the consulting engineer for approval before bulk purchase	91
Quality test obligations clearly stated in the contract agreement	70
Material samples approved by the consulting engineer before bulk delivery to the project site	92
Tests conducted at the commencement of materials	37
Tests conducted under the supervision and approval of the Resident Engineer	62

Quality Control Procedure (Assessment Points)	Rate (%)
Materials delivered comply with contract specifications and quality requirements	63
Tests conducted when changes in material sources are observed	45

4.3.3.2. The case of the AAHDC project

4.3.3.2.1. Suppliers' quality evaluation

According to document review data for AAHDC the process of evaluating suppliers includes a focus on experience, capacity, history, quality, schedule/delivery, location, attitude and cooperation, overall reputation, and financial stability. These parameters are given the most attention in the supplier selection process, with less emphasis placed on labor relations, technical personnel, facility/housekeeping, and service organization/parts. The evaluation process, as indicated in Table 4.6, highlights that technical aspects and supplier support are not prioritized, which may lead to insufficient support and the use of substandard materials, impacting the durability and aesthetic quality of the exterior finishes. Additionally, the use of quality control measures like fabrication tests is rare, and when used, the documentation for failure, marking, packaging, and general workmanship is inadequate, which could result in defects. The document further suggests that large-scale projects may face delays in material imports or manufacturing if materials are frequently rejected.

According to interview data, the process of supplier evaluation at AAHDC also involves ensuring that the materials meet the expected quality standards, with specific attention paid to the timeliness of delivery and the financial stability of the suppliers. While the emphasis is placed on cost efficiency, the interview also indicated that the involvement of technical personnel in the supplier evaluation and quality control process is minimal. As a result, the lack of technical expertise in supplier management and quality control increases the risk of receiving substandard materials, which can lead to defects and compromises in the project's final quality.

Table 4.24 Suppliers quality evaluation criterion evaluation of AAHDC

Description	AAHDC (contractor)
Experience	√
Capacity	√
Technical personnel	O
Facility/ housekeeping	O

Description	AAHDC (contractor)
Quality	√
History	√
Schedule/ delivery	√
Service organization/parts	O
Financial	√
Location	√
Labor relations	O
Attitude, cooperation	√
Overall reputation	√

Both document review and interview data highlight that AAHDC places significant emphasis on factors like experience, capacity, and financial stability, but lacks focus on quality control processes and technical expertise. This neglect increases the risk of substandard materials being used and defects arising in construction projects. These findings align with research emphasizing the need for comprehensive supplier management to ensure long-term project success (Christopher & Peck, 2004; Monczka, 2016). Prioritizing quality control can improve material durability and reduce defects.

4.3.3.2.2. Pre and post award phase

Interviews with AAHDC professionals revealed that the organization prioritizes affordability over quality when selecting suppliers. AAHDC actively involves small enterprises in the manufacturing process to minimize costs. Although this approach supports local businesses, it sometimes results in inconsistent material quality. The purchasing team primarily focuses on submitting specifications to suppliers and briefing them about testing requirements, certifications, and schedules for shop visits and submittals. However, there is limited follow-up on adherence to these standards.

Documents reviewed from AAHDC indicate a clear emphasis on cost efficiency in supplier selection. While specifications and schedules for testing and certifications are well-documented, the absence of stringent quality control measures and lack of monitoring mechanisms for small enterprises were noted. The documents suggest a reliance on local suppliers to reduce costs, but without comprehensive evaluation procedures, there is a risk of quality compromise. Both interview and document review data confirm that AAHDC's procurement process prioritizes

affordability over quality, with a particular focus on involving small enterprises. While specifications and testing requirements are outlined, the lack of strict quality control and follow-up mechanisms limits the effectiveness of the process. This approach aligns with cost-reduction goals but poses risks of substandard materials being used in projects.

4.3.3.2.3. Inspection plan

Interviews with AAHDC professionals revealed that inspections for exterior finishing materials involve visual checks, laboratory testing by the Institute of Ethiopian Standards (IES), and contractor-led inspections of architectural appearance, later approved by consultants. Selection of inspection providers depends on experience, location, inspector availability, and funding. Coordination includes defining test scopes, scheduling, and logistical support. However, professionals noted limitations in the range of quality tests conducted, particularly for materials like brick, ceramic, paint, and glass.

In the case of AAHDC, construction materials are tested, and samples are presented to the consulting engineer for approval before bulk purchase, ensuring initial quality control. However, the contract agreement does not clearly outline specific quality test obligations related to material characteristics, leading to occasional deviations between approved samples and bulk deliveries. Tests at the commencement of materials are not conducted as standard practice, and quality control under the supervision of the resident engineer is not explicitly enforced. Tests of materials are performed when changes in the source are observed, and compliance with contract specifications and quality requirements is conditional, as observed across various projects.

Table 4.25 Wall exterior finishing material quality management description checklist
 “C”- Conditional, “√”- Will be checked, “O”- are not applicable.

Description (Assessment Points)	Conformance
Construction material’s test results and samples are presented to the consulting engineer for approval before bulk purchase	√
Your organization contract agreement contains specific quality tests obligations for conformation.	O
The consulting engineer receives material samples for approval before the project site receives bulk deliveries.	√
Your organization performs material tests at the beginning of each project.	O
The resident Engineer supervises and approves all tests that take place in your organizations.	O
The materials supplied to construction sites must meet both contract specifications and quality standards.	C

Description (Assessment Points)	Conformance
Construction material’s test results and samples are presented to the consulting engineer for approval before bulk purchase	C

Documents from AAHDC confirm that inspections prioritize compliance through visual checks and laboratory testing, with IES handling material property evaluations. Contractors and consultants oversee appearance inspections, while criteria for selecting inspection providers and logistical arrangements are clearly outlined. The documents also highlight gaps in the scope of testing, suggesting some quality aspects may be overlooked.

Both interviews and document reviews agree on AAHDC’s reliance on visual checks, according to table 4.21 laboratory tests, and IES evaluations for quality control. Despite well-defined processes, the limited scope of testing across materials is a consistent concern, emphasizing the need for broader quality assessments to improve material durability.

4.3.3.2.4. Pre shipment quality control

Interviews with AAHDC professionals indicated that pre-shipment quality control ensures bulk quantities match the approved samples. The process involves documenting quality certificates, placing orders according to specified sizes, and monitoring for non-conforming materials after manufacturing or import. Identified non-conforming materials are segregated and prepared for corrective actions before delivery.

Documents from AAHDC confirm that pre-shipment quality control includes verifying bulk quantities against provided samples and ensuring compliance with specifications. Certificates of quality are consistently documented, and the process for identifying and handling non-conforming materials is outlined. Procedures include reporting defects and coordinating corrective measures to prevent delays in delivery.

Both interviews and documents highlight AAHDC’s focus on ensuring compliance with approved samples, documenting certificates, and addressing non-conforming materials. The alignment between sources confirms that quality assurance measures are effectively integrated into pre-shipment processes to maintain material standards and reduce defects.

For the Addis Ababa Housing Development Corporation (AAHDC), 90% agreed that test results and material samples are reviewed and approved by consulting engineers prior to bulk purchase. Around 71% noted stated quality test obligations in contracts, and 89% reported that samples are

inspected before bulk delivery to sites. Only 35% of responses confirmed testing at material commencement, while 61% affirmed tests are conducted under the supervision of the Resident Engineer. Roughly 60% of respondents indicated materials delivered comply with quality and specification requirements, and 48% noted that tests occur upon changes in the material source.

Table 4.26 Procedures of quality control of exterior wall finishing materials (AAHDC)

Assessment Points	Rate (%)
Construction material's test results and samples presented to the consulting engineer for approval before bulk purchase	90
Quality test obligations clearly stated in the contract agreement	71
Material samples approved by the consulting engineer before bulk delivery to the project site	89
Tests conducted at the commencement of materials	35
Tests conducted under the supervision and approval of the Resident Engineer	61
Materials delivered comply with contract specifications and quality requirements	60
Tests conducted when changes in material sources are observed	48

4.3.3.3. The case of the MOH project

4.3.3.3.1. Suppliers' quality evaluation

Interviews with professionals involved in MoH projects revealed that the contractor is responsible for supplier selection. However, clients and consultants, such as project managers, resident engineers, and materials engineers, are actively involved in decisions regarding acceptance, rejection, repair, or replacement of materials. Suppliers are evaluated primarily based on parameters like experience, capacity, quality, history, delivery schedule, location, attitude, cooperation, reputation, and financial stability. Limited emphasis is placed on technical personnel, labor relations, and facility/housekeeping, which has led to challenges in ensuring consistent quality and durability in finishes.

The reviewed documents confirm that MoH uses a supplier evaluation framework emphasizing factors like experience, quality, delivery schedule, and financial capacity. However, technical personnel, housekeeping, and service organization/parts are not adequately addressed. This has resulted in gaps in quality control measures, such as the inconsistent use of fabrication tests and inadequate documentation and packaging standards. The documents also highlight the difficulties faced in large-scale projects when materials are frequently rejected, as this causes delays in procurement and manufacturing processes.

Table 4.27 Suppliers quality evaluation criterion evaluation of MOH

Description	MOH (contractor)
Experience	√
Capacity	√
Technical personnel	O
Facility/ housekeeping	O
Quality	√
History	√
Schedule/ delivery	√
Service organization/parts	O
Financial	√
Location	√
Labor relations	O
Attitude, cooperation	√
Overall reputation	√

Both interview and document data emphasize MoH's reliance on critical supplier evaluation parameters like experience and quality but highlight neglect in technical and operational aspects. This alignment reveals that insufficient attention to quality control processes and personnel expertise impacts material durability and project timelines. Enhanced supplier management practices, including stricter quality checks and technical support, are crucial to improving outcomes in MoH projects.

4.3.3.3.2. Pre and post award phase

Interviews results from MoH projects indicate that *contractors* are responsible for the *selection* and *supply* of *construction materials*. Their primary focus is on finding *affordable* materials with *acceptable quality* to meet project needs. The *purchasing team* ensures that specifications are submitted to potential suppliers, briefing them about the requirements for *testing*, *certifications*, schedules for *shop visits*, and deadlines for submittals. This process is aimed at maintaining efficiency and ensuring the materials meet project specifications.

The reviewed documents validate that MoH relies on *contractors* for material *selection* and *supply*. It is evident from the documents that the *purchasing team* actively engages with suppliers by providing *detailed specifications*, setting expectations for *testing* and *certification* requirements, and outlining schedules for *shop visits* and material submittals. However, there is limited emphasis

on broader *quality assurance* measures beyond these steps, which may impact the consistency of material quality.

Both interview and document data confirm that MoH focuses on *affordability* and *availability* in its material procurement process, with contractors playing a central role in *supplier selection*. While the process involves detailed *briefings* and specification submissions, gaps in comprehensive *quality control* practices persist.

4.3.3.3. Inspection plan

For MoH projects, *IES* conducts *physical* and *mechanical property* tests for *exterior finishing materials*. *Architectural appearance* is inspected by the *contractor* and approved by the *consultant*. The choice of *inspection services* depends on prior experience, *location*, accessibility, and funding. Coordination includes defining the *scope of tests*, scheduling, and logistical arrangements.

At MOH, similar practices are observed where construction material test results and samples are presented to the consulting engineer for approval prior to bulk purchase. However, the absence of specific quality test obligations in the contract agreement undermines comprehensive quality assurance measures. While material samples are approved before bulk delivery, discrepancies between approved samples and bulk deliveries have been noted due to stock issues. Tests at the commencement of materials are not a routine practice, and material quality testing under the supervision of the resident engineer is not applied. Tests are conducted when material sources change, but compliance with specifications and quality standards remains conditional across projects.

Table 4.28 Wall exterior finishing material quality management description checklist
 “C”- Conditional, “√”- Will be checked, “O”- are not applicable.

Assessment Points	Conformance
Construction material’s test results and samples are presented to the consulting engineer for approval before bulk purchase	√
Your organization contract agreement contains specific quality tests obligations for conformation.	O
The consulting engineer receives material samples for approval before the project site receives bulk deliveries.	√
Your organization performs material tests at the beginning of each project.	O

Assessment Points	Conformance
The resident Engineer supervises and approves all tests that take place in your organizations.	O
The materials supplied to construction sites must meet both contract specifications and quality standards.	C
Material tests must be performed whenever a change of source occurs.	C

Documents also confirm MoH uses *IES* for testing, with *contractors* and *consultants* handling appearance inspections. The process includes setting *test scopes*, schedules, and providing logistical support. Limitations in testing for materials like *brick*, *stone*, and *glass* are noted, risking quality issues.

Interviews and documents align on MoH's reliance on *IES* and the role of *contractors* and *consultants*. Both highlight gaps in *testing scope*, stressing the need for improved *quality control*.

4.3.3.3.4. Pre shipment quality control

For MoH, *pre-shipment quality control* ensures that bulk materials match *sample specifications*. The process includes documenting *quality certificates* and placing orders according to sizes specified. After *manufacturing/import*, non-conforming materials are identified and prepared for delivery adjustments.

Records show that MoH implements a defined *pre-shipment quality control* process, including documentation of *certificates of quality*, verification of orders against *specifications*, and monitoring for *non-conforming materials* prior to delivery.

Interviews and document reviews highlight the steps MoH follows in *pre-shipment quality control*, focusing on *certification documentation*, order verification, and managing *non-conforming materials*.

For MoH, 89% of respondents indicated that construction material test results and samples are presented to the consulting engineer for approval before bulk purchase. Furthermore, 73% confirmed that quality test obligations are clearly stated in the organization's contract agreements. Material samples are approved by the consulting engineer before bulk delivery to project sites, as agreed by 88% of respondents. However, only 40% confirmed that tests are conducted at the commencement of materials. Approximately 63% agreed that tests are carried out under the supervision and approval of the Resident Engineer, while 60% indicated that materials delivered

comply with contract specifications and quality requirements, and 50% agreed that tests are performed when changes in material sources are observed.

Table 4.29 Procedures of quality control of exterior wall finishing materials (MOH)

Quality Control Procedure (Assessment Points)	Rate (%)
Construction material's test results and samples presented to the consulting engineer for approval before bulk purchase	89
Quality test obligations clearly stated in the contract agreement	73
Material samples approved by the consulting engineer before bulk delivery to the project site	88
Tests conducted at the commencement of materials	40
Tests conducted under the supervision and approval of the Resident Engineer	63
Materials delivered comply with contract specifications and quality requirements	60
Tests conducted when changes in material sources are observed	50

4.3.4. QC Summary

AADCWB demonstrates a structured approach to quality control, particularly in material storage and pre-shipment inspections. The bureau emphasizes supplier evaluations based on experience, capacity, quality, and delivery schedules but often neglects critical aspects such as technical personnel and facility management, leading to inconsistent material quality. While pre-shipment quality control is implemented, documentation is inconsistent, and material testing is frequently conducted without adequate supervision. Inspections include visual checks and laboratory tests, but limitations in testing scope and insufficient oversight have led to challenges in maintaining material integrity. Issues such as improper mortar mixing and inadequate drying of cement and paint have been identified, which compromise the durability and aesthetics of exterior finishes.

AAHDC's quality control practices focus heavily on cost-efficiency, often at the expense of material quality. Supplier evaluations prioritize affordability and timely delivery, frequently involving small enterprises with limited technical expertise. While initial material samples are tested and approved, ongoing quality checks are limited, leading to inconsistencies between approved samples and bulk deliveries. Testing at the commencement of materials is not standard practice, and supervision during inspections is minimal. As a result, substandard materials are occasionally used, leading to visible defects in exterior finishes. The documentation of quality control measures is also inconsistent, further weakening the effectiveness of the QC process.

MoH relies on contractors for the selection and supply of construction materials, with limited direct oversight from the institution itself. Supplier evaluations focus on factors like experience, capacity, and quality but often overlook technical personnel and facility management, leading to gaps in quality assurance. Testing procedures are conditional and not consistently enforced, with many inspections lacking proper supervision. Although pre-shipment quality control processes exist, non-conforming materials still reach project sites due to inadequate verification. Documentation of QC processes is incomplete, and the scope of material testing is often limited, increasing the risk of defects and compromising the long-term durability of exterior finishes.

4.3.5. Quality Assurance

Quality assurance for building exterior finishing materials plays a pivotal role in ensuring durability, aesthetics, and compliance with design specifications in government construction projects. It encompasses monitoring and verifying processes such as material handling, on-site personnel performance, and installation practices. A study by (Christopher and Peck, 2004b) emphasize that well-defined quality assurance systems enhance performance by minimizing defects and ensuring long-term resilience. This section analyzes government building projects in Addis Ababa, focusing on the AADCWB, AAHDC, and MoH. These organizations are evaluated on their adherence to quality assurance protocols, including personnel training, material storage and handling standards, and precision in installation to achieve sustainable and functional finishes.

4.3.5.1. The case of the AADCW project

The case of Addis Ababa Design and construction bureau quality assurance is done by the design, contract administration and audit team each having checklist under each stage.

Audit department is in charge of making sure the design and contract award process is undergone according to PPA standard. And the design and contract administration team will assure the technical compliance of the design and specification.

Nevertheless, the following processes are undergone Design and Development, Specification, Contract document, Production, Installation, Servicing to documentation, Regulations of the quality of raw materials, Storage, Assemblies Components, Management Inspection are said to be controlled the following defects are observed.

4.3.5.1.1. Material storage and application

AADCWB questionnaire survey results on table 4.10 shows strong quality assurance practices, particularly in cement storage, with 95% of respondents reporting proper conditions, in line with the importance of optimal storage for material integrity. Steel and aluminum storage is also handled well, with 77% confirming corrosion-free conditions, reflecting the finding that appropriate storage minimizes deterioration. However, mortar mixing was only adequately tested by 72% of respondents, highlighting a gap in quality control practices, as inconsistent mixing can lead to material defects. Similarly, only 56% of respondents reported proper drying of cement and paint, which could jeopardize material quality, as poor handling leads to increased risk of failure. Glass storage (82%) aligns with the assertion that careful handling preserves material quality, while the 66% adherence to proper storage of porcelain, ceramic, and brick suggests a need for more control, emphasizing the importance of consistency in material handling to prevent defects.

Table 4.30 Material storage and application (AADCWB)

Quality Control Procedure (Assessment Points)	Rate (%)
Before bulk purchase test results and samples of construction material are presented to the consulting engineer for approval.	91
Quality test obligations clearly stated in the contract agreement	70
Consulting engineer approves samples before bulk delivery to the project site	92
Tests conducted at the commencement of materials	37
Tests conducted under the supervision and approval of the Resident Engineer	62
Materials delivered comply with contract specifications and quality requirements	63
Tests conducted when changes in material sources are observed	45

A. Children and Youth Theatre Project Observation:

In the case of the Children and Youth Theatre building project (basement +G+11), material storage was well-managed. All exterior finishing materials were stored in a dedicated area until required for ongoing tasks, ensuring that they remained organized and in optimal condition. The project employed experienced and certified professionals from a recognized institute to handle the installation of cladding materials, operating high-performance machinery. However, challenges arose during the installation of granite cladding due to the weight of the elements. Initially, the plan specified 20mm thick granite (1600*800mm), but due to market unavailability, a change order resulted in the delivery of 30mm thick granite. This increase in thickness led to difficulties in installation, as the additional weight posed challenges with the manpower and equipment available

onsite. As a result, a revision of the bolted steel load-bearing frame was necessary, and new shop drawings were created to accommodate the change. This alteration highlights the importance of thorough logistical planning and the careful consideration of material characteristics when changes occur during the project. The project underlines the need for flexibility and timely adjustments to ensure smooth execution.

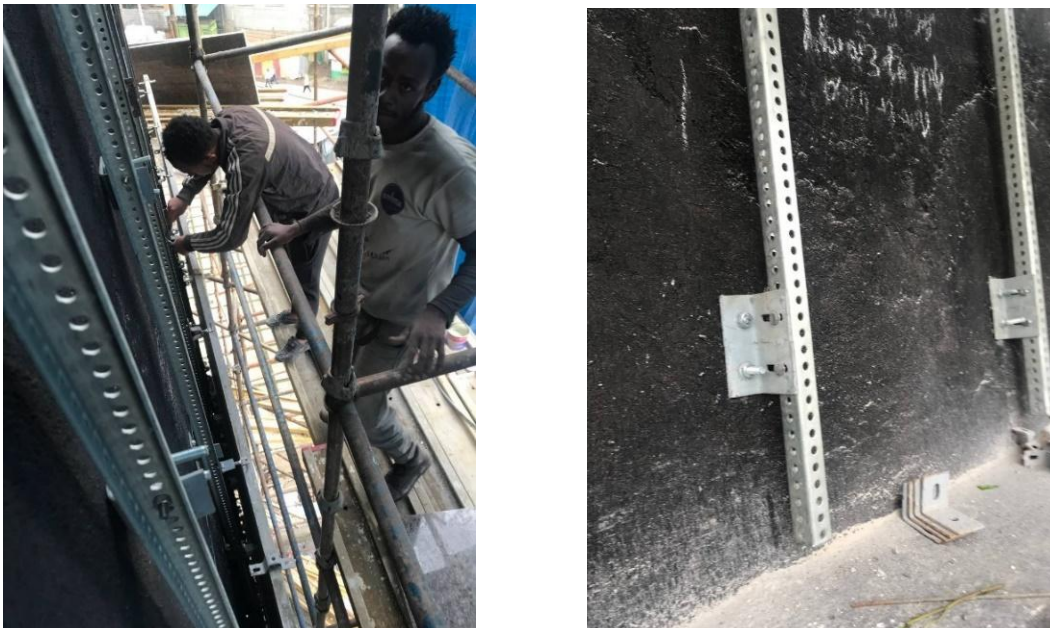


Figure 4.11 Installation of stone cladding at children and youth theatre

Construction materials were stored in a designated area, ensuring proper organization and availability. Exterior finishing materials were applied by experienced laborers who had worked on other projects. However, despite these positive practices, some challenges were observed with the installation of aluminum cladding. Dampness was noted on the cladding elements, which could have been caused by the chemical composition of the aluminum material or potential issues during installation. While the overall quality of material storage and handling met expectations, this issue highlights the importance of closely monitoring the environmental factors that may affect certain materials, such as aluminum, and taking corrective actions when required.

B. Bole Sub City Project Observation:

The Bole Sub City project is complete and has been handed over to the client. According to information from interviews and document review, construction materials were stored in a dedicated storage room. Exterior finishing materials were applied by foremen and laborers brought

by the contractor, who are experienced in other projects. Cranes machineries and scaffoldings were used during the cladding installation. However, challenges were encountered during the installation of marble cladding due to the heavy loads of the elements, compatibility of materials and technical detailing/grooving to attach the clad to the HCB plastering. Additionally, aluminum window frames showed signs of dampness, which might have been caused by the chemical composition of the aluminum, its physical characteristics (due to weathering), or installation problems.

4.3.5.2. Addis Ababa Housing Development corporation

During site observation and interview it is observed that both in the case of Bole Bulbula 40/60 and Arabsa 20/80 condominium housing projects, materials are stored in the delegated area unless they are issued for the purpose of ongoing task. This exterior finishing materials are applied by small enterprises (unemployed labor force) organized by government, had a short-term training prepared by their district's/ sub cities administration offices. Manual exterior plastering tools are widely used. Due to that challenges caused by unexperienced works different defects are seen on exterior and interiors of this housing project.

