Key Dimensions of Discrepancy between Approved Design and Actual Implementation in Addis Ababa Private Residential Construction Projects: Cause, Effect and Mitigation Strategies

WESENU KAFYALEW

A Thesis Submitted to the department of Civil Engineering

College of Civil Engineering and Architecture

Presented in Partial Fulfillment of the Requirement for the Degree of Master's in Civil Engineering (Specialized in Construction Engineering and Management),

Office of Graduate Studies

Adama Science and Technology University

Adama, Ethiopia

May, 2025

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DECLARATION

I hereby declare that this Master Thesis entitled “key dimensions of discrepancy between approved design and actual implementation in Addis Ababa private residential construction projects: cause, effect and mitigation strategies” is my original work. That is, it has not been submitted for the award of any academic degree, diploma or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation

Name: Wesenu Kafyalew

Signature: ______________________

Date: ______________________

RECOMMENDATION

I, the advisor of this thesis, hereby certify that I have read the revised version of the thesis entitled "key dimensions of discrepancy between approved design and actual implementation in Addis Ababa private residential construction projects: cause, effect and mitigation strategies" prepared under my guidance by Wesenu Kafyalew Senbeta submitted in partial fulfillment of the requirements for the degree of Mater's of Science in Civil Engineering. Therefore, I recommend the submission of revised version of the thesis to the department following the applicable procedures.

__________________________	___________________	________________
Major Advisor	Signature	Date

APPROVAL OF ADVISOR

I, the advisors of the thesis entitled “key dimensions of discrepancy between approved design and actual implementation in Addis Ababa private residential construction projects: cause, effect and mitigation strategies” and developed by Wesenu Kafyalew Senbeta hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

__________________________ _______________________ ________________

Major Advisor Signature Date

APPROVAL BOARD OF REVIEWERS

We, the undersigned, members of the Board of Examiners of the final thesis open defense by Wesenu Kafyalew Senbeta have read and evaluated the thesis entitled "key dimensions of discrepancy between approved design and actual implementation in Addis Ababa private residential construction projects: cause, effect and mitigation strategies" and assessed the understanding of the candidate about the final research. This is, therefore, to certify that the final thesis is accepted and we recommend the implementation of the thesis for partial fulfillment of the requirement of the degree of Master of Science in Civil engineering (Specialized by Construction Engineering and Management).

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Internal Examiner	Signature	Date
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External Examiner	Signature	Date

Finally, approval and acceptance of the thesis is contingent upon submission of its final copy to the Office of Postgraduate Studies (OPGS) through the Department Graduate Council (DGC) and College Graduate Committee (CGC).

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College Dean	Signature	Date
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Office of Postgraduate Studies, Dean	Signature	Date

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BIM	Building Information Modeling
RII	Relative Important Index
SPSS	Statistical Package for the Social Sciences
GC-1	Grade One General Contractors
GC-5	Grade Five General Contractors
BC-1	Grade One Building Contractors
BC-5	Grade Five Building Contractors

ABSTRACT

Approved designs serve as blueprints to guide project execution and ensure that the final structure fits the clients' needs and regulatory criteria. However, discrepancies between approved designs and actual implementation often arise during construction, resulting in a range of negative implications for project stakeholders. The study aims to investigate the cause and effects of the gap between approved designs and their actual implementation and developing strategies to minimize implementation gap on private residential construction projects in Addis Ababa. The specific objectives include identifying the causes of variance, to assess the legal and quality impacts of discrepancies, and to developing effective strategies and best practices to minimize the gap between approved designs and actual implementation in order to improve project outcomes and efficiency. To achieve these objectives, the study would employ a quantitative research approach. Data are acquired by using a questionnaire. The research design was used a descriptive research design; a stratified sampling and simple random sampling technique was use. The data analysis methods would use descriptive analysis techniques using fuzzy TOPSIS technique. The study outcomes revealed the main causes are poor communication among stakeholders (CC value 1.0); design changes (CC value 0.795); lack of strict enforcement (CC value 0.777); inadequate project planning (CC value 0.598); and shortage or poor quality (CC value 0.598). Addressing these dominant causes of variance requires a multifaceted approach that emphasizes communication, change management, regulatory compliance, thorough planning, and material quality assurance. The discrepancies between approved designs and actual implementations in residential construction projects in Addis Ababa have far-reaching impacts that compromise safety (CC value 1.0), structural integrity (CC value 0.91), quality (CC value 0.74), legal compliance (CC value 0.73), and durability (CC value 0.72) . Addressing these discrepancies through better oversight, adherence to regulations, and quality control measures is essential to ensure safe and sustainable construction practices in the region. The study outcomes also revealed that, effective strategies and best practices for minimizing the gap between approved designs and actual implementation in construction projects, with the aim of improving project outcomes and enhancing efficiency. The key findings emphasize the importance of a proactive and multifaceted approach, including: strengthening and consistently enforcing building codes and regulations (CC value 1.0), promoting and ensuring the use of quality and certified building materials (CC value 0.80), mandating and enforcing comprehensive on-site supervision (CC value 0.76), conducting regular quality control and quality assurance inspections (CC value 0.73), and establishing a formal change management process for client requests (CC value 0.52). These strategies promote accountability, transparency, and proactive risk management throughout the construction lifecycle, fostering a culture of quality and compliance that leads to safer, more functional, and more sustainable buildings.