4.3.5.3. Ministry of health

Storage and application in the case of St Paul Hospital, materials are stored in the delegated area unless they are issued for the purpose of ongoing task. Exterior finishing is applied by Forman and labors brought by the contractor and are experienced in other projects. While in the St Peter general hospital project is complete and handed over to the client; According to the data from interview and document review, construction materials were stored in the dedicated storage room. Exterior finishing is applied by Forman and labors brought by the contractor and are experienced in other projects. However, to lack of attention for details in exterior construction is seen

4.3.5. QA Summery

AADCWB implements a multi-layered quality assurance (QA) system involving its design, contract administration, and audit teams. The audit department ensures that the design and contract award processes comply with Public Procurement Agency (PPA) standards, while the design and contract administration teams focus on verifying technical compliance with project specifications. Despite these structured processes, challenges persist, particularly in material storage and

application. Although strong QA practices are evident in cement storage and steel handling, gaps exist in processes like mortar mixing and drying of cement and paint, leading to potential defects. The QA framework includes pre-shipment quality checks and inspections, but inconsistencies in supervision and documentation limit its overall effectiveness.

AAHDC's quality assurance practices are less structured, with a significant focus on cost reduction rather than maintaining high-quality standards. The organization often relies on small enterprises for exterior finishing work, many of which lack the technical expertise required for consistent quality. While initial material samples undergo approval processes, continuous QA monitoring is weak, leading to discrepancies between approved samples and materials used on-site. Inspections primarily involve visual checks, and comprehensive testing is limited. The absence of clearly defined quality obligations in contract agreements and inadequate supervision during material application result in frequent defects, affecting the durability and aesthetics of exterior finishes.

MoH follows a decentralized quality assurance approach, with contractors taking primary responsibility for material selection and supply, while consultants and project managers oversee approval and compliance. QA protocols include pre-shipment quality checks, with materials tested by the Institute of Ethiopian Standards (IES) before bulk procurement. However, gaps exist in supervision and documentation, leading to inconsistencies in material quality. While samples are generally approved before delivery, tests at the commencement of material use are not standard practice, and comprehensive inspections are often lacking. These shortcomings in QA processes contribute to material defects and impact the long-term performance and safety of exterior finishes in MoH projects.

4.3.6. Quality assessment

Quality assessment of exterior finishing materials evaluates their performance, durability, and ability to meet project requirements over time. It examines how materials withstand wear, weathering, and degradation while maintaining their functionality and aesthetics. The assessment also identifies causes of quality issues, such as manufacturing inconsistencies or improper material selection, and explores their impact on long-term durability, maintenance costs, and project success. The goal is to provide insights for improving material choices and construction practices.

4.3.6.1. Causes of exterior finishing materials quality issues

Quality management of exterior finishing materials is crucial to the overall success of public construction projects, as these materials directly affect both aesthetics and durability. However, challenges such as poor funding, inadequate quality culture, and material inconsistencies often compromise the final outcome. Factors like design flaws, lack of proper supervision, and weak communication also contribute to the mismanagement of these materials. This section examines the common issues related to the use and application of exterior finishing materials in public construction projects. Addressing these challenges is vital for ensuring long-lasting, high-quality finishes that meet both design specifications and client expectations.

A. The case of the AADCWB project

AADCWB presents some of the most severe quality issues among the three organizations. Poor funding (93%), design flaws (89%), lack of quality culture (88%), and corruption (87%) significantly impact project outcomes. Material testing and sample approvals are performed before bulk procurement, but discrepancies between sample quality and bulk deliveries remain a persistent challenge, as reflected in 85% of the projects reviewed. Moreover, weak supervision (73%) and subcontractor inefficiencies (83%) compound the problem, reflecting inadequate oversight and lack of formalized subcontractor management systems. To address these issues, AADCWB requires improved contract enforcement, tighter supervision protocols, and better communication mechanisms.

Table 4.31 Causes of quality issues questionnaire result in the case of AADCWB

Description	Rate (%)
Poor funding	93
Lack of quality culture	88
Corruption	87

Description	Rate (%)
Design flaws	89
Poor material quality	86
Unqualified manpower	83
Subcontractor inefficiencies	83
Absence of formal quality management strategies	85
Weak communication	73
Weak supervision	73
Leadership and senior management involvement	59

B. The case of the AAHDC project

AAHDC faces the most widespread quality problems as seen on table 4.33, particularly in terms of supervision (80%), communication (79%), subcontractor inefficiencies (85%), and the absence of formal quality management strategies (88%). Poor funding (92%) and lack of quality culture (87%) further exacerbate the challenges. While sample testing and lab analyses are part of the project workflow, material compliance issues (83%) and changes in material sources highlight gaps in supply chain management and quality control. These results underscore the need for enhanced supervision, formal quality management systems, and improved coordination with subcontractors. Substandard communication channels and limited leadership involvement (58%) further hinder the ability to resolve these issues effectively.

Table 4.32 Causes of quality issues questionnaire result in the case of AAHDC

Description	Rate (%)
Poor funding	92
Lack of quality culture	87
Corruption	85
Design flaws	86
Poor material quality	84
Unqualified manpower	82
Subcontractor inefficiencies	85
Absence of formal quality management strategies	88
Weak communication	79
Weak supervision	80
Leadership and senior management involvement	58

C. The case of the MOH project

The findings from MOH indicate a comparatively better approach to quality management compared to the other two institutions. Although issues like poor funding (90%) and lack of a quality culture (85%) are significant, they are slightly less prevalent than in AADCWB and

AAHDC. The structured testing process, including sample approvals and lab tests, has contributed to a relatively better compliance rate with design specifications. However, problems like corruption (82%) and subcontractor inefficiencies (79%) suggest gaps in enforcement mechanisms and accountability. While MOH ensures materials undergo rigorous lab testing before bulk procurement, weak supervision (70%) and poor communication (72%) hinder the consistent implementation of quality standards. Addressing these issues would require strengthening project management and supervision practices.

Table 4.33 Causes of quality issues questionnaire result in the case of MOH

Description	Rate (%)
Poor funding	90
Lack of quality culture	85
Corruption	82
Design flaws	83
Poor material quality	80
Unqualified manpower	78
Subcontractor inefficiencies	79
Absence of formal quality management strategies	81
Weak communication	72
Weak supervision	70
Leadership and senior management involvement	58

4.3.6.2. Quality Problems on exterior finishing materials:

A. The case of AADCWB

In the case of the Bole Sub City Administration Building project, marble cladding and quartz paint were primarily used. Marble cladding was specified in the project's drawings, and laboratory tests were conducted according to the assurance checklist. However, during the exterior finishing process, the claddings began to fall off due to a lack of detailed material specifications, an inadequate inspection process, improper applicability, surface preparation, and construction technique (workmanship), which compromised the quality of the exterior wall. As a result, after the building was handed over to the end user in 2016, cladding defects became evident within one year of occupancy. The cladding was renovated two years after the project's completion. Out of the total 7,034 square meters of marble cladding, 580 square meters fell off and were replaced with seven-layer granite paint before the renovation.



Figure 4.12 Defects seen on Bole sub city administration building (B+ G+12)

In the case of the Children and Youth Theatre building, aluminum cladding exhibited signs of rusting and corrosion due to exposure to moisture, atmospheric humidity, expansion joints filling destruction, and falling off caused by fixing and joint imperfections. Dampness was also observed on the east-facing side of the building due to application gaps in the cladding.



Figure 4.13 Defects seen on children and youth theatre building

Table 4.34 Defects seen on stone facing exterior works (AADCW B)

Description	children and youth theatre building	Bole sub city Admin building
Defects seen on stone facing exterior works		
• Erosion and decomposition	O	O
• Deterioration	O	√
	√	O

Description	children and youth theatre building	Bole sub city Admin building
<ul style="list-style-type: none"> • Frost attack (freezes, expansion in size and creates cracks (frost penetration in pores) • Incorrect bedding • Salt crystallization • Expansion of metals and Wall tie failure • Organic growths • Incorrect pointing • Falling out of cladding 	<p style="text-align: center;">√</p> <p style="text-align: center;">○</p> <p style="text-align: center;">○</p> <p style="text-align: center;">○</p> <p style="text-align: center;">○</p> <p style="text-align: center;">○</p>	<p style="text-align: center;">√</p> <p style="text-align: center;">√</p> <p style="text-align: center;">○</p> <p style="text-align: center;">○</p> <p style="text-align: center;">√</p> <p style="text-align: center;">√</p>
Defects seen on exterior glazing works <ul style="list-style-type: none"> • Glass Breakages • Delamination of laminated glass (occurs where the bond provided by the interlayer between the glass layers is lost) • Movement and gaps (due to frame and size of glass) 	<p style="text-align: center;">○</p> <p style="text-align: center;">○</p> <p style="text-align: center;">○</p>	<p style="text-align: center;">○</p> <p style="text-align: center;">√</p> <p style="text-align: center;">√</p>
Defects seen on exterior metal frame and cladding <ul style="list-style-type: none"> • Rusting and corrosion: due to exposure to moisture, atmospheric humidity • Expansion joints filling destruction • Cracks • Falling off due to fixing and joint imperfections 	<p style="text-align: center;">√</p> <p style="text-align: center;">√</p> <p style="text-align: center;">○</p> <p style="text-align: center;">√</p>	<p style="text-align: center;">√</p> <p style="text-align: center;">○</p> <p style="text-align: center;">√</p> <p style="text-align: center;">√</p>

B. The case of AAHDC

Defects seen one year after completion and handover to end users on both Arabsa 20/80 and 40/60 condominium housing projects include incompatibility of paint with the backing material application of paint to damp surface to which moisture may have an access, effect of weather, poor workmanship, wavy plastering, Organic growth on walls facing misaligned downpipes (linkage), Erosion and decomposition, Deterioration, Organic growth. Defects seen on exterior glazing works, Glass crack and Breakages; Movement and gaps (due to frame and size of glass) and Defects seen on exterior metal frame Rusting and corrosion: due to exposure to moisture, atmospheric humidity; Expansion joints filling destruction, defectiveness of joint installation.



Figure 4.14 Defects seen on 20/80 condominium housing project

Case 3- Bole Bulbula 40/60 condominium housing project: According to observation on using paint render Incompatibility of paint with the backing material (ununiform color and texture), Application of paint to damp surface to which moisture may have an access, Effect of weather (Peeling of paint due to rain). defects on plastering include Wavy plastering, Incorrect bedding Expansion of metals and Wall tie failure Organic growths Organic growth on walls facing misaligned downpipes leakage). And Shortcomings observed on exterior glazing works are Glass crack and Breakages, Movement and gaps (due to frame and size of glass).



Figure 4.15 Defects seen on 40/60 condominium housing project

Table 4.35 Defects seen when using paint render on building exterior (AAHDC)

Defects seen when using paint render on building exterior	Arabsa 20/80 condominium	Arabsa 20/80 condominium
<ul style="list-style-type: none"> • Incompatibility of paint with the backing material • Application of paint to damp surface to which moisture may have an access • Effect of weather (peeling of paint) • Ununiform coloring 	√	√
Defects seen on plastering of exterior works <ul style="list-style-type: none"> • Erosion and decomposition • Deterioration • Wavy plastering, • Incorrect bedding • Expansion of metals and Wall tie failure • Organic growths Organic growth on walls facing misaligned downpipes (leakage) 	√	0
Defects seen on exterior glazing works <ul style="list-style-type: none"> • Glass crack and Breakages • Movement and gaps (due to frame and size of glass) • Rusting and corrosion: due to exposure to moisture, atmospheric humidity 	√	√

In the case of Addis Ababa Housing Development Corporation (AAHDC), the researcher has identified several defects in the *exterior finishes* of construction projects. The top five highly influential factors contributing to these quality problems are: *incompatibility of paint with the backing material*, which was observed in both the Arabsa 20/80 and 40/60 condominium housing projects, as well as the Bole Bulbula 40/60 condominium housing project. This incompatibility led to *ununiform coloring* and *texture*. The *application of paint to damp surface* was observed in the Bole Bulbula 40/60 condominium housing project, where paint was applied to a damp surface, allowing moisture access, which led to *peeling of paint* due to rain. *Poor workmanship*, including *wavy plastering* and *incorrect bedding*, was noted in the Bole Bulbula 40/60 condominium housing project. *Organic growth on walls* was observed in the Arabsa 20/80 condominium housing project, particularly on walls facing misaligned downpipes with *leakage*. Lastly, *defects in exterior glazing works*, such as *glass crack and breakages*, *movement and gaps* due to issues with the *frame* and

size of glass, and rusting and corrosion from exposure to moisture and atmospheric humidity, were observed in both the Arabsa 20/80 and 40/60 condominium housing projects.

C. The case of MoH

Case project 4: On the observation on the case of Application of paint to dump surface to which moisture may have an access, effect of weather (peeling of paint). Poor workmanship such as roof slop, coping and gutter line installation leading to paint discoloration due to rain, water penetration to internal wall causing dampness and growth of algae.

Flaws seen on window and glazing include crack and breakages of glasses, leakage due to inadequate sealant in metal windows and rusting and corrosion: due to exposure to moisture, atmospheric humidity to metal frames

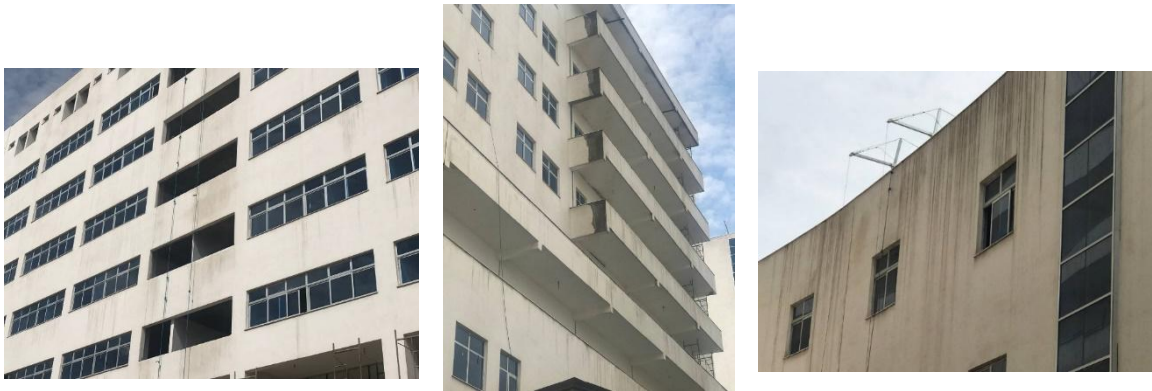


Figure 4.16 Defects seen on exterior finishes of St Paul millennium hospital (MoH)

Case project 5: Defects seen building's exterior includes Application of paint to dump surface to which moisture may have an access, Effect of weather (peeling of paint). Poor workmanship is observed on Roof slop, coping and gutter line installation leading to paint discoloration due to rain;



Figure 4.17 Defects seen on exterior finishes of St Peter hospital (MOH)

Water penetration to internal wall and growth of algae and Dampness. On Glass crack and Breakages, Inadequate sealant in metal windows was observed.

Table 4.36 defects seen when using paint on building exterior (MOH)

Description of defects seen when using paint on building exterior	St Paul millennium	St peter general
<ul style="list-style-type: none"> • Application of paint to damp surface to which moisture may have an access • Effect of weather (peeling of paint) 	√	0
Poor workmanship. <ul style="list-style-type: none"> • Roof slop, coping and gutter line installation leading to paint discoloration due to rain • Dampness • Water penetration to internal wall and growth of algae 	√	√
Defects seen on plastering of exterior works <ul style="list-style-type: none"> • Organic growth (walls facing misaligned downpipes, areas exposed to rain) • Undesired physical change • Aging and degrading • Cracks • falling out 	0	√
Defects seen on exterior glazing works <ul style="list-style-type: none"> • Glass crack and Breakages • Inadequate sealant in metal windows 	√	√
Defects seen on exterior metal frames <ul style="list-style-type: none"> • Rusting and corrosion: due to exposure to moisture, atmospheric humidity • Glass Breakages/ crack of glass 	0	√

the *quality assessment* at the Ministry of Health (MOH) has revealed several issues in the *exterior finishes* of two selected hospital construction project cases, St Paul Millennium Hospital and St Peter General Hospital. The top five highly influential factors contributing to these *quality problems* are: *application of paint to damp surface*, identified at St Paul Millennium Hospital, where painting on a damp surface exposed to moisture resulted in *peeling of paint* due to weather conditions. *Poor workmanship*, noted at both hospitals, including problems such as *incorrect roof slope, coping, and gutter line installation*, led to *paint discoloration* due to rain. Additionally, water infiltration into internal walls caused *dampness* and fostered the growth of algae. *Defects in plastering of exterior works* were observed at St Peter General Hospital, including *organic growth on walls* facing misaligned downpipes and areas exposed to rain, along with undesired *physical*

changes, aging, deterioration, cracks, and pieces falling off. *Defects in exterior glazing works*, such as *glass cracks and breakages* and inadequate *sealant* in metal windows, were noted in both hospitals. Lastly, *defects in exterior metal frames*, including *rusting* and *corrosion* due to exposure to moisture and atmospheric humidity, as well as *glass breakages* or cracks, were observed at St Peter General Hospital.

4.3.6.3. Impacts of quality problems.

A. The case of AADCWB

An interview, document review, and questionnaire results confirm that AADCWB faces several issues affecting project outcomes. Among the survey respondents, 47.6% reported instances of contract termination, while 52.4% highlighted the occurrence of claims. A notable 61.9% of respondents identified idle buildings as a result of repetitive maintenance, leading to a reduction in productivity, as indicated by 66.7% of participants. Additionally, 71.4% noted the occurrence of change orders, which in turn contributed to the extended construction periods, also reported by 71.4% of respondents. Customer dissatisfaction was observed by 81.0%, and 90.5% highlighted the low aesthetic value of some projects. The institute also faces high maintenance and operation costs (95.2%), alongside the financial burden of reworks (100%). These findings underscore the pressing need for more efficient project management strategies, better contract enforcement, and enhanced planning to minimize downtime due to maintenance and avoid costly reworks. Addressing these issues could help improve both the quality and timeliness of construction projects, ultimately leading to greater client satisfaction and reduced operational costs.

Table 4.37 Impacts of quality management problems questionnaire results (AADCWB)

Evaluated Parameters	Rate (%)
Contract termination	47.60
Occurrence of claims	52.40
Idle buildings due to repetitive maintenance	61.90
Reduction of productivity	66.70
Occurrence of change orders	71.40
Extended construction period	71.40
Customer dissatisfaction	81.00
Low aesthetic value	90.50
High maintenance and operation cost	95.20
High cost of reworks	100

B. The case of AAHDC

Based on the interview, document review, and questionnaire results, AAHDC is also struggling with various project challenges. Survey data indicates that 47.6% of respondents reported contract termination issues, while 52.4% confirmed the occurrence of claims. A significant 61.9% mentioned idle buildings due to repetitive maintenance, with 66.7% noting a decrease in productivity. Change orders, reported by 71.4% of the respondents, were also linked to extended construction periods, as confirmed by 71.4% of participants. The level of customer dissatisfaction reached 81.0%, while 90.5% identified a low aesthetic value of certain projects. Moreover, 95.2% of participants expressed concerns about high maintenance and operation costs, and 100% reported the high costs associated with reworks. These results suggest that, like AADCWB, AAHDC faces significant challenges in managing both operational efficiency and customer expectations. To address these, a focus on improved design, proactive maintenance strategies, and cost-effective construction practices would be essential to reduce downtime and customer dissatisfaction, as well as to optimize resources for more sustainable project outcomes.

Table 4.38 Impacts of quality management problems questionnaire results (AAHDC)

Evaluated Parameters/ Assessment Points	Rate (%)
Contract termination	47.60
Occurrence of claims	52.40
Idle buildings due to repetitive maintenance	61.90
Reduction of productivity	66.70
Occurrence of change orders	71.40
Extended construction period	71.40
Customer dissatisfaction	81.00
Low aesthetic value	90.50
High maintenance and operation cost	95.20
High cost of reworks	100

C. The case of MOH

The interview, document review, and questionnaire results reveal that the Ministry of Health (MOH) faces challenges that hinder the successful completion of construction projects. A substantial portion of the respondents, 47.6%, reported contract termination as a frequent issue, and 52.4% identified the occurrence of claims. Repetitive maintenance was also noted as a factor leading to idle buildings, with 61.9% of respondents confirming this. The reduction of productivity, which 66.7% of participants mentioned, was often linked to the occurrence of change

orders, as indicated by 71.4%. This, in turn, contributed to extended construction periods, as seen by 71.4% of the responses. Dissatisfaction among customers was particularly high at 81.0%, while low aesthetic value was a concern for 90.5% of the respondents. The high maintenance and operational costs (95.2%) and the 100% occurrence of high rework costs further underscore the challenges faced by the Ministry.

Table 4.39 Impacts of quality management problems questionnaire results (MOH)

Evaluated Parameters/ Assessment Points	Rate (%)
Contract termination	47.60
Occurrence of claims	52.40
Idle buildings due to repetitive maintenance	61.90
Reduction of productivity	66.70
Occurrence of change orders	71.40
Extended construction period	71.40
Customer dissatisfaction	81.00
Low aesthetic value	90.50
High maintenance and operation cost	95.20
High cost of reworks	100

Similar to AADCWB and AAHDC, the Ministry of Housing could benefit from a shift towards integrated project management practices that address design flaws early, streamline change order management, and invest in long-term asset maintenance strategies. By addressing these issues, the Ministry could reduce both costs and the negative impact on customer satisfaction.

Table 4.40 Defects, their causes and impacts of quality management problems conclusion.

<u>Defects</u>		<u>Causes</u>	<u>Impact</u>
<p><u>Cement render</u></p> <ul style="list-style-type: none"> • Undesired physical change • Aging and degrading • cracks • falling out <p><u>Rendered and painted wall</u></p> <ul style="list-style-type: none"> • Incompatibility of paint with the backing material (ununiform coloring) • Application of paint to damp surface to which moisture may have an access • Effect of weather • Poor workmanship <p><u>Brick</u></p> <ul style="list-style-type: none"> • Fretting/ Salt Attack • Black core • Efflorescence (moisture, water is absorbed and the alkalis crystalizes) • Checks or Cracks Spots (dark surface spots on the brick surfaces) <p><u>Stone</u></p> <ul style="list-style-type: none"> • erosion and decomposition • deterioration • frost attack • (frost penetration in pores) • incorrect bedding • salt crystallization • expansion of metals and wall tie failure • organic growths • incorrect pointing 	Quality Planning	<p><u>Causes</u></p> <ul style="list-style-type: none"> • Inappropriate organizational structure (doesn't promote quality management) • Shortage of capacity and commitment in reinforcing quality culture • Lack of senior management and leadership body commitment in monitoring and coordination to deliver quality projects • Absence of formal quality management implementation system, • Corruption • The participation of different small and micro enterprises in the project, • Lack of qualified trained/experienced manpower on the contractor side • Lack of qualified, trained/experienced manpower on the consultant side • Inappropriate relationship between the consultant and the contractor • Participation of incompetent contractors and consultants • Lack of professional's expertise on a specific project type. • Limited budget / poor funding • Limited time to complete the project, • Low unit price/cost of work items, • Inappropriate selection of exterior finishing materials. • Weather, ground condition and location of the projects • Design problems • Discrepancies between design and specification documents 	<p><u>Impact</u></p> <ul style="list-style-type: none"> • High cost of reworks, • High time consumption due to modification and rework. • High maintenance and operation cost, • Customer dissatisfaction, • Low aesthetic value, • Extended construction period, • less productivity, due to low construction quality. • Occurrence of change of order. • Occurrence of claims. • Contract termination. • Negative influence on Health and safety.

<ul style="list-style-type: none"> • falling out of cladding <p><u>Glass</u></p> <ul style="list-style-type: none"> • Glass Breakages/ crack • Delamination of laminated glass • Movement and gaps <p><u>Metal frame and cladding materials</u></p> <ul style="list-style-type: none"> • Metal Rusting and corrosion (due to water penetration and atmospheric humidity) • Expansion joints filling destruction • Cracks • Falling off due to fixing and joint imperfections 		<ul style="list-style-type: none"> • Unforeseen risk • Political interference • Lack of professional's expertise on a hospital project 	
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	Quality Control	<ul style="list-style-type: none"> • Absence of weekly/monthly supervision & quality control report • Lack of appropriate quality control in selection of supplier. • Inadequate quality caution in inspection of materials • Cost Escalation leading to lower quality of material than what is ordered • Poor quality of materials. • Lack of effective communication between stockholders • Lack of constant control during application • Lack of attention to detail during assembling (fitting and installation problems) • External plastering (out of date methods and tools) • Negligence • Inadequate number of professionals to control quality 	
	Quality Assurance	<ul style="list-style-type: none"> • Low rate of compensation for quality management personnel • Below standard subcontractors' work. • Unorganized quality control and assurance system (undocumented) 	
	Quality Improvement	<ul style="list-style-type: none"> • Unforeseen cost inflation during planning that results change of specifications. • Lack of audit and improvement policy • Focusing on profit rather than quality of the work. 	

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

Public construction projects in Addis Ababa showed substantial quality management practice deficiencies in exterior finishing materials through assessments of the AADCWB and AAHDC and MOH institutions. The extensive use of materials including marble, quartz paint, granite, aluminum and enamel paint resulted in multiple defects because of cracking, discoloration, corrosion and detachment. The material failures stemmed from inappropriate material selection and inadequate design details and weak implementation procedures. The fragmented procurement process together with weak organizational structures and insufficient quality documentation which included specifications and supervision checklists and approved test results contributed to these problems.

All three institutions demonstrated basic documentation and quality principle understanding yet they lacked formalized quality structures with engaged leadership at every level. Quality management policies remained unclear while limited enforcement capabilities resulted in regular discrepancies between approved samples and bulk material deliveries. The assessment revealed organizations paid insufficient attention to long-term material performance aspects including sustainability and safety together with compatibility. The reviewed project case studies revealed that quality issues intensified due to design execution failures combined with inadequate installer training which caused construction delays and increased costs and user dissatisfaction.

The quality assurance system faced continuous deterioration because of insufficient supervision and poor stakeholder communication and inadequate corrective action systems. Quality enforcement suffered because institutions depended on separate internal processes and isolated information sharing systems. Project performance suffered because of structural frameworks when quality management failed to integrate across all phases which led to inefficiencies and repeated maintenance and reduced exterior finish performance. The research shows that public sector construction projects need stronger leadership support combined with quality protocol integration to resolve the widespread problems.

5.2. Recommendation

This study on quality management practices for exterior finishing materials in Addis Ababa's public construction projects, involving key institutions such as AADCWB, AAHDC, and MOH, revealed critical gaps in quality systems. Challenges were identified in areas like cost estimation, planning communication, contract preparation, and resource allocation. While quality management efforts exist, improvements are needed to ensure materials and workmanship meet required standards, reducing defects and rework. Commonly used materials include marble, quartz, granite, and aluminum, whose selection should consider not only cost and aesthetics but also suitability for specific applications.

To improve quality management, the study recommends comprehensive quality planning from project inception through completion, supported by detailed manuals and clear design specifications. Enhanced communication between contractors, consultants, clients, and stakeholders is vital for better coordination and problem-solving. Enforcing stricter compliance for contractors and investing in training professionals involved in quality management will help achieve consistent quality outcomes. Additionally, continuous supervision, corrective actions, and quality assurance systems with performance measurement should be established to monitor and maintain finish quality effectively.

The study also suggests further research on the influence of design completeness on material quality, the role of design review during construction, and the use of scientific tools for quality control. Investigating the impact of installer and applicator skill levels on finishing quality will inform workforce training guidelines. Comparative analysis of quality assurance practices across different projects could identify best practices for standardizing quality management. These measures will contribute to improving the durability, aesthetics, and performance of exterior finishes in Addis Ababa's public buildings.

5.3. Guideline for improvement

	Guideline	Details/Actions
Quality Planning & Design Review	Comprehensive Quality Planning	Implement quality planning at the project's inception and continue through its lifecycle. Develop detailed quality management manuals and incorporate them into job descriptions. Ensure all designs and material specifications are accurate and complete before procurement.
	Design Review System	Establish a formal design review process to verify design completeness. Conduct design checks before material procurement to avoid design-related quality issues.
Communication & Coordination	Enhanced Communication Protocols	- Set up formal communication channels between contractors, consultants, and clients. - Schedule regular meetings to monitor project progress and resolve issues promptly. - Establish a feedback mechanism to address concerns efficiently.
Supervision & Quality Control	Stricter Supervision and Compliance Criteria	- Strengthen on-site supervision to ensure all tasks meet the required quality standards. - Implement stricter quality control measures for materials and workmanship. - Monitor subcontractors' performance and compliance with quality standards.
Professional Development & Training	Extensive Training and Guidelines	- Invest in professional development for staff involved in quality management. - Provide clear guidelines on quality control and quality assurance practices. - Offer training programs to enhance the skills of installers, painters, and plasterers, focusing on meeting material specifications and best practices.
Quality Assurance & Performance Measurement	Quality Assurance System	- Implement a formal quality assurance system to monitor project quality from start to finish. - Continuously supervise, measure performance, and implement corrective actions as needed. - Use quality performance metrics to identify and address issues proactively.
Ethical Practices & Contractor Selection	Stricter Oversight and Accountability	- Enforce transparency and ethical practices in project execution. - Ensure that contractors are selected based on competence and not through unethical practices. - Apply strict oversight to mitigate corruption and ensure adherence to quality standards.
Project Management & Time Planning	Proper Time Management and Resource Allocation	- Ensure project timelines are realistic and account for the necessary quality control stages. - Allocate appropriate financial resources to meet quality standards for exterior finishing materials. - Regularly adjust budgets to reflect actual costs for achieving quality outcomes.
Workmanship & Material Inspection	Strict Standards for Workmanship and Materials	- Conduct thorough inspections of key areas prone to defects, such as plastering, glazing, and paint application. - Enforce quality standards for both workmanship and exterior finishing materials. - Establish criteria for corrective actions in case of non-conformance to quality requirements.

REFERENCE

- ACHINTHA, M. 2016. Sustainability of glass in construction. *Sustainability of construction materials*. Elsevier.
- ADERIBIGBE, O. O. & OGUNMAKINDE, O. E. MATERIAL SELECTION FOR EXTERNAL FINISHES: A TOOL FOR SUSTAINABILITY IN SOUTH WEST NIGERIA.
- ADMASU, R. J. U. M. T., ADDS ABABA UNIVERSITY 2018. Urban Redevelopment Challenges in Addis Ababa City Administration: The Case of Kirkos Sub-city.
- ALARCON, L. & MARDONES, D. 1998. Improving the design-construction interface.
- ALKHAIAT, H. & FATTUHI, N. 1990. Evaluating building materials used in Kuwait. *Construction and Building Materials - CONSTR BUILD MATER*, 4, 32-36.
- ALREAD, J., LESLIE, T. & WHITEHEAD, R. 2014. Interior Finish Materials. *Design-Tech*. Routledge.
- ALSHAMRANI, O., MUJEEBU, M. A., ASHRAF, N., AL-GHONAMY, A. & AICHOUNI, M. 2017. Selection of External Wall Material by LCC Technique for Office-cum-Commercial Building in the Eastern Province of Saudi Arabia. *Journal of Architecture and Planning*, 29, 243-256.
- ARDITI, D., GUNAYDIN, H. M. J. J. O. C. E. & MANAGEMENT 1998. Factors that affect process quality in the life cycle of building projects. 124, 194-203.
- ARIZZI, A., VILES, H. & CULTRONE, G. 2012. Experimental testing of the durability of lime-based mortars used for rendering historic buildings. *Construction and Building Materials*, 28, 807-818.
- AWASHO, T. T. & ALEMU, S. K. 2023. Assessment of public building defects and maintenance practices: Cases in Mettu town, Ethiopia. *Heliyon*, 9, e15052.
- AWOL, A., ADUGNA, T. & MOSISA, A. 1948. Assessment on causes of defect and the maintenance management practices on low cost building (A case study of Jimma Town Condominium). *Human Rights*, 25, 1.
- AYALEW, T., DAKHLI, Z. & LAFHAJ, Z. 2016. Assessment on performance and challenges of Ethiopian construction industry. *Journal of Architecture and Civil Engineering*, 2, 01-11.
- BALA, K., KEFTIN, N., ADAMU, S. J. I. T. C. P., AREAS OF BUILDERS III. COUNCIL REGISTERED BUILDERS OF NIGERIA & PROGRAMME, N. I. O. B. M. C. P. D. 2012. Imperatives of Project Quality Management Plan and Health and Safety Plan as Pre-Contract Documents. 1-8.
- BEDRU, M. 2015. Study of Construction Defects in Public Building Projects in Addis Ababa (A Case study of Federal Government Office Building Projects). B.
- BEKELE, Z. G. 2021. *The Level of Building Color Harmonization Prospect in Addis Ababa*. Addis Ababa science and Technology University.
- BENATOR, B. & THUMANN, A. 2003. *Project Management & Leadership Skills for Engineering & Construction Projects*, CRC Press.
- BERHAN, E. & BESHAH, B. Key project planning processes affecting project success. *International Journal for Quality Research*, 11, 159-172.
- BERHE, L. & GIDEY, T. J. I. I. M. 2016. Assessing the awareness and usage of quality control tools with emphasis to statistical process control (SPC) in Ethiopian manufacturing industries. 8, 143.
- BOARD, C. I. T. 2016. UK industry performance report based on the UK construction industry key performance indicators. *Watford, UK: Construction Industry Training Board*.
- BRIFFETT, C. 1995. *Building maintenance technology in tropical climates*, NUS Press.

- CHATURVEDI, R., DAROKAR, H., PATIL, P., KUMAR, M., SANGEETA, K., KOITHYAR, A. & KADHIM, A. 2023. Maximizing towards the Sustainability: Integrating Materials, Energy, and Resource Efficiency in revolutionizing Manufacturing Industry. *E3S Web of Conferences*, 453.
- CHERENET, Z. & SEWNET, H. 2012. Building Ethiopia. EiABC.
- CHEW, M. 2022. Grading maintainability parameters for sanitary plumbing system for high-rise residential buildings.
- CHING, F. D. 2019. *Building construction illustrated*, John Wiley & Sons.
- CHRISTOPHER, M. & PECK, H. 2004a. Building the Resilient Supply Chain. *The International Journal of Logistics Management*, 15, 1-14.
- CHRISTOPHER, M. & PECK, H. 2004b. Building the resilient supply chain.
- CIANFRANI, C. A. & WEST, J. 2009. *Cracking the Case of ISO 9001: 2008 for Service: A Simple Guide to Implementing Quality Management in Service Organizations*, Quality Press.
- COHENDET, P., LEDOUX, M. J. & ZUSCOVITCH, E. 1988. Structural Materials and Functional Materials. In: COHENDET, P., LEDOUX, M. J. & ZUSCOVITCH, E. (eds.) *New Advanced Materials: Economic Dynamics and European Strategy A Report from the FAST Programme of the Commission of the European Communities*. Berlin, Heidelberg: Springer Berlin Heidelberg.
- CRESWELL, J. W. & CRESWELL, J. D. 1994. Research design. Thousand Oaks, CA: Sage.
- CROSBY, P. B. 2005. Crosby's 14 steps to improvement. *Quality Progress*, 38, 60-64.
- CUNNINGHAM, T. 2013. Factors affecting the cost of building work-an overview.
- DABOK, M. M. 2022. A Training and Skills Development Conceptual Framework for Construction Technicians in Nigeria.
- DAS, S., CHEW, M., POH, K. L. J. C. M. & ECONOMICS 2010. Multi-criteria decision analysis in building maintainability using analytical hierarchy process. 28, 1043-1056.
- DASUKI, M. K. B. M. & MALAYSIA, U. U. 2015. MANAGING QUALITY MANAGEMENT PROCESSES IN A NAVAL SHIP CONSTRUCTION COMPANY: A QUALITATIVE CASE ANALYSIS.
- DE SILVA, N., DULAIMI, M., LING, F. & OFORI, G. 2004. Improving the maintainability of buildings in Singapore. *Building and Environment*, 39, 1243-1251.
- DIYANA, N. & KASIM, M. Y. Building defect : case study at Taman Seri Indah , Pulau Pinang. 2009.
- DUGGAL, S. K. 2007. *Earthquake resistant design of structures*, Oxford university press New Delhi.
- DUGGAL, S. K. 2017. *Building materials*, Routledge.
- ELMAGHRABY, S. 1989. Managing Quality, By David A. Garvin. *Iie Transactions*,
- FINDLAY, A. M. & LI, F. 1999. Methodological issues in researching migration. *The Professional Geographer*, 51, 50-59.
- FISSEHA, A. 2021. Assessment Of Quality Management Practices Of Grade One Building Contractors In Addis Ababa.
- FOLORUNSO, C., AKINGBOHUNGBE, D., OGUNRUKU, M. J. I. J. O. R. I. E. & SCIENCES, S. 2017a. Choice prediction factors in building exterior finishes' selection in Lagos, Nigeria: clients' perspective. 7, 14-20.
- FOLORUNSO, C. O., AKINGBOHUNGBE, D. O. & OGUNRUKU, M. P. 2017b. Choice prediction factors in building exterior finishes' selection in Lagos, Nigeria: clients'

- perspective. *International Journal of Research in Engineering and Social Sciences*, 7, 14-20.
- FONSECA, L. M. ISO 9001: 2015 Revision. Proceedings of the 1st International Conference on Quality Engineering and Management, 2014. 391-400.
- FONSECA, L. M. J. C. 2015. ISO 9001 quality management systems through the lens of organizational culture. 16, 54.
- FREEMAN, R. E. 2010. *Strategic management: A stakeholder approach*, Cambridge university press.
- GARVIN, D. J. H. B. R. 1987. Competing on the eight dimensions of quality.
- GELETU, N. 2020. FACTORS AFFECTING QUALITY OF CONSTRUCTION PROJECTS: IN THE CASE OF SELECTED BUILDING CONSTRUCTION INDUSTRIES IN ADDIS ABABA, ETHIOPIA.
- GUAN, Y. & CHEUNG, K.-S. J. B. 2023. The Costs of Construction and Housing Prices: A Full-Cost Pricing or Tendering Theory? 13, 1877.
- HARRIS, F., MCCAFFER, R., BALDWIN, A. & EDUM-FOTWE, F. 2021. *Modern construction management*, John Wiley & Sons.
- HAYWARD, E., IBE, C., YOUNG, J. H., POTTI, K., JONES, P., POLLACK, C. E. & GUDZUNE, K. A. 2015. Linking social and built environmental factors to the health of public housing residents: a focus group study. *BMC Public Health*, 15, 351.
- HERZOG, T., KRIPPNER, R. & LANG, W. 2004. *Facade Construction Manual*, Birkhäuser.
- HO, D., LO, S. M., YIU, E. & YAU, L. M. 2004. A survey of materials used in external wall finishes in Hong Kong. *Hong Kong Surveyors*, 15, 7-11.
- HRBÁČKOVÁ, L. & TUČEK, D. 2019. An analysis of two new process approach-related terms in ISO 9001: 2015: risk-based thinking and context of the organization.
- HUANG, Q. & HASEEB, M. 2013. Construction analysis based on total quality management and six sigma methodologies. *African Journal of Business Management*, 7, 2757-2766.
- ILLSTON, J. M. & DOMONE, P. 2001. *Construction materials: their nature and behaviour*, CRC press.
- ISHAK, S. N. H., CHOCHAN, A. H. & RAMLY, A. J. J. O. B. A. 2007. Implications of design deficiency on building maintenance at post-occupational stage. 3, 115-124.
- JOHNSON, B. & TURNER, L. A. 2003. Data collection strategies in mixed methods research. *Handbook of mixed methods in social and behavioral research*, 297-319.
- JURAN, J. M. 1992. *Juran on quality by design: the new steps for planning quality into goods and services*, Simon and Schuster.
- KABIR, S. M. 2016. METHODS OF DATA COLLECTION.
- KANNIYAPAN, G., MOHAMMAD, I. S., JAWAHAR NESAN, L., MOHAMMED, A. H. & GANISEN, S. 2015. FAÇADE MATERIAL SELECTION CRITERIA FOR OPTIMISING BUILDING MAINTAINABILITY. *Jurnal Teknologi*, 75.
- KANNIYAPAN, G., NESAN, L., MOHAMMAD, I., TAN, S. & PONNIAH, V. 2019. Selection criteria of building material for optimising maintainability. *Construction and Building Materials*, 221, 651-660.
- KOCA, G. 2016. Interior Finishing Materials.
- KOSKELA, L. 1997. Lean production in construction. *Lean Construction*.
- KOTHARI, C. R. 2004. *Research methodology: Methods and techniques*, New Age International.
- KULTERMANN, E. & SPENCE, W. P. 2021. *CONSTRUCTION MATERIALS, METHODS AND TECHNIQUES*, Cengage Learning.

- LYNCH, E. J. A. R. C. O. C. A. H. E. & BUILDERS, H. P. N. A. O. H. 2023. Cost of Constructing a Home-2022.
- MANE, P. P. & PATIL, J. R. Quality management system at construction projects. Proceedings of the Civil Engineering PG Conference-2015, 2015. 24.
- MANGHANI, K. 2011. Quality assurance: Importance of systems and standard operating procedures. *Perspectives in clinical research*, 2, 34.
- MIRESSA, A. 2017. ASSESSMENT OF QUALITY MANAGEMENT PRACTICES OF HOSPITAL CONSTRUCTION PROJECTS IN OROMIA.
- MOAVENZADEH, F. & ROSSOW, J. A. K. 1975. <THE CONSTRUCTION INDUSTRY IN DEVELOPING COUNTRIES.pdf>. *TECHNOLOGY ADAPTATION PROGRAM*, 374, 374.
- MONCZKA, R. M., HANDFIELD, R. B., GIUNIPERO, L. C., & PATTERSON, J. L. . (2016). *Purchasing and supply chain management*. .
- MUGO, F. W. 2002. Sampling in research.
- MWESIGWA, R., NTAYI, J., BAGIRE, V. & MUNENE, J. 2018. Stakeholder behavior, relationship building practices and stakeholder management in Public Private Partnership Projects in Uganda. 14, 1-21.
- NAOUM, S. G. 2012. *Dissertation research and writing for construction students*, Routledge.
- NATARAJAN, D. 2017. *ISO 9001 Quality management systems*, Springer.
- NYOMEK, L. J. U. M. T., UNIVERSITY OF TECHNOLOGY, MALAYSIA 2010. The integration of quality management system in construction industry.
- O'BRIEN, J. J. 2013. *Construction inspection handbook: Quality assurance/quality control*, Springer Science & Business Media.
- OGUNLANA, S. O. J. I. J. O. P. M. 2010. Beyond the 'iron triangle': Stakeholder perception of key performance indicators (KPIs) for large-scale public sector development projects. 28, 228-236.
- OGUNSOTE, O. & PRUCNAL-OGUNSOTE, B. 2015. Optimization of Choice of External Finishes and Roofing of Buildings in Nigerian Universities. *Nigerian Institute of Architects Journal*, 1&2.
- OLUWOLE, F. C. 2014. Building Exterior Paint Performance in Tropical Salty Environment of Lagos.
- ORJI, S., OBODOH, D. A. & FELIX EMENIKE, O. 2019. QUALITY MANAGEMENT PRACTICES IN CONSTRUCTION; A KEY TO SUCCESSFUL BUILDING PROJECT DELIVERY. *Imperial Journal of Interdisciplinary Research (IJIR)*, 2, 531-538.
- PARK, K. 2009. Whole Life Performance Assessment: Critical Success Factors. *Journal of construction engineering and management*, 135.
- QI, J., MAZUMDAR, S. & VASCONCELOS, A. C. 2024. Understanding the Relationship between Urban Public Space and Social Cohesion: A Systematic Review. *International Journal of Community Well-Being*, 7, 155-212.
- REEVES, C. A. & BEDNAR, D. A. 1994. Defining Quality: Alternatives and Implications. *The Academy of Management Review*, 19, 419-445.
- RICH, P. & DEAN, Y. 2012. *Principles of element design*, Routledge.
- RUMANE, A. R. 2017. *Quality management in construction projects*, CRC press.
- SAHELU, M. 2015. Building Maintenance Management Practices in Public Hospitals Of Addis Ababa.