Key words: Approved Design, Actual Implementation, Discrepancy, Implications and Mitigation Strategies.

CHPTER ONE

1. INTRODUCTION

1.1.Background of Study

The construction industry is distinguished by complicated processes involving numerous stakeholders, including architects, engineers, contractors, and clients. In private residential construction projects, the design phase is crucial stage it establishes the framework for the entire project. Approved designs serve as blueprints to guide project execution and ensure that the final structure fits the clients' needs and regulatory criteria (Luo et al., 2017). However, discrepancies between approved designs and actual implementation often arise during construction, resulting in a range of negative implications for project stakeholders.

These discrepancies can take many forms, including changes to structural elements, noncompliance with requirements, variances in materials utilized, and changes to construction procedures. Poor stakeholder communication, a lack of compliance monitoring, insufficient training, and unrealistic timetables are all contributing factors to such differences. As a result, these misalignments can cause additional costs, project delays, substandard quality, safety concerns, and legal battles with clients or regulatory bodies (Aslam et al., 2019).

In residential construction, adherence to approved designs is essential not only for meeting aesthetic and functional expectations but also for ensuring compliance with safety regulations and building codes. However, discrepancies often arise between the approved designs and the actual implementation of these designs in the field, leading to significant legal and quality implications. Recent studies have shown that discrepancies between approved designs and the actual as-built conditions can result in substantial legal challenges for construction firms and property owners. Non-compliance with local building regulations can lead to fines, demolition orders, and legal disputes, which not only disrupt construction timelines but also incur additional costs (Choudhry et al., 2017). The potential need for legal recourse highlights the importance of understanding the implications of design discrepancies, particularly within the context of private residential construction projects.

Furthermore, the quality of residential buildings is directly affected by discrepancies during implementation. Deviations from approved designs can compromise the structural integrity of a building, leading to safety hazards and long-term maintenance issues (Asmerom, 2021; Milion et al., 2021). As these structures age, non-compliance with original specifications may also result in deteriorating quality that affects the living conditions of occupants. The impact on quality is especially critical for G+3 residential projects, where safety considerations such as load-bearing capabilities and adherence to fire and safety codes are paramount. Moreover, addressing these discrepancies is critical for the overall industry environment, as they can contribute to a broader trend of mistrust in building methods. When clients see repeated departures from approved plans, their trust in contractors and the industry erodes, with far-reaching consequences for market dynamics and professional reputations.

Therefore, this study focuses on G+3 and above existing private residential construction projects that have been completed before five years. This study was addresses critical issues within the private residential construction sector in Addis Ababa by identifying causes of variances, assessing their legal and quality impacts of discrepancies, and proposing actionable strategies to improve compliance and project efficiency. The findings were contribute valuable insights for practitioners, policymakers, and researchers aiming to enhance the effectiveness of construction practices on the private residential construction projects in Addis Ababa.

1.2.Statement of the Problems

Despite the importance of adhering to approved designs for ensuring safety, regulatory compliance, and quality, there is a lack of comprehensive understanding regarding the underlying causes of these discrepancies. Factors such as communication breakdowns, resource constraints, client-initiated changes, and organizational culture may contribute to the observed variances, affecting project delivery. Furthermore, the failure to effectively implement approved designs not only presents potential legal challenges such as non-compliance with local building codes and safety regulations but also compromises the quality of the constructed residences, leading to safety hazards and dissatisfaction among occupants (Asmerom, 2021; Bolanle, 2024; Yihdego, 2017).

In the context of private residential construction projects, discrepancies between approved designs and as-built conditions pose significant challenges, particularly regarding the financial aspects managed by banks and financial institutions. These discrepancies, which may arise from design changes, communication breakdowns, regulatory issues, or resource limitations, can lead to a gap between what has been approved and what is ultimately constructed (Choudhry et al., 2017). This gap raises concerns about compliance with building codes, safety standards, and overall project quality.

The existing body of research has not adequately addressed the specific context of private residential construction projects in Addis Ababa, particularly regarding the legal and quality implications tied to these discrepancies. Consequently, this knowledge gap presents a pressing need to assess the impacts of such discrepancies, as well as to identify effective strategies and best practices to minimize or eliminate the implementation gap (Choudhry et al., 2017; Rahman et al., 2017; Yihdego, 2017).

Finally, a clear need exists for the development of effective strategies and best practices to minimize the design implementation gap. General best practices from other contexts are not necessarily suited to the specific challenges and characteristics of the construction sector in Addis Ababa. There is a critical gap in research that identifies locally relevant and actionable recommendations to ensure projects meet design intent, enhance efficiency, and improve overall project outcomes (Asmerom, 2021; Menon, 2024; Yihdego, 2017).