- ŠAPARAUSKAS, J., KAZIMIERAS ZAVADSKAS, E. & TURSKIS, Z. J. I. J. O. S. P. M. 2011. Selection of facade's alternatives of commercial and public buildings based on multiple criteria. 15, 189-203.
- SATTERFIELD, Z. J. O. T. 2005. Quality control in construction projects. 5.
- SHAHRAKI, S., SAGHATFOROUSH, E., RAVASAN, A. J. J. O. E., PROJECT & MANAGEMENT, P. 2018. Identification and Classification of Factors Affecting the Performance of Building Supervisor Engineers for Construction Industry. 8.
- SIBIYA, M., AIGBAVBOA, C. & THWALA, W. 2015. Construction projects' key performance indicators: a case of the South African construction industry. *ICCREM 2015*.
- SIEGESMUND, S. & TÖRÖK, Á. 2010. Building stones. *Stone in architecture: properties, durability*. Springer.
- SOM, R. K. 1995. *Practical sampling techniques*, CRC press.
- SONG, S.-H., LEE, H.-S. & PARK, M. 2004. Development of quality performance indicators for quality management in construction projects. *Dept. of Architecture, Seoul National University*, 310-320.
- STUKHART, G. J. J. O. P. O. C. F. 1989. Construction materials quality management. 3, 100-112.
- TAKIM, R. & AKINTOYE, A. Performance indicators for successful construction project performance. 18th Annual ARCOM Conference, 2002. 545-55.
- TAYLOR, H. 2014. Cost of constructing a home. *HousingEconomics.com*.
- THISSE, L. C. J. Q. P. 1998. Advanced quality planning: A guide for any organization. 31, 73-77.
- TISHLER, A., DVIR, D., SHENHAR, A. & LIPOVETSKY, S. 1996. Identifying critical success factors in defense development projects: A multivariate analysis. *Technological Forecasting and Social Change*, 51, 151-171.
- TORGAL, F. P. & JALALI, S. 2011. *Eco-efficient Construction and Building Materials*, Springer London.
- TUHUS-DUBROW, D., KRARTI, M. J. B. & ENVIRONMENT 2010. Genetic-algorithm based approach to optimize building envelope design for residential buildings. 45, 1574-1581.
- VARGHESE, P. 2015. *Building materials*, PHI Learning Pvt. Ltd.
- WATT, A. 2014. 14. Quality Planning. *Project Management*.
- WAWAK, S., LJEVO, Ž. & VUKOMANOVIĆ, M. 2020. Understanding the Key Quality Factors in Construction Projects—A Systematic Literature Review. 12, 10376.
- WAZIRI, B. S. 2016. Design and construction defects influencing residential building maintenance in Nigeria. *Jordan Journal of Civil Engineering*, 10.
- WIDJAJA, S. & DARMAWAN, B. 2022. Importance of Supplier Quality and Supplier Relationship Quality in Supply Chain. *Journal of Logistics and Supply Chain*, 2, 41-48.
- YACOB, S., ALI, A. S., AU-YONG, C. P., YACOB, S., ALI, A. S. & AU-YONG, C. P. J. M. B. D. P. M. F. P. S. I. D. C. 2022. An Overview and Understanding the Building Deterioration. 11-40.
- YIRGALEM, D. & ABDULKADIR, E. 2019. Assessment of building construction defect causes in North Shoa zone, Ethiopia. *Journal of Civil Engineering and Construction Technology*, 10, 1-11.
- ZEGEYE, A., WORKU, A., TEFERA, D., GETU, M. & SILESHI, Y. 2009. Introduction to Research Methods: Preparatory Module for Addis Ababa University graduate programs. *Unpublished. Graduate Studies and Research Office Addis Ababa University*.
- ZHANG, H. 2011. *Building materials in civil engineering*, Elsevier.

ZUNGUZANE, N., SMALLWOOD, J. & EMUZE, F. 2012. Perceptions of the quality of low-income houses in South Africa: Defects and their cause. *Acta Structilia: Journal for the Physical and Development Sciences*, 19, 19-38.

ZWIKAEEL, O. J. C. I. 2009. Critical planning processes in construction projects. 9, 372-387.

Appendix 1: Questionnaire survey

**Ethiopian Institute of Architecture, Building Construction, and
City Development, (EiABC), Addis Ababa University**

**Department of Construction Management (School of
Graduates)**



Dear participants

This questionnaire is a survey prepared by a post graduate student in (MSc in construction management) for conducting thesis on **“Assessing quality management practices of selected wall exterior finishing materials” under the supervision of Tadesse Ayalew (PhD).**

The questionnaire is developed to assess the current practice of quality management of exterior wall finishing materials in case of public owned project in Addis Ababa. The aim is to identify the commonly used exterior wall finishing materials, assess the quality planning, control and assurance process, identify factors affecting quality of exterior finishing materials/ finishes and identify and describe the Key Performance Indicators (KPIs) based on the finding of the study.

Filling out the questionnaires will take approximately 10 (ten) minutes. The responses that you fill out on this questionnaire will be kept confidential and will only be used for academic and research purposes.

Thank you for your invaluable time and cooperation.

With regards

Hawi Bogale (Researcher)

General direction

Please consider each question in terms of your organization's experience and/or your professional experience in general. Please indicate your responses by **ticking (X or √)** mark at the appropriate box/es or by filling the blank spaces provided.

Section I: Respondents' professional & educational background assessment

1. Profession

Architects Civil engineers Electrical engineers
Quantity surveyors Forman Quality supervisor
Mechanical engineers Project manager Water /Sanitary engineer
If other (please specify) _____

2. Education qualification:

Level –III Level- IV Diploma
Degree Postgraduate Others _____

3. Company category

Contractor Consultant Research institute
Government Bureau/permitting agency If other please specify _____

4. Your position in the company _____

5. Years of experience working in Construction projects

0 – 5 (years) 11 - 15 (years)
6 - 10 (years) 16 – 20 (years)
Above 20

6. Years of experience working in a works associated with exterior finish and materials.

0 – 5 (years) 11 - 15 (years)
6 - 10 (years) 16 – 20 (years)
Above 20

7. At which stage of project are you involved in?

Planning Design
Construction Post construction
Specify (if other) _____

Section II: About materials used for exterior finish and factors affecting the selection in Addis Ababa Design and Construction Works Bureau

Please, indicate your opinion by marking (✓ or X) the appropriate box on the five point scale where: **Strongly Disagree (1), Disagree (2), No opinion (3), Agree (4), Strongly Agree (5).**

1.	What is the most used finishing material for exterior use for projects in Addis Ababa design and construction bureau?	1	2	3	4	5
	1.1.Earth based finishing materials					
a	Ceramic					
b	Porcelain					
c	Brick					
Please specify reason (if any) _____						
	1.2.Stone based materials					
a	Granite					
b	Marble					
c	Limestone					
d	Sandstone					
e	Quartzite					
f	If other, Please specify type (e.g. Block, slab, tile) _____					
Please specify reason (if any) _____						
	1.3.Renders					
a	Cement/ Mortar render					
b	Polymer rendering					
c	Acrylic rendering					
	1.4.Paint					
a	Quartz					
b	Emulsion paint					
c	Oil paint					
d	Enamel Paint					
Please specify type _____						
Please specify reason (if any) _____						
	1.5.Metal					
a	Cast iron (Ferrous materials)					
b	Wrought iron (Ferrous materials)					
c	Steel (Ferrous materials)					
d	Aluminum (Non-ferrous materials)					
e	Copper (Non-ferrous materials)					
f	Zinc (Non-ferrous materials)					
g	Lead and tin (Non-ferrous materials)					
Please Specify reason (if any) _____						
	1.6.Glass					
a	Insulating flat glass, toughened safety					
b	Laminated safety glazing.					

c	Block glass					
Please specify type _____						
Please Specify reason (if any) _____						
2	What are the factors to be considered during selection of exterior material selection in design stage?					
2.1	Durability (ability of a material to perform its functions and requires a minimum cost for maintenance and operation throughout its life cycle)					
2.2	Cleanability (ability to be cleaned easily and be dirt free)					
2.3	Material sustainability (energy conservation in manufacturing health hazards, global environmental hazards, and recyclable of the material)					
2.4	Compatibility and Suitability (integration with its adjacent materials in a system with less modification and less conversions)					
2.5	Health and safety (weight and chemical content)					
2.6	Material economy (initial and lifetime cost)					
2.7	Material Availability (availability locally and easy to obtain during repair and replacement work)					
2.8	Functional Performance (behavior of materials to perform up to the best of their capability with minimum defects)					
2.9	Thermal performance (performance when exposed to thermal loads and humidity)					
2.10	Acoustic (The acoustical façade load that concern the sound pressure level at the outside of the building also determining interior sound pressure levels)					
	Are you aware of physical and mechanical properties of used materials used as building exterior finish? Please specify that you are aware of _____ _____					
3	After materials are selected during testing, what properties are given attention the most?					
3.1	Physical properties					
a	Density (dry mass per unit volume of a substance under absolute compact)					
b	Porosity (the degree to which volume of the material is interspersed with pores)					
c	Water Absorption (Weather resistance, water permeability and frost resistance)					

d	Thermal property (Heat conductivity, thermal capacity, fire resistance, refractoriness)					
e	Chemical Resistance (ability of a material to withstand the action of acids, alkalis, seawater and gases)					
3.2	Mechanical properties					
a	Strength (ability of the material to resist failure under the action of stresses)					
b	Hardness (ability of a material to resist penetration by a harder body)					
c	Elasticity (Elasticity is the ability of a material to restore its initial form and dimensions after the load is removed)					
d	Plasticity (Plasticity is the ability of a material to change its shape under load without cracking)					
e	Brittleness (property of a material that fractures when subjected to stress but has a little tendency to deform before rupture)					
f	Toughness (ability to absorb much energy and deform greatly without rupture)					
5	In your organization: the construction process, materials stored and used	1	2	3	4	5
a	Cement is fresh (less than month from date of manufacture)					
b	Cement stored in stacks less than 10 bags height over a raised (>20cm)					
c	Steel and aluminium frame and cladding elements used for the project are free of corrosion					
d	Steel and aluminium frame and cladding elements are stored in clean condition					
e	Render/ Mortar were mixed as per the mix design The workability of mortar is as per slump test result					
f	Appropriate material transportation method is used to minimize segregation					
g	Cement and paint is dried as per the requirement on the specification					
h	Proper application and fixing technique and machines has been adopted					

i	Glasses are stored in dry and clean space, safe from scratch and pressure					
j	Porcelain, ceramic and bricks are stored in dry and clean space					
4	Wall exterior material quality management related	1	2	3	4	5
4.1	Construction material test results and samples are presented to the consulting engineer for approval before bulk purchase					
4.2	There are clearly stated quality tests obligations in your organization contract agreement for					
4.4	Material sample is supplied to the consulting Engineer for approval before bulk delivery to the project site					
4.3	Test at commencement of materials are done in your organization.					
4.4	Are the tests in your organizations carried out under the supervision and with the approval of the Resident Engineer					
4.5	Materials delivered to construction projects comply the contract specification and quality requirements					
4.5	Test of materials are done when change of source is observed for					

Section III: Application of quality management practice and defects seen on past projects.

Part 1- Specific issues related to application of quality management of exterior building

Please (√ or X) mark your opinion on the appropriate box 1=Disagree, 2=No opinion, 3=Agree

1	Is your organization aware of the following quality management process?	1	2	3	4	5
a	Quality planning					
b	Quality control					
c	Quality assurance					
d	Quality improvement					
e	Quality management policy					
2	An entity employed in your organization comply the contract agreement					
a	Contractors key personnel					
b	Consultant key personnel					
c	Client key personnel					
d	Construction Small & Micro Enterprises					
e	Production Small & Micro Enterprises					
3	The consulting firm has	1	2	3	4	5
a	The required acceptance criteria for construction materials					

b	The required acceptance criteria for works under construction					
c	Trained key personnel in quality management					
d	Experienced and competent key personnel in quality management					
e	The required skill to read, interpret designs and specification					
f	Key personnel to communicate verbal or in writing					
g	Qualified quality control personnel to perform their assigned duties					
h	Motivated personnel to insure conformance/compliance of works					
i	Favorable organizational structure for quality management					
j	Production quality control Engineers which fulfill minimum requirements					
k	Committed supervisors to reject inferior quality materials/works ethically					
l	A power/practice to reject inferior quality materials delivered by the client					
m	Free flow of quality management information					
n	Supervisors follow clearly stated acceptance criteria for installed finishing materials					
4	The contractor has	1	2	3	4	5
a	Key personnel complying the contract agreement requirement					
b	Trained key personnel in quality management					
c	Experienced key personnel in quality management					
d	The required skill to read, interpret designs and specification					
e	Key personnel to communicate verbal or in writing					
f	Qualified quality control personnel to perform their assigned duties					
g	Motivated personnel to insure conformance/compliance of works					
h	Favorable organizational structure for quality management					
i	Commitment to remove inferior quality materials/works rejected by the supervisor					
j	A power/practice to reject inferior quality materials delivered by the client					
k	Key personnel from commencement to provisional acceptance of the project					
5	Client Related	1	2	3	4	5
a	Top managers have awareness and sound control of quality					

b	Top managers in your organization play a leadership role in quality management initiatives					
c	The organization practices a proper quality management technique					
d	The organization has a formal quality management structure					
e	Employees in this company are empowered on quality management perspectives					
f	there is free flow of quality management information					
g	The organization has quality mission and policies					
6	Are there quality management related documents in your organization?	1	2	3	4	5
a	Clear quality management /quality control manuals					
b	Easily available quality management manuals in Addis Ababa Design and construction works bureau					
c	Clearly stated construction material specifications					
d	Complete and clear construction designs					
e	Clearly stated specification of works					
f	Supervision check lists for construction works					
g	Production check lists for building exterior work					
h	Clearly stated site book or resident Engineer observation records					
i	Contract document which clarifies quality management techniques					
j	Properly endorsed quality control test results by the Engineer					
7	Causes of Poor Quality Management	1	2	3	4	5
a	The ground conditions and the land where projects are executed					
b	Lack of effective communication between stockholders					
c	Lack of qualified, trained/experienced manpower on the contractor side					
d	Lack of qualified, trained/experienced manpower on the consultant side					
e	Inappropriate relationship between the consultant and the contractor					
f	Limited cost or poor funding					
g	Limited time to complete the project.					
h	Labors employed are contributors to poor quality projects delivery					
j	Lack of senior management body commitment to deliver quality projects					
k	Lack of capacity in reinforcing quality culture					

l	Absence of formal quality management implementation strategies					
m	Lack of leadership involvement in monitoring and coordinating					
n	Inappropriate organizational structure					
o	Corruption					
p	Participation of incompetent contractors					
q	Design problems					
r	Absence of weekly/monthly supervision & quality control report					
s	The participation of different small and micro enterprises in the project					
t	Low unit price/cost of work items					
w	Extended construction period of the project					
x	Problems with subcontractors' work					
y	Low rate of salary for quality management personnel					
z	Poor quality of materials					
8	In your opinion or practice, who is the cause of most quality problems in public projects in your organization	1	2	3	4	5
a	Client					
b	Contractor					
c	Consultant					
d	Electrical, Sanitary, metal work small and micro enterprise					
e	Production small and micro enterprise					

Part 2 - Defects seen on exterior buildings on constructed buildings

1	What are the defects seen when using cement render on building exterior?	1	2	3	4	5
1.1	Undesired physical change due to the presence of water/humidity (from soil, construction works, precipitation, condensation, accidental causes etc)					
1.2	Ageing and degradation					
a	Continuous exposure in the environment					
b	Inadequate use or absence of maintenance procedures					
1.3	Cracks					
a	Excessive moisture in the background					
b	Excessive thermal changes either in the background or in plaster itself					
c	Rapid drying					
d	Insufficient drying between each coat of plaster					
1.4	Falling out					
a	Excessive moisture in the background					

b	Excessive thermal changes either in the background or in plaster itself,					
c	Rapid drying					
d	Insufficient drying between each coat of plaster					
Note: Please underline the reasons you agree on from the choices in the bracket. If you agree more than one, you can underline on each you agree on.						
2	Causes of defects seen on exterior building wall of a building/materials related					
2.1	What are the defects seen when using paint render on building exterior?	1	2	3	4	5
a	Incompatibility of paint with the backing material					
b	Application of paint to damp surface to which moisture may have an access					
c	Effect of weather					
d	Poor workmanship					
2.2	What are the defects seen when using Brick render on building exterior?					
a	Fretting/ Salt Attack (due to salt presence/ water penetration into pores)					
b	Black core (improper burning, existence of bituminous matter or carbon)					
c	Efflorescence (moisture, water is absorbed and the alkalis crystalizes)					
d	Checks or Cracks (when there is a contact with water, expansion of brick and consequent disintegration)					
e	Spots (dark surface spots on the brick surfaces)					
2.3	Defects seen on stone facing exterior works					
a	Erosion and decomposition					
b	Deterioration					
c	Frost attack (freezes, expansion in size and creates cracks (frost penetration in pores)					
d	Incorrect bedding					
e	Salt crystallization					
f	Expansion of metals and Wall tie failure					
g	Organic growths					
h	Incorrect pointing					
i	Falling out of cladding					
2.4	Defects seen on exterior glazing works					
a	Glass Breakages					
b	Delamination of laminated glass (occurs where the bond provided by the interlayer between the glass layers is lost)					
c	Movement and gaps (due to frame and size of glass)					
2.5	Defects seen on exterior metal frame and cladding					

a	Rusting and corrosion: due to exposure to moisture, atmospheric humidity					
b	Expansion joints filling destruction					
c	Cracks					
d	Falling off due to fixing and joint imperfections.					
	Please specify if there are other problematic issues related to quality management in your organization.					

Section IV: General assessment from the professional's perspective and feedback.

Part 1- General assessment from the professional's perspective

1	Organization, professional and quality performance					
1.1	How does projects promote quality management	1	2	3	4	5
a	Through continuous supervision					
b	Through quality performance measurement					
c	Using feedback if performance measurements undertaken					
d	By implementing quality assurance system					
e	Through training					
f	Using preventive action					
g	Using corrective action					
h	By termination /punishment					
	Specify (If other) _____					
1.2	How do you rate the impact of quality management problem in your organization?	1	2	3	4	5
a	High cost of reworks					
b	High maintenance and operation cost					
c	Idle buildings due to repetitive maintenance					
d	Customer dissatisfaction					
e	Contract termination					
f	Low aesthetic value					
g	Extended construction period					
h	Occurrence of claims					
i	Occurrence of change of order					
j	Reduction of productivity					
	Please Specify (If other) _____					
1.3	How do you track and measure the organization's quality management practice (related to exterior wall finishing materials)	1	2	3	4	5
a	Time (Project, design, construction)					
b	Cost (Project, design, construction)					

c	Project management					
d	Material (ordering, handling and management)					
e	Defect					
f	Quality assurance (inspections)					
g	Client satisfaction (product)					
h	Client satisfaction (Service)					
i	Health and Safety					
j	Time predictability (project, design, construction)					
k	Cost predictability (project, design, construction)					
l	Productivity					
m	Procurement					
n	Human resource management					
o	profitability					
1.4	How do you categorize Key Performances Indicators (KPIs) of Quality management for the use of analysis and base of improvement	1	2	3	4	5
a	Economic, Respect for people, Environmental					
b	On level of management (Strategic management, Project management level, Operational management level)					
c	Compering contract document (estimated /actual delivery)					
d	Stage of the project					
	Please specify if other _____					

Part 2- personal professional Feedback related

1. Are you interested to get feedback about the quality of your work?

Yes No

2. Have anyone ever gave you a feedback concerning the quality of your work?

Yes No

3. Who did gave you a feedback concerning the quality of your work?

Client Contractor Consultant
Occupants Small & Micro enterprises

4. How did you consider the feedback given to you concerning the quality of work?

Constructive Destructive Neither

5. What is your view on the quality of exterior finishing works on completed projects under your organization?

Poor quality. Unsatisfactory quality.

Satisfactory quality Good quality Exceptional quality

6. Your work in **your organization** mostly based on

The contract agreement personal knowledge/ opinion

No opinion

What do you recommend to improve the quality of the projects under construction in organization? please state your opinion

Please kindly check no points are skipped!

Thank You!

Appendix 2. Interview questions

The interview questions are prepared based on the literature review. The questions are carefully designed to encourage interviewees to reveal accurate and detailed information as much as possible.

Appendix 2.1: For Employer/ client (For Team Leader/Top Level Management)

1. Tell me about your educational and professional background and your involvement in the process of quality management
2. Tell me about your organization (service you provide, project type and scope under it)
3. Do you have a policy for quality management?
4. Tell me about the current quality management practice of wall exterior finishing materials, as per your professional experience and observation, in terms of the following core principles & objectives of quality management;
 - a) What are the processes included in quality planning of exterior finishing material.
 - b) What procedures do you use in terms of quality control
 - c) Methods of quality assurance
 - d) and improvement
 - e) Do you analyze each stage of the process? What are the factors affecting the process? How do you manage the problems? Do you use the output for future studies and improvement of system?
 - f) What is the time interval for revision of quality management plan?
5. Tell me about the selection and application of wall exterior building materials in your organization
 - a) What are the most frequently used exterior finishing material in this organization.
 - b) What factors are considered in selection of exterior finishing materials?
6. Tell me about the influence of wall exterior materials on a building?
7. How does exterior finishing material quality affect life cycle cost of a building?
8. Do you have a system **specifically** designed to manage wall exterior building materials and their application, if “**yes**”, can you tell me the process?
9. What is your say about the current wall exterior finishing material quality management, as per your professional experience and observation?
10. What are the frequent problems existing in quality of wall exterior finishing materials
11. Tell me about the **challenges** and **Key Performance Indicators** (KPIs) of quality management practice for wall exterior finishing materials.
12. Do workers know the hierarchy and organizational structure and of quality management?
13. Do you have personnel specifically assigned for quality process/ management (who is involved in the process and what is their role/ contribution?)
14. Do you prefer employing trained workers or do organize trainings for a specific project?

15. What do you recommend for improvement of quality management of wall exterior finishing materials?

Appendix 2.2: For experts under contractor/ consultant organizations/ companies

1. Tell me about your educational and professional background and your involvement in the process of quality management
2. What do you frequently use as an exterior finishing material in your year of experience?
 - a) Can you tell percentage of use for a specific material (hypothetically)
 - b) Can you tell me where most of your projects are located who were/are the clients and their scope?
3. What do you prefer to work with as an exterior finishing material in your area of expertise? Why?
4. Tell me about design and Specification process of your organization/ company.
 - a) Design review system
 - b) Design complete before purchase
 - c) Design change program includes effect on materials
 - d) Do you change design of an exterior building because of exterior finishing material quality? Tell me about the scenarios
 - e) Specifications kept current (up-to-date)
 - f) Standards current, accurate, applicable
 - g) Standards readily available to suppliers
 - h) Are specifications revised for errors and for consistency? How?
 - i) Coordination with materials management
 - j) Submittals clearly defined
5. What is included in relation to supplier relations?
 - a) Pre-qualifications include quality history
 - b) Quality evaluations in selection of certain suppliers
 - c) Supplier quality performance is computerized/ manual
 - d) Supplier contacts through buyers
 - e) Formal supplier quality programs on certain critical items
 - f) Suppliers aware of acceptance procedures
 - g) Supplier aware of submittal requirements and implications
6. Do you have procedures for Pre-shipment and on site quality Control and assurance?
7. Do you have a system **specifically** designed to manage quality of wall exterior finishing, tell me about the start to end process of quality management process of exterior wall finishing materials, if there is any.
8. Tell me about quality management process of wall exterior finishing material
 - a) Planning, tell me the details process and execution
 - b) Control, tell me the details of process and execution
 - c) Assurance, tell me the details of process and execution

d) Improvement, tell me the details of process and execution

9. Do you analyze the each stage of process? What are main factors identified **key performance indicators and critical success factors (CSFs)** and do you use the output for future studies and improvement of system
10. What are the problems in the process of quality management? How do you manage them?
11. What standards do you use in permit and declining of wall exterior finishing material and their process of application?
12. What are the frequent flaws/ problems in quality of wall exterior finishing materials, and what is the impact on life cycle of building project?
13. Do workers know the hierarchy and organizational structure and of quality management?
14. Do you prefer employing trained workers or do organize trainings for a specific project?
15. What do you recommend for improvement of quality management of wall exterior finishing materials?

Checklist for quality management observation.

No	Description	Yes	No	Remark
	A. Quality palnning			
1	<i>Quality planning</i>			
1	<i>Does the guideline ensure all relevant parties are included in the task of quality planning for the project</i>			
	<i>• Client</i>			
	<i>• Consultants,</i>			
	<i>• Subcontractors</i>			
	<i>• Suppliers</i>			
2	<i>Is the purpose of the quality system established and defined?</i>			
3	<i>Does it Minimize the effort required to amend copies of documents?</i>			
4	<i>Is there a quality system development team so that the team can produce an effective plan?</i>			
5	<i>Is the quality planning task constantly focused on the client's requirements?</i>			
2	<i>Quality in organizations:</i>			
1	<i>Is quality management part of the organizational structure</i>			
2	<i>Is wall exterior finishing materials quality management part of the organizational structure</i>			
3	<i>Are this personnel aware/ involved in exterior finishing materials quality management system (is it included in their job description (or on website, contract document)</i>			
	<i>• Project manager</i>			
	<i>• Project materials manager</i>			
	<i>• Design engineer</i>			
	<i>• project quality manager</i>			
	<i>• Buyer</i>			
	<i>• Shop inspector</i>			
	<i>• Site materials manager</i>			
	<i>• The vendor's quality management personnel</i>			
3	<i>Design and specification</i>			
1	<i>Is the Design manger submit a quality design, drawings and specifications, free of errors, ambiguities, and duplication.</i>			
	<i>• Does she/he consider Physical characteristics/ test requirements of materials during design and specification</i>			<i>(drawing and specifications)</i>
	<i>• Method of manufacture and raw materials</i>			
	<i>• Performance specifications</i>			

No	Description	Yes	No	Remark
	<ul style="list-style-type: none"> Industry standards published by technical associations or government agencies Standard used 			Specification and contract document
	What factors are considered during design of an exterior (in process of selecting exterior finishing materials)			(TOR and design specification)
	<ul style="list-style-type: none"> Durability, Cleanability, Material sustainability, Compatibility and Suitability, Health and Safety, Material Economy, Material Availability, Functional Performance, Thermal Performance Acoustical Performance 			
	B. Quality control:			
1	Preset levels of accuracy or performance of a component, system, process or procedure and making sure that these levels are achieved.			
1	Supplier's quality evaluation			
1	Selection of buyer (who is involved in selection) (contract document)			
	<ul style="list-style-type: none"> Client Engineering department, quality assurance materials management construction mangers Others 			
2	Do the company have a supplier database and information			
3	Performance of supplier measurement criteria			
4	Is there a criteria/ format for section of supplier (content checklist)			
	<ul style="list-style-type: none"> Experience Technical personnel Facility/ housekeeping Quality observed History Schedule/ delivery 	<ul style="list-style-type: none"> Service organization/parts Financial Location Labor relations Attitude, cooperation Overall reputation 		
5	Do the organization have a requirement for quality material and their application?			
	<ul style="list-style-type: none"> Acceptance Rejection Repair Replacement 			

No	Description	Yes	No	Remark
6	<i>Do the organization have a form to document a non-conforming materials/ procedures?</i>			
	• <i>Fabrication test</i>			
	• <i>Failure</i>			
	• <i>Improper or inadequate documentation</i>			
	• <i>Marking</i>			
	• <i>Packaging</i>			
	• <i>General workmanship.</i>			
2	<i>Pre and post award phase</i>			
1	<i>Are Senior corporate managers and project managers well aware of the importance of quality in supplier selection</i>			
2	<i>Are potential suppliers aware of importance of quality in selection of supplier?</i>			
3	<i>Are suppliers briefed about requirements for testing, certifications, and submittals, deadlines for submittals</i>			
4	<i>Aware of schedules for shop visit</i>			
5	<i>Aware of schedule and procedure in manufacturing process</i>			
3	<i>Inspection plan:</i>			
1	<i>Evaluating the need for shop inspection</i>			
	<i>Under what circumstances</i>			
	• <i>Engineered items</i>			
	• <i>Permanent plant equipment</i>			
	• <i>Critical fabricated materials</i>			
	• <i>Others</i>			
	<i>For what kind of materials</i>			
	• <i>Complex and/ or very costly</i>			
	• <i>Critical to the safe and reliable operation of the facility</i>			
	• <i>Deemed essential to meeting the construction and startup schedule</i>			
	• <i>Others</i>			
2	<i>Evaluating the level of inspection</i>			
3	<i>Deciding whether to use in house or contract inspection services</i>			
4	<i>What factors are considered to choose in house or contract inspection services?</i>			
	• <i>The special skills available and needed</i>			
	• <i>The location of the plant and accessibility to the inspection</i>			
	• <i>The desirability of maintaining a permanent inspection staff</i>			
	• <i>The availability and quality of inspectors for the particular procurement</i>			

No	Description	Yes	No	Remark
	<ul style="list-style-type: none"> Selecting inspectors and arranging their funding and administrative support 			
5	Coordinating details of the inspection during and after award of the purchase order			
	<ul style="list-style-type: none"> Notification of test date sand schedules of visits 			
	<ul style="list-style-type: none"> Access for inspectors 			
	<ul style="list-style-type: none"> Logistical support for inspectors 			
	<ul style="list-style-type: none"> Agreement on forms and certifications 			
	<ul style="list-style-type: none"> Agreement on requirements set out in technical specifications 			
6	What is to be checked during inspection			
	<ul style="list-style-type: none"> Dimensional checks 			
	<ul style="list-style-type: none"> Material tests 			
	<ul style="list-style-type: none"> Non-destructive tests 			
	<ul style="list-style-type: none"> Pressure tests 			
	<ul style="list-style-type: none"> Leak tests 			
	<ul style="list-style-type: none"> Performance tests 			
	<ul style="list-style-type: none"> Documentation control 			
	<ul style="list-style-type: none"> Others 			
4	Pre-shipment quality control (quality surveillance/ Inspection)			
1	Audit of a supplier's quality program before fabrication			
2	Using selected tests of certain materials by a selected commercial laboratory			
3	Required inspection checklists			
	<ul style="list-style-type: none"> Certifications 			
	<ul style="list-style-type: none"> Packing 			
	<ul style="list-style-type: none"> Marking 			
	<ul style="list-style-type: none"> Tagging (dates, names, codes, lot numbers, and other identification) 			
	<ul style="list-style-type: none"> Traceability 			
4	Nonconforming materials marks (destroy, re-temper, change rating, use elsewhere and others)(underline the selected)			
	C. Quality assurance			
	Does the application of quality involved in this stages			
	<ul style="list-style-type: none"> Design 			
	<ul style="list-style-type: none"> Development 			
	<ul style="list-style-type: none"> Specification 			
	<ul style="list-style-type: none"> Contract document 			
	<ul style="list-style-type: none"> Production 			

No	Description	Yes	No	Remark
	• <i>Products</i>			
	• <i>Installation</i>			
	• <i>Servicing to documentation,</i>			
	• <i>Regulations of the quality of raw materials</i>			
	• <i>Storage</i>			
	• <i>Assemblies</i>			
	• <i>Components</i>			
	• <i>Management</i>			
	• <i>Inspection processes</i>			
1	<i>Onsite quality assurance</i>			
<i>a</i>	<i>Is quality control onsite pre-established responsibility</i>			
	• <i>Site construction manger</i>			
	• <i>Material manger</i>			
	• <i>Other</i>			
	<i>Decision</i>			
	• <i>Accepted</i>			
	• <i>Returned</i>			
	• <i>replaced</i>			
<i>b</i>	<i>Is authority to accept or reject affected by schedule, cost or vendor pressure.</i>			
<i>c</i>	<i>Steps involved in onsite quality assurance</i>			
	<i>Planning of receiving materials (documents and procedures required)</i>			
	• <i>Receipt</i>			
	• <i>Visual checks</i>			
	• <i>Document Review</i>			
	• <i>Report (material receiving report (MRR), over, short, and damage report (OS&D), Non-Conformance report (NCR)</i>			
	• <i>Notification of supplier</i>			
	• <i>Repair or replacement</i>			
	• <i>Handling</i>			
	• <i>Storage</i>			
	• <i>Maintenance</i>			
	• <i>Process of application, workmanship and installed equipment protection</i>			
	• <i>Office quality checklist during and after execution.</i>			
2	<i>Organizational and personnel</i>			
<i>a</i>	<i>Personnel included related to quality management.</i>			
	• <i>Project manager</i>			
	• <i>Senior Project engineer</i>			
	• <i>Architectural coordination engineer</i>			
	• <i>Architectural designer</i>			
	• <i>Planning engineer</i>			

No	Description	Yes	No	Remark
	• Site engineer			
	• Quantity surveyor			
	• Material manger			
	• Quality control engineer			
	• Safety officer			
	• Structural engineer			
	• Civil engineer			
	• Land surveyor			
	• General foreman			
	• Finishing Forman			
	• Others			
b	Are the staff members aware of the quality hierarchy			
c	Are the staff members aware of the quality plan and execution in every stage			
d	Are the staff members aware of their own responsibility How is it addressed			
	D. Audits or quality reviews			
1	Is checking the adequacy and effectiveness of Quality programs regular, if there is any			
	• Client			
	• Consultant			
	• Contractor			
	• Supplier			
2	Is effectiveness of supplier performance evaluations checked			
3	extent of communications among the home office, manufacturer/supplier, site			
4	adequacy of pre-shipment quality control and assurance			
5	Adequacy of quality planning, control, and assurance			
	Are problems in planning and execution process identified and documented			
6	Does the audit of quality review specify where the problem arises			
7	Are measures taken? (specify)			
8	Effectiveness and efficiency (key performance indicators)			

Appendix 3

Name and Address Appraisal		Commodities Supplied:		Date of
_____		_____		_____
_____		_____		_____
_____		_____		_____
Rating categories	Weights	Rater A	Rater B	Rater C
Experience				
Technical personnel				
Facility/ housekeeping				
Quality observed				
History				
Schedule/ delivery				
Service organization/ parts				
Financial				
Location				
Labor relations				
Attitude, cooperation				
Overall reputation				
TOTAL				
Notes and Recommendations:	Overall Rating			
	Excellent	Good	Satisfactory	Unsatisfactory
Prepared by _____				

Supplier Quality Appraisal Form

Source: Stukhart, G. (1989). Construction materials quality management. Journal of performance of Constructed Facilities, 3(2).

Appendix 4

**OFFICE CHECKLIST:
FIELD QUALITY NOTICE**

Project: _____
 Contractor: _____ Date: _____ Report No. _____
 Problem: _____
 Item Identification: _____ Vendor: _____
 Drawing No.: _____ Specification No.: _____
 Date Found: _____
 Work Category: _____ Date Needed: _____
 Work Area: _____

Demolition <input type="checkbox"/>	Earthwork <input type="checkbox"/>	Concrete <input type="checkbox"/>	Steel <input type="checkbox"/>	Sheet Metal <input type="checkbox"/>	Welding <input type="checkbox"/>
U/G Pipe <input type="checkbox"/>	A/G Pipe <input type="checkbox"/>	Equipment <input type="checkbox"/>	Painting <input type="checkbox"/>	Insulation <input type="checkbox"/>	Electrical <input type="checkbox"/>
Instrumentation <input type="checkbox"/>	Roofing <input type="checkbox"/>	Other <input type="checkbox"/>			

Possible Cause:

Owner Change <input type="checkbox"/>	Vendor Change <input type="checkbox"/>	Transportation Error <input type="checkbox"/>
Design Change <input type="checkbox"/>	Vendor Error <input type="checkbox"/>	Other _____
Design Error <input type="checkbox"/>	Construction Error <input type="checkbox"/>	_____
Design Omission <input type="checkbox"/>	Construction Change <input type="checkbox"/>	_____

Problem Found: Receipt Inspection Has Vendor____ Carrier____ been notified? Yes No
 Before Installation Contact: _____ Date _____ N/A
 During Installation Correction to be made by: Contractor
 After Installation Vendor

Description of Problem: _____

 Representative _____

Description of Solution: _____

 Contractor _____ Date _____

Remarks: _____

A form for documenting field quality problems

Indicates cause, status, and proposed corrective actions

Source: Stukhart, G. (1989). Construction materials quality management. Journal of performance of Constructed Facilities, 3(2).

Appendix 5

Category	Group/ individual	Role
Client	Private	<ul style="list-style-type: none"> • Ensure the project will support the organization’s strategy • Ensure the organization’s resources will be used economically and effectively • Learn skills, earn wages, work on the frontline • Link between the client and consultants, ensure the project is completed successfully in terms of quality, time and cost. • Provide financial support maximize return with minimized risk and purchase the construction product
	Public client	<ul style="list-style-type: none"> • Serve public interest based on the organization’s strategic objectives • Consume what is delivered in order to satisfy functional and basic needs • Allocates funds to the project • Ensures that public funds will be used properly • Link between the client and the consultants, ensure the project completed successfully in terms of quality, time and cost
Project professional	Architect	<ul style="list-style-type: none"> • Develops the design of the project; produces drawings and specification; ensures that a project is implemented within cost and time, and according to quality control
	PMC (Project Management Contract)	<ul style="list-style-type: none"> • Advises client on financial and budgetary matters; assists in preparing tender documents examines and reports upon tenders monitors costs during construction and seeks to understand valuation and measurement assesses the legitimacy of claims from contractors and prepares final accounts
	Structural engineer	<ul style="list-style-type: none"> • Designs all structural calculations and elements; designs building structure; ensures statutory compliance
	Building service engineer	<ul style="list-style-type: none"> • Design electrical and mechanical building services system such as HVAC, Fire, Water, Electronics etc
Contractors/ suppliers	Main contractor	<ul style="list-style-type: none"> • Carries out and completes the work designed by consultants to meet time, cost and quality objectives; supervises and manages operations on site; sometimes assists in design; coordinates and supervises all sub-contract work, materials and suppliers
	Sub-contractor	<ul style="list-style-type: none"> • Carry out work assigned by main contractors
	Laborer	<ul style="list-style-type: none"> • Finish tasks assigned, earn living, learn skills

	Supplier	<ul style="list-style-type: none"> Supply, install and commission the hardware that constitutes the finished building (e.g. materials suppliers, equipment suppliers and manufacturers)
Customer	Owner	<ul style="list-style-type: none"> Future owner of the project, the individual or organization that will use the product of the project
	User	<ul style="list-style-type: none"> The end-user who does not pay for the product of the project, other than by the taxes

Appendix 6

Category	Group/ individual	Role
External public parties	Government authorities	Ensure that the project abides by laws and regulations; may be indifferent to any project so long as it complies with codes (e.g. planning department, electrical and mechanical services department, transport department, highways department, etc.)
	Consultation bodies such as district board	Ensure the local communities' requirements will be reflected in the project
	Town planning board	Ensures the project will be in line with district planning
	Labor union/ employers' association	Influences the conduct of its members (privilege protection function)
	General public	Participate in and contribute to the government process of a society as a whole
	Media	Influence project decisions (influence company reputations)
	Institutional Forces/Nationalized Industries	Influence professional institutions upon the activities of their members through rules of conduct, education, conditions of engagement and fee scales
External private parties	Local residents/community	May fear a fall in amenity, therefore against the project
	Local landowners	Own land ensure that their interests will not be hurt by the project
	Archaeologists	Concerned about the loss of important historical artefacts
	Environmentalists/ conservationists	Wish to protect the environment from destruction or pollution
	Competitors	Seek to gain competitive advantage
	Tourists	Enjoy the scene
	Others	Their connection to the project is not immediately clear, but their operation and support may be vital to the project success

Appendix 7

Materials	Standard	Performance indicators	Acceptance criteria	Means of verification
Earth based materials	ISO			
	ASTM	Bond Strength of Ceramic Tile to Portland Cement Paste Breaking Strength of Ceramic Tile Evaluating Ceramic Floor Tile Installation Systems Using the Robinson-Type Floor Tester Facial Dimensions and Thickness of Flat, Rectangular Ceramic Wall and Floor Tile Measuring Warpage of Ceramic Tile Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser Wedging of Flat, Rectangular Ceramic Wall and Floor Tile Ceramic White wares and Related Products Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired White ware Products	C 482 – 02, C 648 – 04 C 627 – 93(1999), C 499 – 78(2003) C 485 – 83(2003), C 501 – 84(2002), C 502 – 04, C 242 – 01 C 373- 88(2006), E 518- 03, C62-05 C 126 – 99(2005), C 279 – 88(2001) C 216 – 07, C 1261- 05, C 1405-05a C 212 – 00(2006), C 67- 07, C73-05 C 55 – 06 , C140 – 06	Laboratory test, dimension and color verification
	CES	Uses ISO as a reference 91.100.25 Clay- bricks solid clay bricks specification Clay- bricks hollow clay bricks and beam tiles- specification	ISO 91.100.25 CES 26 : 2013 CES 27 : 2013	Laboratory test, dimension and color verification
	EBCS	—		
	ES	Advanced technical ceramics - Methods of test for ceramic coatings (part 4, 10, 11, 12) EN 15254-2:2009 Extended application of results from fire resistance tests - Non-loadbearing walls - Part 2: Masonry and Gypsum Blocks EN 15870:2009 Adhesives - Determination of tensile strength of butt joints (ISO 6922:1987 modified)	EN 1071-(1-12): 2010	Laboratory test, dimension and color verification
IS	Lime - Classification (classes), Chemical requirements (hydration, composition) - Physical requirements (Fineness, residue on slaking, Setting time, compressive and transverse strength, workability...) Packaging Calcium silicate bricks, Clay products, Common burnt clay building bricks and Facing Brick - Classification (class and function) - Physical Requirement (general quality dimension and tolerance compressive strength) - Chemical Requirement (drying shrinkage of calcium silicate bricks)	Blocks 3952 : 1988 1725 : 1982, 1077 : 1992 3952 : 1988 1725 : 1982 1077 : 1992 2117 : 1991, ISO 2180 : 1988, 2222 : 1991, 2691 : 1988 ISO 3495 (Parts 1 to 4) : 1992 ISO 3583 : 1988, 4885 : 1988 5454 : 1978 5779: 1986, 6165 :1992 11650:1991 13757:1993	Laboratory test, dimension and color verification, site observation	
Stone based materials	ISO	NATURAL STONES/ ENGINEERED STONES Standardization of definitions	ISO/TC 327 and 328 ISO/TC	Laboratory test

Materials	Standard	Performance indicators	Acceptance criteria	Means of verification
		Requirements (Requirements for preparation and installation procedures) Terminology, Requirements and Test methods (Environmental compatibility of engineered stones during their life cycle), Application, and Use	(327/AG (1,2,3), 327/AHG 1, 328/WG 1, 328/WG 2, 328/WG 3, 328/WG 4)	Color verification Dimension
	ASTM	DIMENSION STONE Selection, Design, and Installation of Dimension Stone Anchoring Systems Material specification Granite Dimension Stone, Limestone Dimension Stone, Marble Dimension Stone, Quartz-Based Dimension Stone, Roofing Slate, Serpentine Dimension Stone, Slate Dimension Stone, Travertine Dimension Stone Nomenclature and Definitions Dimension Stone Test Methods Abrasion Resistance of Stone Subjected to Foot Traffic; Absorption and Bulk Specific Gravity of Dimension Stone; Compressive Strength of Dimension Stone; Flexural Strength of Dimension Stone; Modulus of Rupture of Dimension Stone; Strength of Individual Stone Anchorages in Dimension Stone; Structural Performance of Exterior Dimension Stone Cladding Systems by Uniform Static Air Pressure Difference	C 1242 – 05, C 615 – 03 C 568 – 03, C 503 – 05 C 616 – 03, C 406–06 C 1526 – 03, C 629 – 03 C 1527 – 03, C 119 – 06 C 241 – 90(2005), C 97 – 02 C 170 – 06, C 880 – 06 C 99 – 87(2006), C 1354 – 96(2004) C 1201 – 91(2003)	Laboratory test Color verification Dimension
	CES	—		
	EBCS	—		
	EN	Natural stone products - Slabs for cladding - Requirements - Characteristics of natural stone for cladding geometrical characteristics, thickness, flatness, dimension commercial size of slabs for cladding, surface finish, physical and mechanical character, Denomination, Visual appearance, Resistance to fixings, Water absorption at atmospheric pressure Reaction to fire, Water absorption by capillarity, Apparent density and open porosity, Durability, Water vapor permeability, Direct airborne sound insulation, Thermal conductivity, Release of dangerous substances, Bond strength/adhesion - Testing, assessment and sampling methods - Assessment and verification of constancy of performance - Marking and packaging.	EN 1469:2015 EN 1467, EN 1468, 2012 EN 1469, EN 12057, EN 12058, EN 12059,	Laboratory test Color verification Dimension
	IS	<u>Natural stones for masonry (SP21: 2005, 3.3)</u> Dimensions and Tolerances (Specified length breadth and height in millimeter (mm) according to the specific use) Workmanship (specifies the quarrying, dressing and laying plane) <u>Limestone (Slab and tiles), Marble, Sandstone and Granite</u> - Selection (Structural and ornamental)	IS 1127 : 1970 IS 1128 : 1974 IS 1130 : 1969 IS 3316 : 1974 IS 3620 : 1979 IS 14223	Laboratory test Color verification Dimension

Materials	Standard	Performance indicators	Acceptance criteria	Means of verification
		<ul style="list-style-type: none"> - Classification (White and Colored Described in appendix), General requirement (flaws, injurious veins, composition imperfections, hairline cracks , coloring, and surface finish)selection, grading, strength requirement, chemical composition, construction use) - Dimension, Tolerances, Physical Properties (water absorption, durability, Moisture content, dry density, specific gravity, water absorption, porosity, compressive strength, tensile strength, shear strength, hardness, ultrasonic pulse velocity, resistance to wear with requirements) - Workmanship (edges, finishes (sand and abrasive finish, Hone finish or polish finish 		
Mortar	ISO	<p>ISO 17738-2:2019 Thermal insulation products -- Exterior insulation and finish systems (EIFS) Consists of 6 component</p> <ul style="list-style-type: none"> • A water resistive barrier to protect the substrate; the substrate has a means for drainage to the exterior; a means of attaching the system to the substrate; a thermal insulation layer; a base coat material; a reinforcing mesh embedded into the base coat, and; A finish material to provide the aesthetic appearance of the cladding assembly. <p>Methods of test for mortar for masonry <u>CEMENT. GYPSUM. LIME. MORTAR (ISO 91.100.10)</u> Ceramic Tiles - Grouts and adhesives – (Part 1, 2, 3, & 4) Appendix ISO 13007 standards for adhesives and grouts</p>	<p>ISO 17738-2:2019 ISO 13007-(1, 2, 3,4) (ISO 91.100.10) ISO 13765-1:2004 ISO 29465:2008 ISO 29466:2008 ISO 29470:2008</p>	<p>Laboratory test of cement and sand Type of (sand) Viscosity and applicability Mix ratio Activity of binding Time to dry</p>
	ASTM	<p><u>MORTARS AND GROUTS FOR UNIT MASONRY</u> Grout for Masonry Specifications for Aggregates for Mortars Aggregate for Masonry Mortar and Grout Specifications for Mortars Extended Life Mortar for Unit Masonry Surface Bonding: Packaged, Dry, Combined Materials for Surface Bonding Mortar Practices for: Construction of Dry-Stacked, Surface-Bonded Walls Mortar: Chemical resistant sulfur mortar; bond strength of chemical resistant mortar; hydraulic cement mortars in chemical-resistant masonry; test method for water penetration and leakage through masonry; test methods for flexural bond strength of masonry; test method for diagonal tension (shear) in masonry assemblage; compressive strength of chemical-resistant mortars, grouts, monolithic surfacing, and polymer concretes Flexural strength and modulus of elasticity of chemical-resistant mortars, grouts, monolithic Surfacing, and polymer concretes</p>	<p>C 476 – 02 C 144 – 04 C 404 – 06 C 1142 – 95(2001) C 270 – 07 C 887 – 05 C 946 – 91(2001) C 287 – 98(2003) C 321 – 00(2005) C 398 – 98(2003) E 514 – 06 E 518 – 03 E 519 – 02 C 579 – 01(2006) C 580 – 02</p>	<p>Laboratory test of cement and sand Type of (sand) Viscosity and applicability Mix ratio Activity of binding Time to dry</p>

Materials	Standard	Performance indicators	Acceptance criteria	Means of verification
	CES	Used ISO as a reference Cement-part 1: composition, specification and conformity criteria for common cement	ISO 91.100.10 CES 28 : 2013	Laboratory test
	EBCS	Used ISO as a reference		
	EN	<u>SPECIFICATIONS FOR EXTERNAL RENDERS AND INTERNAL PLASTERS BASED ON ORGANIC BINDERS</u> Applicable to factory-made renders and plasters based on organic binders used for external or internal covering on walls, columns, partitions and ceilings. The products are manufactured in paste form, ready to use, or in powder form. This European Standard is also applicable to renders and plasters with inorganic binders such as silicates, silanes, siloxanes and silicones. This European Standard contains definitions and final performance requirements. It includes relevant characteristic categories to designate renders and plasters. Design, preparation and application of external rendering and internal plastering Methods of Test for Mortar for Masonry Adhesives for ceramic tiles (performance and test method)	CEN - EN 15824 EN 1015 (1-21) EN 13914-1:2016 EN 12004-(1 &2) 1:2017 (adhesives)	Laboratory test of cement and sand Type of (sand) Viscosity and applicability Mix ratio Activity of binding Time to dry
	IS	<u>External rendering (IS:2402-1963)</u> Pre selection, preparation and application Materials, tools and accessories , Cement, Sand, Lime, Tools and accessories ⁷ Care of materials, Design consideration ⁸ Nature of Background in Relation to Choice of Rendering, Resistance to Water Penetration. Durability (Resistance to Cracking ⁹ , Resistance to Crazing, Thermal Properties, Sound Insulation, Fire Resistance and Combustibility, Recommended Mix Proportions, Number of Coats, Functions of Different Coats and Their Recommended Thicknesses ¹⁰ , Color ¹¹ , Preliminary work ¹² , Preparation of Mortar Mix, Preparation of Background Application of rendering coats (Curing (to gain strength, density and post treatment) Maintenance (Cleaning, Repairs to Cracks)	IS:2402-1963 1542 : 1992 IS 4456 IS 4832 (part 1, 2 and 3) (IS: 1641-1960, IS: 1641-1960) IS 269-1958 IS 455-1962 (cement) IS: 1542-1960 (Sand) IS: 712-1956 (Lime) IS: 1630-1960 (tools and accessories)	Laboratory test of cement and sand Type of (sand) Viscosity and applicability Mix ratio Activity of binding Time to dry

⁷ Tools and accessories Specification for Mason's Tools for Plaster Work and Pointing Work.

⁸ Design consideration:: Function of external rendering, Suitability of Various Types of Rendered Finishes)

⁹ Resistance to cracking Movements of the Structural Background, Movement of the Rendering, Another factor affecting adhesion, Mixed Backgrounds

¹⁰ **Their Recommended Thicknesses:** Undercoat, final or finishing coat, single coat

¹¹ Color: finishing coat need to be colored

¹² **Preliminary work** (scaffolding, cleanliness and protection of adjacent work)

Materials	Standard	Performance indicators	Acceptance criteria	Means of verification
		Repair of damaged areas (General, Loss of Adhesion, Mechanical Damage, Overcoming Unsatisfactory Appearance, Overcoming Damp Penetration)		
Paint(coating)	ISO	<p>PAINTS AND VARNISHES (ISO/TC 35)</p> <p>General test methods for paints and varnishes</p> <p>Preparation of steel substrates</p> <p>Protective coatings, Chemical analysis, Determination of scratch resistance, fineness of grind, film thickness, Natural weathering of coatings, density, resistance to liquids, viscosity, effect of heat, non-volatile-matter content, Temperatures and humidity for conditioning and testing, Visual comparison of color of paints, resistance to filiform, resistance to abrasion, hiding power and evaluation of degradation of coatings, resistance to humidity, rapid-deformation</p>	<p>ISO/TC 35, WD 9607-1, TC 35/SC 9, TC 35/SC 12</p> <p>TC 35/SC 15, TC 35/SC 16, 1513:2010, 1514:2016</p> <p>DIS 1518(1- 3), 1524:2020</p> <p>2808:2019, 2810:2020, 2811 1:2016, DIS 2811-1 to 4- 2011, 2812 1:2017</p> <p>ISO 2884-1 and 2 :1999</p> <p>ISO 3233- 1- 3:2019</p> <p>ISO 3248: 2016</p> <p>ISO 4623-1 & 2:2016</p> <p>ISO 4628-(1-10):2016</p> <p>ISO/AWI 4628 - 10</p> <p>ISO 6270-2:2017 (1, 2,3)</p> <p>ISO 6272-(1, 2) : 2011</p> <p>ISO/DIS 7784-(1- 3)</p> <p>ISO 16474-3</p>	Laboratory test Viscosity and applicability Chemical composition
	ASTM	<p><u>PAINT AND RELATED COATINGS, MATERIALS, AND APPLICATIONS</u></p> <p>Architectural coatings, chemical analysis of paints & paint materials, coil coated metal, evaluation of weathering effects, factory applied coatings on preformed products, flammability and safety, industrial protective coatings, optical properties, physical properties of applied paint films, Physical properties of liquid paints & paint materials</p>	<p>D2248– 01a, D822– 01(2006), D4585– 99, D1735- 04, D 870- 02, D2247- 02, D2486- 06, D1644- 01(2006), D2697- 03, D 4145- 83(2002), D3960- 05, D714- 02</p> <p>D1654- 05, D3170- 03, D1308- 02</p>	
	CES	—		
	EBCS	—		
	ES	<p>Paints and varnishes - Coating materials and coating systems for exterior masonry and concrete</p> <p>This European Standard specifies a general system for the description of coating materials and coating systems for the preservation, decoration and protection of exterior new and old, coated or uncoated masonry and concrete. A classification including those for use in external thermal insulation systems.</p> <p>Introduction, selection of coating, suitability factor, substrate factor, architectural factor, durability factors, specification factors, coating properties and characteristics, special requirement for coating systems, for exterior masonry concrete, coating application (basic principles)</p>	<p>EN 1062-1:2004</p> <p>EN 1062-11:2002</p> <p>EN 1062 11:2002/AC:2005</p> <p>EN 1062-1:2004</p> <p>EN 1062-3:2008</p> <p>BSI - BS EN 16566</p> <p>EN ISO 19403-1: 2020</p> <p>ISO19403, (1,2,3,4,5,6,7,8,9,14): 2020</p>	

Materials	Standard	Performance indicators	Acceptance criteria	Means of verification
	IS	<p>Scope (requirements, methods of sampling and test enamel, synthetic, exterior: (a) undercoating (b) finishing, color as required used in painting system for protection and decoration.)</p> <p>Terminology Classes, Color categories and Wet Opacity Requirements, Condition in Container, Freedom from Coarse Particles, Skin Formation, Thinning Properties, Application Properties, Durability, Resistance to Acid (for Finishing Only), Resistance to Alkali (for Finishing Only)</p> <p>Packing and marking, Sampling (Preparation of Test Samples, Criteria for, Conformity)</p> <p>Test methods, General provisions (Supply, Vendor's Certificate and Tests and References)</p>	<p>IS 2932:2003</p> <p>IS 1303</p> <p>IS 1745</p> <p>IS 101</p> <p>IS 1407 and IS 2552)</p> <p>IS 5661</p> <p>IS 1303</p>	
Steel based materials	ISO	<p>ISO 77.140 (Iron and steel products)</p> <p>Sheets, strips and plates:</p> <ul style="list-style-type: none"> Part 1 to 5: Technical conditions for inspection and delivery, Chemical composition, Mechanical properties, Strips, Sheets and plates, : Tolerances on shape and dimensions <p>In addition, we produce standards for measuring the carbon emissions and sustainability, Building environment design of buildings and others structures, Design life way of plan in the service life of buildings including :</p> <p><u>ISO 404:2013 STEEL AND STEEL PRODUCTS</u></p> <p><u>General technical delivery requirements</u></p> <p>Requirements (general, chemical composition, mechanical properties, surface and internal quality)</p> <p>Inspection and testing</p> <p>Sorting and reprocessing, marking, disputes</p> <p>Steel and steel products- inspection documents, Steel and iron- sampling and preparation of samples for the determination of chemical composition</p>	<p>77.140 (IRON AND STEEL PRODUCTS)</p> <p>77.150.01 (Products of non-ferrous metals in general)</p> <p>77.150.10 (Aluminium products) ISO 6361</p> <p>ISO 21930, ISO/TC 205,</p> <p>ISO/TC 59/SC 13</p> <p>ISO/TC 59/SC 14</p> <p>ISO 15686, ISO/TC59</p> <p>ISO/TC 162, ISO 404:2013</p> <p>STEEL AND STEEL PRODUCTS</p> <p>ISO 377, ISO 4948- 1 &2</p> <p>ISO 6929, ISO 10474</p> <p>ISO (14284, 80000-1:2009,1463)</p>	Laboratory test Size of frame/profile/cladding
	ASTM	<p><u>LIGHT METALS AND ALLOYS</u></p> <p>Aluminum and Aluminum-Alloy Drawn Tube and Pipe for General Purpose Applications, Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric]</p> <p>Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes</p> <p>Packaging/Packing of Aluminum and Magnesium Products</p> <p>Installing Factory-Made Corrugated Aluminum Culverts and Storm Sewer Pipe</p> <p><u>METALLIC-COATED IRON AND STEEL PRODUCTS</u></p> <p>Sheet Specifications</p> <p>General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process</p> <p>Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process</p> <p>Steel Sheet, Aluminum-Coated, by the Hot-Dip Process</p> <p>Structural Shapes and Hardware Specifications</p>	<p>B 209M – 06</p> <p>B 483 / B 483M – 03</p> <p>B 221M – 06, B 221 – 06, B 209- 06</p> <p>B 660 – 02, B 660 – 02</p> <p>B 788 / B 788M – 04</p> <p>A 924 / A 924M – 07</p> <p>A 792 / A 792M – 06a</p> <p>A 463 / A 463M – 06</p> <p>A 123 / A 123M – 02</p>	Laboratory test Size of frame/profile/cladding

Materials	Standard	Performance indicators	Acceptance criteria	Means of verification
		Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products		
	CES	<p>Uses ISO as a reference 77.140.50 flat steel products and semi-products *including plate, sheet and strip *steel strip for spring</p> <ul style="list-style-type: none"> Continuous hot-dip aluminum/syncopated steel sheet of commercial, drawing and structural qualities 	ISO77.140.50 CES 45 : 2013	Laboratory test Size of frame/profile/cladding
	EBCS	—		
	ES	<p>Stainless steels Stainless steels – Part 1 to part 5: List of stainless steels, Technical delivery conditions Stainless steels - Part 5: Technical delivery conditions for bars, rods, wire, sections and bright products of corrosion resisting steels for construction purposes. Steel castings for structural uses Execution of steel structures and aluminium structures</p> <p>Aluminium Aluminium and aluminium alloys (terms and definition) Aluminium and aluminium alloys (Technical conditions for inspection and delivery, Tolerances on dimensions and form(part 1 &2))</p>	EN 10088-1-3:2014 EN 10088-4:2009 EN 10088-5:2009 EN 10089:2002 EN 10340:2007 EN 1090-1:2009+A1:2011, EN 1090- (2, 3,4, 5) EN 12020-1:2008 EN 12020-2:2016 EN 12258-(1, 2, 3, 4):2012 EN 12020-2:2016/AC:2017 EN AW-6060 and EN AW-6063	Laboratory test Size of frame/profile/cladding
	IS	<p><u>Is 737 : 1986 wrought aluminum and aluminum alloy sheet and strip for general engineering purposes</u> Scope – Requirements for wrought aluminum and aluminum alloy sheet and strip for general engineering purposes. Freedom from defects- Dimensions and Tolerances: (IS 2676:1981* IS 2677:1979) Designation and Typical uses of Alloys Chemical composition, Mechanical properties</p>	Light metals and their alloys Section 16 IS 733: 1983, IS 737:1986, IS 736:1986, IS 737: 1986, IS1254:1991, IS1285: 2002 IS2676: 1981,IS 2677:1979 BUILDER’S HARDWARE 204: 1991, 1992	Laboratory test Size of frame/profile/cladding

Materials	Standard	Performance indicators	Acceptance criteria	Means of verification
Glass	ISO	<p>Glass in building (81.040.20)</p> <p>Determination of the bending strength</p> <p>Determination of light transmittance, solar direct transmittance, total solar energy transmittance, ultraviolet transmittance and related glazing factors.</p> <p>Determination of steady-state U values (thermal transmittance) of multiple glazing.</p> <p>Coated glass — Part 1: Physical defects</p> <p>Coated glass — Part 2: Color of façade</p> <p>Curved glass (Terminology definitions and quality requirements (Requirements for curved tempered and curved laminated safety glass)</p> <p>Laminated safety glass (description and components, test methods for durability, dimensions and edge finishing, appearance)</p> <p>Basic soda lime silicate glass products — Part 1: (Definitions and general physical and mechanical properties, float glass, polished wired glass, wired patterned glass, patterned glass)</p>	<p>ISO 81.040.20</p> <p>ISO 1288 (1, 2, 3, 4,5) :2016</p> <p>ISO 9050:2003</p> <p>ISO 10291:1994,</p> <p>ISO 10292:1994,</p> <p>ISO 10293:1997,</p> <p>ISO/AWI 10293</p> <p>ISO 11479-(1,2):2011.</p> <p>ISO 11485- (1, 2, 3) :2011</p> <p>ISO 12543-(1, 2, 3, 4, 5, 6):2021</p> <p>ISO 16293-(1, 2, 3, 4,5):2016</p>	<p>Dimension measurement,</p> <p>visual analysis</p> <p>Laboratory test</p>
	ASTM	<p>GLASS AND GLASS PRODUCTS</p> <p>Flat Glass</p> <p>Bent Glass, Chemically Strengthened Flat Glass, Flat Glass, Heat-Treated Flat Glass—Kind HS, Kind FT Coated and Uncoated Glass, Laminated Architectural Flat Glass, Silvered Flat Glass Mirror</p> <p>Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference</p>	<p>E 330 – 02, C 1464 – 06</p> <p>C 1422 – 99(2005), C 1036 – 06</p> <p>C 1048 – 04, C 1172 – 03</p> <p>C 1503 – 01</p>	
	CES	—		
	EBCS	—		
	ES	<p>Glass in building</p> <p>Glass blocks and glass pavers (part 1 and 2)</p> <p>Coated glass – (Part 1, 2, 3, 4, 5)</p> <p>Thermally toughened soda lime silicate safety glass Pendulum test - Impact test method and classification for flat glass, Glazing and airborne sound insulation, Insulating glass unit, Determination of bending strength of glass, Determination of the emissivity, Structural sealant glazing</p> <p>- Laminated glass and laminated safety glass</p> <p>Curtain wall- Terminology, Impact resistance</p> <p>- Air permeability (Performance requirements and classification, test method)</p> <p>- Water tightness (Performance requirements and classification, Laboratory test under static pressure site test)</p>	<p>EN 1051-1:2003</p> <p>EN 1096- (1-5) :2012 EN 12150- (part 1 &2):2004</p> <p>EN (12600:2002, 12758:2019)</p> <p>EN 1279-(1- 6):2018</p> <p>EN 1288- (1- 5):2000</p> <p>EN 13022- (1 &2) :2014</p> <p>All are ‘EN’ (13051:2001, 13052:2001, 13119:2016</p> <p>14019:2016, 14449:2005</p> <p>13830:2015+A1:2020</p> <p>12898:2019, 12152:2002</p>	<p>Laboratory test</p> <p>Dimension</p>

Materials	Standard	Performance indicators	Acceptance criteria	Means of verification
		Windows and doors (Resistance to wind load, classification and test method) Doors (operating force, climatic influence)	12153:2000, 12154:1999, 12155:2000, 12210:2016 12211:2016, 12217:2015, 12219:1999)	
	IS	SP 21: 2005 IS 2553 (PART 1) : 1990 SAFETY GLASS Types (toughened and laminated) Specific requirement for toughened safety glass (thickness, dimension tolerance (length and width), fragmentation test, wrap and resistance to shock test) Specific Requirements for laminated Safety glass (thickness, cut size, length stability, boil test and Fracture and adhesion test) FLAT TRANSPARENT SHEET GLASS Scope (classification, requirement and method of sampling and test for use of photographic plates, projection slides, silvered glass mirror , toughened or laminated safety glasses and for glazing and framing purposes) Requirements (material (flat, transparent and clear), dimensions (length width and thickness)	SP 21: 2005 IS 2553 IS 2835 : 1987 IS 3438 : 1994 IS 5437 : 1994 IS 14900 : 2000	Laboratory test Dimension

Appendix 8

Client	Consultant	Contractor	Supplier	End-user	Community
PROCUREMENT STAGE - PERFORMANCE					
Client attribution Procurement & delivery Strategy Contractual arrangement Briefing Process Communication/ Interactive Process Commitment from employees Social Obligation	Management capabilities Good working relationship Competency Commitment Meeting functional requirements Meeting technical specification Communication/ Interactive process Efficiency of technical approval authorities	Level of experience Past performance Management capabilities Performance (project personnel) Construction method and technology Manpower and technical capabilities	Quality assurance on products Quality control system Product life span Nonconformance value The concept of JIT ¹³ Product mechanization Track record Level of service Capabilities of key personnel	Involvement (need Definition, ideas and requirements, decision making process) Commitment via representatives Joint evaluation on procurement selection.	Pressures Demands Community involvement Community Policy Battleground Closer relationship
PROJECT PHASE - PERFORMANCE					
Management structure Project interfaces Fragmentation Loyalty Project life cycle	Team Management Accountability Communications and reporting Quality control and assurance system of design and specifications	Performance standard Organizational structure Labor utilization & relaxation Safety Constructability Communications and reporting Cost control mechanism Efficiency	Material Procurement Cooperation and Coordination Commitment to quality Ability to deliver Product reliability Delivery time Contractual agreement Product defect	Continuous participation Involvement in maintenance and documentation	Support Cooperation visual and environmental effect
PHASING-OUT STAGE - EXPECTATION					
Meets pre stated (objectives, time, budget, technical specification and quality) Absence of any claims & Proceedings, conflicts/ disputes Transfer of experience	Profitability, reliability Learning, growth and harmony Absence of any legal claims & proceedings Increase the level of professional	Profitability Achieve business purpose (strategically, tactically & operationally) Settlements of conflicts Business relationship, market penetration, positive reputation Develop new knowledge expertise and growth	New market penetration on products Future potential Exploit technology Profitability	Meets requirements Functionality Desired outcomes Free from defects On-time deliveries Required future service Safety Usable life expectancy Easy to maintain	Benefits Use of it Safety Pleasant environment (blend to the surroundings) Public image
Source: TAKIM, R. & AKINTOYE, A. Performance indicators for successful construction project performance. 18th Annual ARCOM Conference, 2002					

¹³ Just In Time (JIT) an inventory management method in which goods are received from suppliers only as they are needed.

Appendix 9

Properties	Earth based		Stone based			Metals		Mortar	Paint	Glass
	Brick	Ceramic	Marble	Granite		(Ferrous) e.g. Steel	(Nonferrous) e.g. Zink			
Dimension	√	√	√	√	√	Custom	Custom			√
Texture	√	√	√	√	√				√	√
Color	√	√	√	√	√			√	√	√
Grade/ type	√	√				√	√	√	√	√
Specific gravity			√	√	√	√	√			
Thermal property			√	√	√	√	√	√	√	√
absorption	√	√	√	√	√				√	
Porosity			√	√	√					
Crushing strength	√	√	√	√	√					
tensile strength			√	√	√	√	√	√		√
compressive strength	√	√	√	√	√	√	√	√		√
Warpage	√	√								
Toughness	√	√	√	√	√	√	√			
Hardness and soundness	√	√	√	√	√	√	√	√		
Resistance to wear	√	√	√	√	√					
Bulk density	√	√						√		
Seasoning			√	√	√					
Melting point						√	√			
Chem composition			√	√	√	√	√	√	√	√
Acid test			√	√	√	√	√		√	
Water retention								√	√	

Properties	Earth based		Stone based			Metals		Mortar	Paint	Glass
	Brick	Ceramic	Marble	Granite		(Ferrous) e.g. Steel	(Nonferrous) e.g. Zink			
Building unit						√	√	√		√
Type of sand								√		
Mix ratio								√	√	
Type/ quality (mortar)								√		
Time to dry								√	√	
Base of application								√	√	
Workability	√	√	√	√	√			√	√	
Viscosity								√	√	
Consistency of volume								√		
Coverage									√	
Elasticity						√	√		√	
Malleability						√	√			
Ductility						√	√			
Brittleness						√	√			√
Resistance to corrosion						√	√			
Resistance to weathering						√	√		√	√
Light (absorption, reflection and transmittance)									√	√
Acoustical property										√

Table: Prepared by the author, tests to be done during inspection of materials

Source: (ISO (International Organization for Standardization), ASTM (American Society for Testing and Materials), CES (Compulsory Ethiopian Standard), EBCS (Ethiopian Building Code Standard), IS (Indian Standard))

Checklist Inspection for rendering work (111) Make a (√)

	C	NC	NA
▪ Qualification of Plasterer	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Area to be rendered with reference to quality	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Checking readiness of surface wall to be rendered			
a. Completion of erection of designed surface	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Dryness of proposed surface	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. Cleanliness of surface from external un - necessities (Dust, Solid etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. Completion of other embedded element positioning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. Centering work of areas to be rendered (Level, plumping, shaping etc.)			
▪ Quality of sieved sand, crushed aggregate, water etc..	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Service ability of rendering tool	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Mix ratio of mortar(1:2) and W:C ratios	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Wetting of surface before start of rendering	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Presentation of plots of sample wall (Independent of project part)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Maximum deviation of rendering components from average coat thickness;	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Checking homogeneity of color appearance of rendering	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Lines (Vertical and Horizontal) where discontinuity can be allowed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Additional Remarks _____

For the above items are *fulfilled* /not *fulfilled*, the Contractor is hereby allowed /refused to proceed rendering work. The take-off sheet of this activity shall immediately be signed upon completion.

For the Consultant

For the Contractor

Name: _____

Name: _____

Signature: _____

Signature: _____

Date: _____

Date: _____

C=conformed

NC= not conformed

NA= not applicable

Checklist for Painting

Make a (√)

Metal and Non Metal

	C	NC	NA
▪ Submittal of work methodology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Surface Material	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Receive of approved paint schedule	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Submittal of paint manufacturer manual	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Preparation of estimated measurement and storage condition	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Qualified Work men	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Scaffolding design	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Paint type and proposed glue for white wash	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Availability of paint material	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Availability of tools	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Quality of surface area	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Priming paint (etching primer if applied)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Sufficiency of primer coverage/Painting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Time gap between successive paint applications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Quality test of paint materials	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Finishing stage of the corresponding room	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Additional Remarks _____

For the above items are *fulfilled* /not *fulfilled* ,the Contractor is hereby allowed /refused to proceed Glazing work. The take-off sheet of this activity shall immediately be signed upon completion.

For the Consultant

For the Contractor

Name: _____

Name: _____

Signature: _____

Signature: _____

Date: _____

Date: _____

C=conformed

NC= not conformed

NA= not applicable

Checklist Glazing Work

Make a (√)

	C	NC	NA
▪ Label of window/door/roof	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Stability of frame	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Type of glazing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Colour of glazing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Qualification of work men	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Estimated measurement preparation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Size of cut and thickness of glazing material	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Quality of putty	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Quality test	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Fixing of samples with putty application	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Putty application position	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Sufficiency of space for putty application	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Spacing of bead screws/Firmness	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
▪ Condition of final coat of paint to frames	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- End of works at roof level
- Qualification of work men

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Additional Remarks _____

For the above items are *fulfilled* / *not fulfilled* ,the Contractor is hereby allowed /refused to proceed Pavement construction work. The take-off sheet of this activity shall immediately be signed upon completion.

For the Consultant

For the Contractor

Name: _____

Name: _____

Signature: _____

Signature: _____

Date: _____

Date: _____

C=conformed

NC= not conformed

NA= not applicable

ASSESSMENT OF QUALITY MANAGEMENT PRACTICES OF SELECTED WALL EXTERIOR FINISHING MATERIALS

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ABSTRACT

This study focuses on evaluating the quality management practices of wall exterior finishing materials in public construction projects in Addis Ababa, Ethiopia. particularly focusing on mid-rise buildings constructed in the last fifteen years; drawing a data from different organizations including detailed case studies from Addis Ababa Design and Construction Works Bureau, Addis Ababa Housing Development Corporation, and the Ministry of Health. Exploring the commonly used exterior finishing materials, assess quality planning, control, and assurance processes related to these materials to identify factors affecting quality, and provide areas of study for a better implementation. The study employed a mixed-method approach, integrating data collected through questionnaires, interviews, observations, and document reviews to deliver insights into current practices, identify prevalent quality issues, various factors affecting the performance of these materials and suggest improvements. The findings reveal significant gaps within the quality management systems, notably a weak quality culture across institutions, which severely undermines adherence to standards and impacts construction outcomes. Furthermore, issues related to unqualified manpower and subcontractor inefficiencies exacerbate the situation. Issues such as limited documentation, lack of formal design reviews, and poor coordination among stakeholders further reflect the systemic challenges faced by these organizations. Ultimately the study aims to uncover the current quality management practices, provide valuable insights into improving the quality management practices of exterior finishing materials in public construction projects for better outcomes, urban aesthetics and development in the city.

Key words: Exterior finishing materials, Quality management, Quality planning, Quality control, Quality assurance, quality assessment, Construction defects

1. INTRODUCTION

The quality management of exterior wall finishing materials plays a critical role in ensuring the durability, aesthetics, and long-term performance of buildings. Key components of quality management include quality planning, control, assurance, and improvement, each vital during different stages of construction. Exterior finishes, such as paints, tiles, curtain walls, and metal cladding, not only contribute to a building's protection and energy efficiency but also define its visual character and influence urban aesthetics. In Addis Ababa, rapid urbanization has led to an increase in public construction projects, many of which emphasize quantity over quality, resulting in poor finishes that degrade quickly and increase maintenance costs. Despite a significant portion of public budgets being allocated to construction materials, inadequate quality management practices persist, often leading to premature deterioration and reduced property value.

This study focuses on the widespread issue of poor-quality exterior finishes in mid-rise public buildings in Addis Ababa. These problems largely stem from inadequate quality management systems, including weaknesses in planning, control, and assurance processes. Frequent defects and substandard material application are common, resulting from poor material selection, environmental stresses, and limited local expertise. Such deficiencies negatively affect building performance and the city's urban aesthetics. The research specifically targets buildings over five stories tall, constructed within the past fifteen years. It aims to identify the types of exterior finishing materials commonly used in these projects. The study also evaluates current quality management practices related to these materials. Additionally, it investigates the factors influencing material quality in this context. This information is critical for construction professionals, suppliers, contractors, and regulatory bodies. The goal is to improve decision-making and ensure better compliance with quality standards. The study also aims to reduce costly repairs and rework caused by poor finishes. Furthermore, it seeks to promote sustainable urban development through enhanced material quality management. However, the research faces challenges due to limited local data and a lack of empirical studies specific to the region. These gaps highlight the need for foundational research tailored to Addis Ababa's unique context. Ultimately, the findings aim to guide improvements in quality management practices for exterior finishes.

2. LITERATURE REVIEW

Building construction relies heavily on materials, and the role of exterior finishes is vital to both performance and aesthetics. Exterior wall finishes, being non-structural elements, include coatings such as metal cladding, curtain walls, paints, and tiles (Aderibigbe and Ogunmakinde, Herzog et al., 2004). These materials must provide environmental protection, durability, and visual appeal. Poor quality in design, material selection, or workmanship can result in severe aesthetic and structural issues (Orji et al., 2019), which emphasizes the importance of a sound quality management system (QMS). A QMS integrates quality planning, control, assurance, and improvement (Orji et al., 2019, Dabok, 2022).

Understanding the properties of building materials mechanical, physical, thermal, and chemical is key to quality control. Important attributes include durability, porosity, thermal conductivity, and resistance to weather and chemicals (Duggal, 2007, Zhang, 2011). Exterior materials must meet specific performance requirements depending on climate and usage, and their improper application can cause degradation, as seen in poorly maintained public buildings in Ethiopia (Alshamrani et al., 2017, Awasho and Alemu, 2023, Thisse, 1998).

Quality management begins with planning defining standards, setting objectives, and identifying risks. Effective planning includes stakeholders like consultants and subcontractors and is continuous throughout the design and pre-construction phases (Thisse, 1998). The selection of facade materials must consider not only durability and cost but also cleanability, sustainability, compatibility, health, safety, and thermal/acoustic performance (Chaturvedi et al., 2023). Quality control ensures conformance with specifications and includes activities such as dimensional checks and lab tests. Organizations must implement systems to verify materials during procurement and installation stages (Benator and Thumann, 2003, Rumane, 2017). Quality assurance, on the other hand, is a broader system of policies and procedures to prevent defects and ensure performance throughout the project lifecycle (Arditi et al., 1998).

2.2. Quality Management in Ethiopia

In Ethiopia, quality management is a critical factor influencing the success of construction projects, particularly during the execution phase, alongside cost and time considerations (Wawak et al.,

2020). As the construction sector plays a key role in economic development and attracts foreign investment, enhancing quality standards is essential for maintaining competitiveness (Shahraki et al., 2018). The Ethiopian Building Proclamation No. 624/2009 provides a regulatory framework for construction quality, covering project approval, material compliance, inspections, and safety measures, as well as land use, sanitation, and energy efficiency. However, the industry remains relatively stagnant and isolated from competitive pressures, resulting in minimal adoption of modern quality control systems (Berhe and Gidey, 2016)

3. METHODOLOGY

The study employed a mixed-method approach, integrating both qualitative and quantitative research methods. This design allowed for a comprehensive analysis of quality management practices for exterior finishing materials in public construction projects in Addis Ababa. By combining different data sources, the research aimed to enhance the richness of the findings and provide a broader perspective on the subject matter. The rationale behind using a mixed-method approach is rooted in its effectiveness in triangulating data, which enhances the validity and reliability of the results.

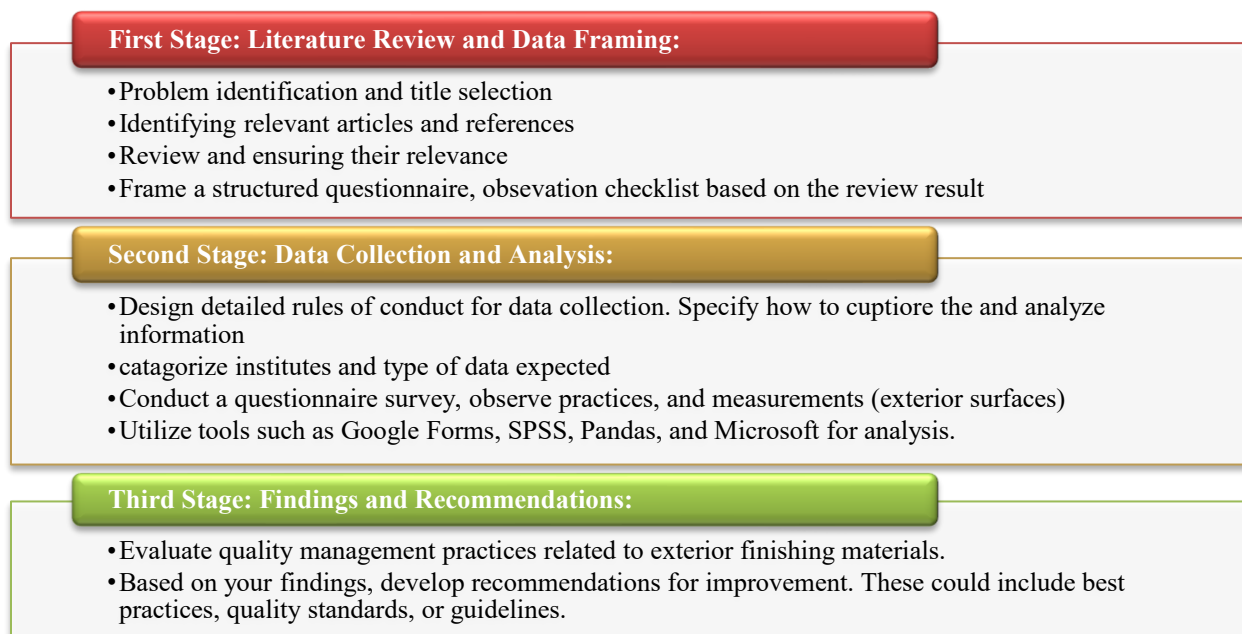


Figure Error! No text of specified style in document..1 Structure of the research developed by the author

Primary data were collected by questionnaires, interviews, observations, and measurements focused on defects, material types, and construction quality. Secondary data included literature, reports, standards, and archival documents.



Figure Error! No text of specified style in document..2 Measurement sample image of exterior finishing of case projects
Participants were selected using purposive and snowball sampling to target professionals and projects relevant to quality management. The sample size was guided by data saturation (Findlay and Li, 1999).

Data were analyzed using content analysis for qualitative data and statistical methods for quantitative data. Triangulation of methods ensured validity and minimized bias throughout the study. (Findlay and Li, 1999) Desta, 2015).

4. FINDINGS AND DISCUSSION

4.1. Commonly Used Materials

The study analyzed the ranking of exterior finishing materials based on questionnaire responses, interviews, and document reviews. The findings identified marble, quartz paint, granite, aluminum cladding, and enamel paint as the top five most commonly used materials.

- **Marble & Quartz Paint** for its affordability, durability, and ease of maintenance in large-scale applications.
- **Granite & Aluminum Cladding** for their aesthetic appeal, durability, and low maintenance. Aluminum cladding's lightweight nature and weather resistance contributed to its popularity.

- **Enamel Paint** commonly used for high-traffic areas due to its glossy, moisture-resistant finish, ensuring long-lasting color and protection from environmental factors.

4.2. Quality management of exterior finishing materials

Quality management of exterior finishing materials is critical for ensuring their durability, performance, and aesthetic value in construction projects. This study evaluates the complete quality management cycle—quality planning, control, assurance, and assessment across projects managed by AAHDC, MOH, and AADCWB. It begins by analyzing the Awareness, Level of commitment and resources; selection of contractors and consultants and Materials selection, design, specification and contract document in planning quality as well as examining how standards, materials, and methods were defined (quality planning), followed by an examination of inspection records, testing procedures, and construction practices (quality control). The study then assesses the effectiveness of oversight and execution of control measures (quality assurance) and finally reviews the long-term performance of materials, identifying causes and impacts of quality failures (quality assessment). This comprehensive evaluation highlights strengths and gaps in current practices, aiming to enhance overall construction quality.

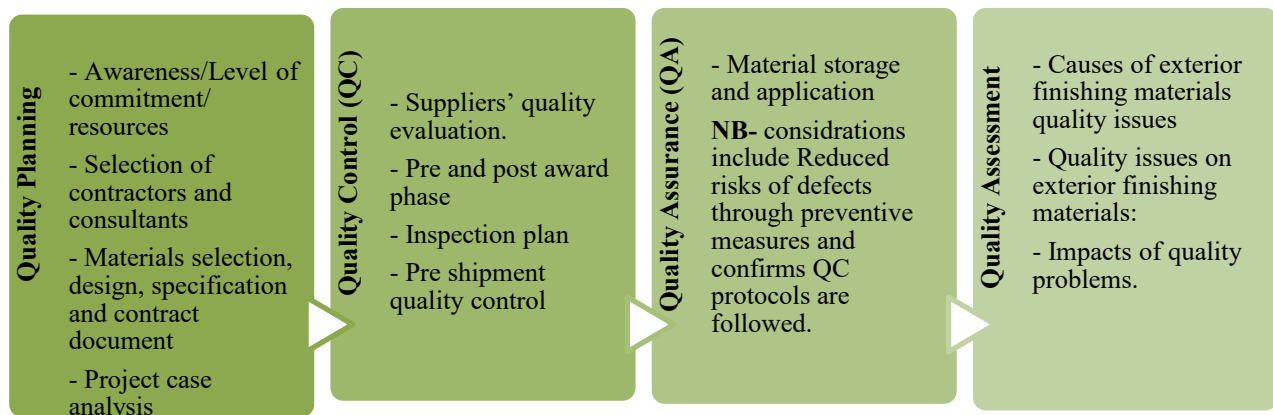


Figure Error! No text of specified style in document..3 Sub titles and key points included under each phase in the quality management.

4.2.1. Quality planning

Quality planning is the first step in managing exterior finishing materials, involving the establishment of performance objectives, material selection, and setting usage standards. Focuses on ensuring requirements of materials durability, aesthetics, and environmental resistance are met.

During this phase, design teams determine selection criteria and outline installation and maintenance processes. Effective quality planning lays the foundation for the overall quality management process contribute to the project's long-term success. This section of analysis assesses main factors affecting quality planning in exterior finish quality and includes the level of awareness, commitment and organizational resources; selection of consultant and contractors and contract documents compliance and reviews as well as case projects analysis.

4.2.1.1. The case of AADCWB

The Addis Ababa Design and Construction Works Bureau (AADCWB) is a government agency responsible for managing and overlooking the planning, design, and construction of infrastructure projects within Addis Ababa owned by the government. The institute handles a wide range of projects, including hospitals, schools, administrative, and public building projects, from small to large scale. Projects under this institute were evaluated based on interviews, questionnaire survey, site observations, and document reviews.

The Addis Ababa Design and Construction Works Bureau (AADCWB) faces several quality planning challenges, including the absence of a formal quality structure and limited leadership engagement, despite having strong information flow and basic quality control manuals. Documentation gaps in material specifications, supervision checklists, and test result endorsements undermine enforcement. Consultant and contractor selection prioritizes technical knowledge and communication but lacks emphasis on quality management experience and authority to reject poor materials, with cost often prioritized over quality credentials. Material selection favors durability and affordability, while sustainability, functionality, and safety are often overlooked. Case studies such as the Bole Sub-City Administration Building and the Children and Youth Theatre expose material compatibility issues, inadequate documentation, Inconsistent specifications, limited worker proficiency and misalignment between design intent and contract details, resulting in delays and cost overruns. Overall, the analysis calls for improved

documentation, integration of design and specifications, and consideration of sustainability and safety to enhance public project quality planning.

4.2.1.2. The case of AAHDC

AAHDC oversees 40/60 and 20/80 housing projects, currently managing 10 projects, with 500 professionals involved. Most projects are near to completion with 95%, with ongoing work at the foundation level for new ones.

AAHDC demonstrates weak commitment to quality management, marked by the absence of quality mission statements, limited staff training, and missing essential documents such as manuals, specifications, and checklists, all of which hinder consistent quality monitoring. While consultants perform well in communication and design interpretation, they lack quality management experience and authority to reject substandard materials. Similarly, contractors show



Figure Error! No text of specified style in document..4 Bole sub city building project (left)
Children and Youth Theatre (Right)

competence in design reading but demonstrate low commitment to removing poor work, with vague contract documents and limited stakeholder involvement further weakening the selection process. Material selection emphasizes durability, availability, and economy, yet overlooks sustainability, safety, and long-term performance. Observations confirm frequent mismatches between design intent and actual site implementation, compounded by installers' mostly entry- to intermediate-level skills. Case analysis reveals that the Arabsa 20/80 project suffered from vague color specifications, documentation gaps, and absent test results, undermining quality control, while the Bole Bulbula 40/60 project showed improvement due to better materials, clearer

specifications, and responsive record-keeping, reflecting the benefits of stronger alignment between design and procurement.



Figure **Error! No text of specified style in document.**5 20/80 condominium housing project, Arabssa site (left), Bole Bulbula 40/60 condominium housing project (right)

4.2.1.3. The Case of MOH

The Ministry of Health (MoH) classifies projects based on scale and manages them accordingly: small projects in-house, medium projects either internally or with consultants, and large projects with external consultants. Professionals are primarily engaged in contract administration and understand their roles in maintaining quality, although fast-track projects are directly assigned to Ethiopian Construction Works Corporation. Contracts are awarded based on technical and financial evaluations, along with the bidder's experience.

The Ministry of Health (MoH) exhibits a weak quality culture with limited leadership involvement, despite having a formal quality structure and stated mission. Internal engagement is poor, and critical documentation—such as quality control manuals, specifications, and QA/QC checklists—is missing, leaving only observation records available onsite. Consultant and contractor selection processes highlight strong communication and design skills but lack quality management experience and authority to reject inferior materials. Weak quality information flow and vague specifications further hinder effective implementation, particularly in finishing works. Material selection focuses on durability, cost-efficiency, and availability, yet neglects key aspects such as functional performance, sustainability, safety, and compatibility. Budget constraints, political interference, and poor specification detail negatively impact quality control. Case studies reinforce

these findings: the St. Paul Cardiac Hospital project experienced cost and time overruns due to scope changes and material shortages, while the St. Peter General Hospital faced facility readiness issues stemming from incomplete designs and rushed handover. These outcomes underscore the



Figure **Error! No text of specified style in document..6** St Paul hospital, cardiac need for stronger leadership, clearer specifications, and improved training and documentation to enhance quality in MoH construction projects.

4.2.2. Quality Control

Quality control (QC) of building exterior finishing materials is essential to ensure durability, aesthetics, and resistance to environmental factors. This process involves careful material selection, compliance with standards, proper storage and handling, and skilled installation guided by clear inspection protocols. This section evaluates the QC measures applied to exterior finishing materials in Addis Ababa government building projects. Key areas assessed include Suppliers' quality evaluation, Pre- and Post-Award Phase, Inspection Plan, Pre-shipment Quality Control using data from project records, inspections, and professional input.

4.2.2.1. The case of AADCWB

Suppliers' quality evaluation

AADCWB evaluates suppliers based on factors like experience, capacity, quality, delivery schedule, financial stability, and reputation. However, technical personnel, facility conditions, and service infrastructure are largely overlooked. This gap in evaluation criteria leads to inconsistent supplier performance and substandard material quality. Furthermore, fabrication tests and other QC documentation are often missing or inconsistently used. Time constraints discourage rejection of inferior materials, as re-sourcing may delay large-scale projects. These issues weaken the

quality assurance process, increasing the risk of defects and long-term deterioration in exterior finishes. Results show that supplier oversight is incomplete, particularly in technical and operational capabilities, contributing to weaker material performance and increased rework or maintenance costs.

Pre- and Post-Award Phase

During procurement, contractors and professionals are briefed on quality expectations. Contractors typically focus on sourcing affordable yet acceptable materials, and the purchasing team provides suppliers with specifications, stock capacity needs, and quality requirements. Though this shows intent to integrate QC early, gaps in post-award monitoring reduce its impact.

Inspection Plan

AADCWB's inspection plan includes visual inspections, lab tests, and checks on quantities, dimensions, packaging, and shipping marks. An in-house lab conducts tests on the physical and mechanical properties of materials, while architectural appearance is first verified by the contractor and then approved by the consultant. Quality inspection service providers are selected based on experience, location, availability, and cost considerations. The plan also involves coordination of test scope, scheduling, logistics, determining attendees and participants, arranging logistical support for inspectors, and reaching agreements on certifications. Despite this structure, the scope of testing is limited, especially for materials like stone, brick, paint, and glass, compared to standard expectations.

While cost-effectiveness drives procurement, material quality is not overlooked. The purchasing team provides clear specs and testing requirements to suppliers, aiming for a balance between affordability and compliance.

Pre-shipment Quality Control

Pre-shipment quality control ensures that bulk materials match approved samples and meet specified standards. Quality certificates are documented, and non-conforming materials are addressed before delivery. Survey results indicated that the highest compliance was in sample approvals by consulting engineers before bulk delivery (92%) and presentation of test results before purchase (91%). In contrast, the lowest figures were for tests conducted at the commencement of materials (37%) and when changes in material sources are observed (45%).

while approval and documentation practices are largely in place, improvements are needed in enforcing initial material testing and updating procedures when material sources change, to ensure consistent quality across all stages.

4.2.2.2. The Case of the AAHDC Project

Suppliers' Quality Evaluation

Addis Ababa Housing Development Corporation (AAHDC), supplier evaluation prioritizes factors like experience, capacity, schedule, financial stability, and overall reputation. However, less attention is given to technical personnel, facility management, and service support, increasing the risk of substandard materials. Both documents and interviews highlight rare use of fabrication tests and inadequate documentation of quality control practices, contributing to potential defects in exterior finishes.

Pre- and Post-Award Phases

Interviews and documents reveal that AAHDC emphasizes cost efficiency over quality, often engaging small enterprises to reduce expenses. While specifications and testing requirements are formally issued, there is limited follow-up on compliance. The absence of robust quality monitoring and technical oversight leads to inconsistent material standards and undermines construction durability.

Inspection Plan

Inspections involve visual assessments, laboratory testing by the Institute of Ethiopian Standards (IES), and consultant approval of architectural finishes. While processes for selecting inspection providers and coordinating logistics are in place, gaps exist in the scope of material testing, particularly for brick, ceramic, paint, and glass. Quality test obligations are not clearly stated in contracts, and practices such as testing at commencement or under resident engineer supervision are often absent. The current system, while partially effective, lacks comprehensive enforcement of quality standards, highlighting the need for broader testing coverage and stronger technical oversight to ensure durable and compliant exterior finishes in AAHDC projects.

Pre-Shipment Quality Control

pre-shipment quality control ensures materials match approved samples and comply with specifications. The process involves documenting quality certificates, verifying order dimensions, and identifying non-conforming materials for corrective action prior to delivery.

Survey results indicate strong compliance in some areas, with 90% confirming that material samples are reviewed and approved by consulting engineers before bulk purchases, and 89% affirming pre-delivery inspections. However, quality testing at the commencement of materials is less consistently applied, with only 35% confirming this practice. Similarly, just 48% noted testing upon changes in material sources. These findings highlight AAHDC's strength in approval and documentation processes but point to the need for enhanced early-stage and source-change testing to ensure consistent quality throughout the supply chain.

4.2.2.3. The Case of the MoH Project

Suppliers' Quality Evaluation

In the MoH project, supplier evaluation is handled by contractors with active involvement from clients and consultants for material acceptance or rejection. The evaluation emphasizes key factors such as experience, quality, delivery schedule, and financial stability, while placing little focus on technical personnel, facility/housekeeping, and labor relations. This imbalance has contributed to challenges in maintaining consistent material quality and durability, as well as delays when materials are rejected due to poor documentation or inadequate quality control procedures. These gaps highlight the need for improved supplier evaluation practices, including greater emphasis on technical capacity and structured quality control measures, to enhance performance and minimize risks of using substandard materials in MoH projects.

Pre and Post Award Phase

In MoH projects, contractors are primarily responsible for material selection, emphasizing affordability and acceptable quality. The purchasing team provides suppliers with detailed specifications and expectations related to testing, certifications, and shop visit schedules. Both interviews and document reviews confirm that while these steps help maintain procedural efficiency, there is limited emphasis on comprehensive quality assurance practices, raising concerns about material consistency and long-term performance.

Inspection Plan

MoH relies on the Institute of Ethiopian Standards (IES) to perform physical and mechanical tests on exterior finishing materials, with contractors inspecting architectural appearance and consultants granting approval. Although samples are reviewed prior to bulk delivery, there are no clearly stated quality test obligations in contracts, and tests at the commencement stage or under resident engineer supervision are not standard practice. Gaps in testing scope for materials such as brick, stone, and glass, emphasizing the need to enhance the extensive and rigorous quality control procedures.

Pre-shipment Quality Control

Ensures bulk materials align with approved samples. The process includes verifying orders against specifications, documenting quality certificates, and identifying non-conforming materials for correction before delivery. Both interview and document review findings confirm that certification documentation, order verification, and handling of defects are standard practice. Survey data shows that 89% of respondents confirmed material tests and samples are presented to the consulting engineer before bulk purchase, and 88% agreed samples are approved prior to site delivery highlighting strong adherence to sample-based verification. In contrast, only 40% testing at material commencement, and 50% noted testing occurs when sources change. These figures suggest that while MoH performs well in document-based and visual controls, it should improve early-stage and source-change testing practices to strengthen material quality assurance.

Table Error! No text of specified style in document..1 Quality Control assessment findings summarized

Category	AADCWB	AAHDC	MoH
Suppliers' Quality Evaluation	Focus on experience, capacity, financial stability, and reputation. Less emphasis on technical personnel and service organization.	Strong focus on experience and financials, but lacks technical expertise and structured quality control.	Prioritizes experience, quality, schedule, and financials. Lack technical staff, housekeeping, and labor relations.
Pre- and Post-Award Phase	Contracts emphasize quality. Consultants involved in approving materials. Some gaps in enforcing early-stage testing and source-change checks.	Procurement prioritizes cost and local enterprise involvement. Technical oversight and follow-up mechanisms are weak.	Contractor-driven procurement focusing on affordability. Specification briefings done, but broader QA mechanisms are minimal.
Inspection Plan	Uses IES tests and visual inspections. Coordination defined, but limited range of tests for some materials like paint and glass.	Involves IES and consultants for checks. Contract lacks detailed test obligations. Tests not routine at commencement; source-change testing weak.	IES handles physical testing; consultants approve appearance. Limited testing scope for key materials; contract lacks clear QA obligations.
Pre-Shipment Quality Control	Certificates documented; sample matching ensured. 91% confirmed test approval before purchase; 92% sample approval before delivery.	Focus on matching samples, documentation of certificates. 90% confirm test approvals before purchase; 89% for pre-delivery approval.	Verifies bulk against approved samples. 89% confirm pre-purchase approvals, 88% pre-delivery. Weak testing at commencement (40%).

4.2.3. Quality Assurance

Quality assurance in government construction projects plays a critical role in ensuring that building exterior finishing materials meet durability, aesthetic, and design compliance standards. This process includes oversight of material storage, handling, skilled labor use, and the installation of materials. In Addis Ababa, the AADCWB, AAHDC, and MoH are examined for their performance in these areas. Across the board, the effectiveness of these institutions depends largely on how well-defined their quality assurance procedures are, including training, storage protocols, and precision during material installation.

4.2.3.1. The Case of the AADCWB

At AADCWB, the quality assurance system is structured through the design, contract administration, and audit departments, with each team using stage-specific checklists. While a full spectrum of quality control activities is formally included from design to documentation survey results reveal both strengths and weaknesses.

Material Storage and Application

Cement storage was reported as optimal by 95% of respondents, and material approval before delivery received 92% confirmation, showing strong storage and procedural controls. However, only 37% confirmed material testing at the commencement of work, and 45% confirmed testing upon source change, exposing weaknesses in early-stage and adaptive quality control practices. These findings point to the need for more rigorous implementation of testing protocols to improve consistency and reliability.

Children and Youth Theatre: Demonstrate well-managed material storage and skilled personnel deployment. Despite overall effective storage and experienced labor, installation challenges arose when a change from 20mm granite (1600*800mm) to 30mm granite cladding introduced unforeseen logistical demands, requiring frame redesign and revised shop drawings. Similarly, aluminum cladding showed signs of dampness potentially caused by chemical or environmental factors, stressing the need for proactive environmental condition monitoring.

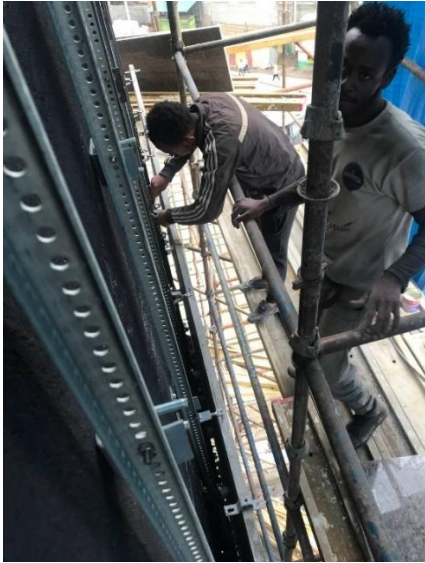


Figure Error! No text of specified style in document..7 Installation of stone cladding at children and youth theatre

Bole Sub City administration building: The Bole Sub City project followed proper storage practices and used appropriate machinery for installation. Yet, it faced installation difficulties with marble cladding due to heavy loads and detailing issues. As with the previous project, dampness on aluminum window frames was observed, hinting at recurring issues in managing weather-sensitive materials. These observations suggest that while material storage is generally sound, installation quality and responsiveness to material-specific challenges remain key areas for improvement.

4.2.3.2. The case of AAHDC

In the Bole Bulbula 40/60 and Arabsa 20/80 condominium projects, exterior finishing materials were generally stored appropriately in delegated areas until needed. Application was handled by small enterprises composed of unemployed laborers organized by local government offices, following short-term training programs. Manual plastering tools were predominantly used. However, the use of inexperienced workers led to visible defects on both exterior and interior finishes, indicating a clear gap in labor competency and oversight.

4.2.3.3. The case of MoH

MoH follows a decentralized quality assurance approach, with contractors taking primary responsibility for material selection and supply, while consultants and project managers oversee

approval and compliance. QA protocols include pre-shipment quality checks, with materials tested by the Institute of Ethiopian Standards (IES) before bulk procurement. However, gaps exist in supervision and documentation, leading to inconsistencies in material quality. While samples are generally approved before delivery, tests at the commencement of material use are not standard practice, and comprehensive inspections are often lacking. These shortcomings in QA processes contribute to material defects and impact the long-term performance and safety of exterior finishes in MoH projects.

4.2.4. Quality Assessment

Quality assessment of exterior finishing materials focuses on evaluating their long-term performance, durability, and alignment with design requirements. It is critical for ensuring that materials can resist weathering, physical wear, and environmental degradation, while also maintaining functionality and aesthetics. This section explores not only the technical performance of materials but also the underlying causes of quality failures, such as manufacturing inconsistencies, inadequate supervision, and poor material choices.

4.2.4.1. Causes of Exterior Finishing Materials Quality Issues

Quality challenges in public construction projects are poor funding, lack of quality culture, corruption, design flaws, poor material quality, unqualified manpower, subcontractor inefficiencies, absence of formal quality management strategies, weak communication, weak supervision, lack of leadership and senior management involvement. These factors lead to substandard outcomes, elevated maintenance needs, and unmet project expectations.

Table Error! No text of specified style in document..2 Causes of exterior finishing materials quality issues

Category	AADCWB	AAHDC	MOH	Remark
Weak Supervision	✓	✓	✓	All institutions report inadequate supervision as a key issue.
Poor Funding	✓	✓	✓	Funding constraints are common across all cases, affecting quality outcomes.
Subcontractor Inefficiencies	✓	✓	✓	Ineffective subcontractor performance contributes significantly to defects.

Category	AADCWB	AAHDC	MOH	Remark
Lack of Formal Quality Strategy	✓	✓	✓	Absence of structured quality frameworks is evident across all projects.
Communication Issues	✓	✓	✓	Barriers to information flow and coordination hinder quality control.
Material Compliance Gaps	✓	✓	O	Present in AADCWB and AAHDC; MOH has more consistent compliance.
Leadership Engagement	✓	✓	✓	Leadership involvement is consistently weak, limiting quality oversight.
Corruption	✓	✓	✓	Integrity issues influence project performance and procurement transparency.

The causes of exterior finishing material quality issues across AADCWB, AAHDC, and MOH share common systemic deficiencies. All three institutions struggle with weak supervision, poor funding, subcontractor inefficiencies, lack of structured quality strategies, communication barriers, and insufficient leadership engagement. AADCWB is hampered by material mismatches and design flaws, while AAHDC suffers from inconsistent material sourcing and minimal leadership involvement. MOH shows comparatively better organization with structured testing procedures, but its implementation is undermined by oversight limitations and contextual challenges like corruption and funding constraints.

4.2.5. Quality Problems on exterior finishing materials:

4.2.5.1. The case of AADCWB

Bole Sub City Administration Building: The project primarily used marble cladding and quartz paint. Despite laboratory tests and inclusion in the project design, cladding failures occurred within the first year due to incomplete material specifications, poor inspection processes, improper surface preparation, and inadequate construction techniques. As a result, 580 m² out of the total 7,034 m² of marble cladding fell off and was later replaced with granite paint. This highlights significant flaws in material selection, detailing, and execution, leading to early deterioration and the need for renovation within two years of completion.



Figure **Error! No text of specified style in document..8** Defects seen on Bole sub city administration building (B+ G+12)

Children and Youth Theatre Building: aluminum cladding exhibited rusting and corrosion due to exposure to moisture and atmospheric humidity, failure in expansion joint fillings, and imperfections in fixing and joints. Dampness observed on the east-facing wall revealed further gaps in cladding application and moisture protection. These defects highlight critical weaknesses



Figure **Error! No text of specified style in document..9** Defects seen on children and youth theatre building

in both material suitability and installation practices.

4.2.5.2. The Case of AAHDC

Arabsa 20/80 and 40/60 Condominium Housing Projects: Defects observed within a year of completion included incompatibility of paint with backing materials, leading to **ununiform coloring and texture**, and application of paint on damp surfaces, which resulted in peeling due to moisture infiltration and weather exposure. Additional issues were noted in plastering, such as erosion, deterioration, and organic growth, particularly on walls exposed to leaking or misaligned



Figure Error! No text of specified style in document..10 Defects seen on 20/80

downpipes. Exterior glazing works showed glass cracks and gaps due to poor frame sizing, and metal elements suffered from rusting, corrosion, and expansion joint failures.

Bole Bulbula 40/60 Condominium Housing Project: Exterior finishing showed several flaws stemming from improper paint application techniques, particularly painting over damp surfaces, which caused early peeling due to rain. The paint used was also incompatible with the backing surface, leading to texture inconsistency. Plastering issues included wavy finishes, incorrect bedding, organic growth, and expansion of metal components, indicating poor surface preparation and low-quality workmanship. Exterior glazing also exhibited glass breakages, misalignment-related gaps, and metal frame corrosion. The result reinforces the need for effective site supervision, strict adherence to material compatibility standards, and better training for application teams. Implementing a structured quality management system remains a critical step for future improvements.



Figure Error! No text of specified style in document..11 Defects seen

4.2.5.3. The Case of Ministry of Health (MOH)

St. Paul Millennium Hospital: Key exterior finishing defects included application of paint on damp surfaces, which led to peeling due to weather exposure. Poor workmanship, especially in roof slope, coping, and gutter installation, caused paint discoloration, internal wall dampness, and algae growth. Exterior glazing works showed glass cracks and breakages alongside inadequate sealant application in metal windows. These issues reflect insufficient surface preparation, weatherproofing, and installation standards.



Figure Error! No text of specified style in document..12 Defects seen on exterior finishes of St Paul millennium hospital (MOH)

St. Peter General Hospital: Observed issues included weather-related paint failure due to painting on moisture-prone surfaces and poor workmanship in drainage elements, similar to St. Paul. Additional problems in plastering were evident, such as organic growth, cracks, material aging, and falling plaster. Glazing defects mirrored those at St. Paul, with glass breakages and sealant failure. Furthermore, exterior metal frames suffered from rust and corrosion, as well as glass cracking due to environmental exposure.



Figure Error! No text of specified style in document..13 Defects seen on exterior finishes of St. Peter hospital (MOH)

4.2.6. Impacts of quality problems.

The impacts of quality problems across AADCWB, AAHDC, and MOH reflect consistent institutional challenges. All three entities face high costs of reworks and maintenance, idle buildings, claims, and contract terminations that reduce productivity and prolong construction timelines. These deficiencies also contribute to widespread customer dissatisfaction and diminished aesthetic appeal of public buildings. The evidence underscores the need for comprehensive improvements in early project planning, preventive maintenance strategies, and tighter quality enforcement mechanisms to achieve better construction outcomes and long-term efficiency.

Table Error! No text of specified style in document..3 Impacts of Quality Problems

Impact Category	AADCWB	AAHDC	MOH
High cost of reworks	✓	✓	✓
High maintenance/operation cost	✓	✓	✓
Contract termination	✓	✓	✓
Claims occurrence	✓	✓	✓

Impact Category	AADCWB	AAHDC	MOH
Idle buildings (due to rework)	✓	✓	✓
Reduction in productivity	✓	✓	✓
Change orders	✓	✓	✓
Extended construction period	✓	✓	✓
Customer dissatisfaction	✓	✓	✓
Low aesthetic value	✓	✓	✓

5. CONCLUSION

This study on the quality management of exterior finishing materials in Addis Ababa’s public construction projects specifically within AADCWB, AAHDC, and MOH uncovered widespread challenges across quality planning, control, assurance, and assessment. Commonly used materials like marble, granite, enamel paint, aluminum, and quartz paint are selected for their durability and weather resistance. However, recurring defects in other materials such as glass, cement render, and metal frames stem from poor workmanship, inadequate material selection, and weak maintenance. Contributing factors include flawed organizational structures, lack of commitment to a quality culture, incomplete specifications, corruption, and the involvement of unqualified contractors and consultants.

The study found major deficiencies in quality planning due to vague specifications, missing manuals, and poor coordination among stakeholders. Quality control showed inconsistencies between approved samples and bulk deliveries, while reliance on in-house testing proved insufficient. Quality assurance efforts were hampered by inadequate supervision, communication gaps, and rushed timelines. These issues led to rework, high maintenance costs, customer dissatisfaction, and diminished aesthetics. Ultimately, the research underscores the urgent need for stronger leadership, comprehensive planning, stricter enforcement, and a structured quality management framework to ensure better construction outcomes and lasting exterior finishes.

Based on the identified gaps in the quality management practices of exterior finishing materials in public construction projects in Addis Ababa, several key areas are recommended for future research. One critical area is the impact of design completeness on the quality of finishing materials, including how early and detailed design influences quality planning, control, and

assurance processes. Another important area is the effectiveness of design review systems in verifying and enforcing specification accuracy during implementation. Research should also focus on the role and application of scientific quality assurance techniques, such as modeling and analysis tools, in identifying and managing quality deviations. Additionally, the relationship between the technical proficiency of installers, painters, and plasterers and the quality of finishing works warrants investigation, particularly regarding training needs and workforce selection criteria. Comparative studies across different public construction projects are also needed to assess the consistency and effectiveness of quality assurance practices, including contractor compliance, presence of trained quality personnel, and information flow within quality management systems. These areas of study will provide a foundation for developing more robust and effective quality management frameworks for exterior wall finishes in the construction sector.

6. Guideline for improvement

	Guideline	Details/Actions
Quality Planning & Design Review	Comprehensive Quality Planning	Implement quality planning at the project's inception and continue through its lifecycle. Develop detailed quality management manuals and incorporate them into job descriptions. Ensure all designs and material specifications are accurate and complete before procurement.
	Design Review System	Establish a formal design review process to verify design completeness. Conduct design checks before material procurement to avoid design-related quality issues.
Communication & Coordination	Enhanced Communication Protocols	<ul style="list-style-type: none"> - Set up formal communication channels between contractors, consultants, and clients. - Schedule regular meetings to monitor project progress and resolve issues promptly. - Establish a feedback mechanism to address concerns efficiently.
Supervision & Quality Control	Stricter Supervision and Compliance Criteria	<ul style="list-style-type: none"> - Strengthen on-site supervision to ensure all tasks meet the required quality standards. - Implement stricter quality control measures for materials and workmanship. - Monitor subcontractors' performance and compliance with quality standards.
Professional Development & Training	Extensive Training and Guidelines	<ul style="list-style-type: none"> - Invest in professional development for staff involved in quality management. - Provide clear guidelines on quality control and quality assurance practices. - Offer training programs to enhance the skills of installers, painters, and plasterers, focusing on meeting material specifications and best practices.
Quality Assurance & Performance Measurement	Quality Assurance System	<ul style="list-style-type: none"> - Implement a formal quality assurance system to monitor project quality from start to finish. - Continuously supervise, measure performance, and implement corrective actions as needed. - Use quality performance metrics to identify and address issues proactively.
Ethical Practices & Contractor Selection	Stricter Oversight and Accountability	<ul style="list-style-type: none"> - Enforce transparency and ethical practices in project execution. - Ensure that contractors are selected based on competence and not through unethical practices. - Apply strict oversight to mitigate corruption and ensure adherence to quality standards.
Project Management & Time Planning	Proper Time Management and Resource Allocation	<ul style="list-style-type: none"> - Ensure project timelines are realistic and account for the necessary quality control stages. - Allocate appropriate financial resources to meet quality standards for exterior finishing materials. - Regularly adjust budgets to reflect actual costs for achieving quality outcomes.
Workmanship & Material Inspection	Strict Standards for Workmanship and Materials	<ul style="list-style-type: none"> - Conduct thorough inspections of key areas prone to defects, such as plastering, glazing, and paint application. - Enforce quality standards for both workmanship and exterior finishing materials. - Establish criteria for corrective actions in case of non-conformance to quality requirements.

- ADERIBIGBE, O. O. & OGUNMAKINDE, O. E. MATERIAL SELECTION FOR EXTERNAL FINISHES: A TOOL FOR SUSTAINABILITY IN SOUTH WEST NIGERIA.
- ALSHAMRANI, O., MUJEEBU, M. A., ASHRAF, N., AL-GHONAMY, A. & AICHOUNI, M. 2017. Selection of External Wall Material by LCC Technique for Office-cum-Commercial Building in the Eastern Province of Saudi Arabia. *Journal of Architecture and Planning*, 29, 243-256.
- ARDITI, D., GUNAYDIN, H. M. J. J. O. C. E. & MANAGEMENT 1998. Factors that affect process quality in the life cycle of building projects. 124, 194-203.
- AWASHO, T. T. & ALEMU, S. K. 2023. Assessment of public building defects and maintenance practices: Cases in Mettu town, Ethiopia. *Heliyon*, 9, e15052.
- BENATOR, B. & THUMANN, A. 2003. *Project Management & Leadership Skills for Engineering & Construction Projects*, CRC Press.
- BERHE, L. & GIDEY, T. J. I. I. M. 2016. Assessing the awareness and usage of quality control tools with emphasis to statistical process control (SPC) in Ethiopian manufacturing industries. 8, 143.
- CHATURVEDI, R., DAROKAR, H., PATIL, P., KUMAR, M., SANGEETA, K., KOITHYAR, A. & KADHIM, A. 2023. Maximizing towards the Sustainability: Integrating Materials, Energy, and Resource Efficiency in revolutionizing Manufacturing Industry. *E3S Web of Conferences*, 453.
- DABOK, M. M. 2022. *A Training and Skills Development Conceptual Framework for Construction Technicians in Nigeria*.
- DUGGAL, S. K. 2007. *Earthquake resistant design of structures*, Oxford university press New Delhi.
- FINDLAY, A. M. & LI, F. 1999. Methodological issues in researching migration. *The Professional Geographer*, 51, 50-59.
- HERZOG, T., KRIPPNER, R. & LANG, W. 2004. *Facade Construction Manual*, Birkhäuser.
- ORJI, S., OBODOH, D. A. & FELIX EMENIKE, O. 2019. QUALITY MANAGEMENT PRACTICES IN CONSTRUCTION; A KEY TO SUCCESSFUL BUILDING PROJECT DELIVERY. *Imperial Journal of Interdisciplinary Research (IJIR)*, 2, 531-538.
- RUMANE, A. R. 2017. *Quality management in construction projects*, CRC press.
- SHAHRAKI, S., SAGHATFOROUSH, E., RAVASAN, A. J. J. O. E., PROJECT & MANAGEMENT, P. 2018. Identification and Classification of Factors Affecting the Performance of Building Supervisor Engineers for Construction Industry. 8.
- THISSE, L. C. J. Q. P. 1998. *Advanced quality planning: A guide for any organization*. 31, 73-77.
- WAWAK, S., LJEVO, Ž. & VUKOMANOVIĆ, M. 2020. Understanding the Key Quality Factors in Construction Projects—A Systematic Literature Review. 12, 10376.
- ZHANG, H. 2011. *Building materials in civil engineering*, Elsevier.