This study aims are to investigate the causes of variance between approved designs and actual construction, evaluate the associated legal and quality impacts, and develop actionable strategies to enhance alignment between design and implementation. By addressing these issues, the research seeks to contribute valuable insights that will not only improve project outcomes but also elevate the standards of residential construction practices in Addis Ababa, ultimately benefiting construction stakeholders and the wider community.

1.3.Research Questions

In relation to the research questions, this study seeks to answer the following questions:

- What are the most common causes of variances observed between approved designs and actual implementations on private residential construction projects in Addis Ababa?
- What are the legal and quality impacts of discrepancies between approved designs and actual implementation on private residential construction projects in Addis Ababa?
- What can be effectively strategies and best practices to minimize the gap between approved designs & actual implementation on private residential construction projects in Addis Ababa?

1.4.Objective of the study

1.4.1. General objective of the study

The main objective of this study is to investigate the cause and effects of the gap between approved designs and their actual implementation and developing strategies to minimize implementation gap on private residential construction projects in Addis Ababa.

1.4.2. Specific objectives of the study

The specific objectives of this study are:

- To identify the causes of variance between approved designs and actual implementation on private residential construction projects in Addis Ababa.
- To assess the legal and quality impacts of discrepancies between approved designs and actual implementation on private residential construction projects in Addis Ababa.
- To developing effective strategies and best practices to minimize the gap between approved designs and actual implementation in order to improve project outcomes and efficiency in Addis Ababa.

1.5.Scope of the study

The scope of this study focuses on understanding the discrepancies between approved designs and actual implementations specifically in the context of private residential construction projects in Addis Ababa, Ethiopia. The scope of the study was concentrate exclusively on private residential construction projects within Addis Ababa, Ethiopia, includes significant renovations of existing residential buildings before 5 years completed. The scope of the study was encompassing various types of private residential projects above G+3 building.

The scope of this study was designed to provide a detailed exploration of the discrepancies between approved designs and actual implementations on private residential construction projects in Addis Ababa. By the identifying the root causes of variances, assessing their impacts on legal compliance and construction quality, as well as exploring effective mitigation strategies, this research aims are to make a meaningful contribution to enhancing the effectiveness and accountability of construction practices in Addis Ababa. The study's goal with this concentrated analysis is to encourage better alignment between design objectives and actual building outcomes, thereby encouraging the creation of a more sustainable and high-quality residential construction sector in Addis Ababa. The study was used a quantitative methodologies approach to data collection methods. Surveys/questionnaires was done to collect pertinent information from various stakeholders involved GC-1 up to GC-5, and BC-1 up to BC-5 in the selected private residential construction projects in Addis Ababa.

1.6.Significances of the study

This study is significant for its potential to enhance the understanding of discrepancies between design and implementation on private residential construction projects in Addis Ababa. By identifying causes, assessing legal and quality impacts, and developing actionable strategies, the study is not only benefit the specific context of Addis Ababa but also contribute to broader discussions about improving practices in the construction industry. The resulting insights were be expected to lead to better construction outcomes, increased stakeholder satisfaction, and strengthened regulatory compliance within the private residential construction projects.

The overall contribution of this study was lies in its potential to foster a more effective, compliant, and quality-driven construction environment in Addis Ababa. By addressing the gaps between approved designs and actual implementations, the study aims to enhance stakeholder satisfaction, improve project success rates, and ultimately contribute to the sustainable development of the city's residential infrastructure.

1.7.Operational Definitions

- Approved Design refers to final architectural and engineering plans, specifications, and supporting documentation that have gained formal approval from authorities or clients prior to construction.
- Actual Implementation refers to on-site construction activities and processes, including materials and techniques used to bring approved designs to life.
- The term "discrepancy" refers to the difference between the approved design and its actual implementation during construction.
- Implications refer to the effects of differences between authorized designs and their actual implementation.
- Mitigation strategies aim to mitigate or prevent inconsistencies between authorized designs and their implementation.

1.8.Limitation of the study

This research is carry out under the limitation of very few previous researches recent studies published on the local context, limited access and availability actual historical data and multi-stakeholder and actors. While this thesis study seeks to contribute valuable knowledge on the causes, impacts, and strategies related to discrepancies in construction projects, the identified limitations must be acknowledged. These limitations highlight areas for caution in interpreting the findings and suggest avenues for future research that can expand on this study by addressing its limitations. By recognizing these constraints, the study can inform efforts to enhance accuracy and efficacy in assessing discrepancies between approved designs and actual implementation.

1.9.Structures of the Thesis

This thesis is organized with the preliminary part and main body part, which is the preliminary part of the thesis document, consisted of the cover page, title page, approval sheet, acknowledgment, table of content, list of tables, list of figures, list of acronyms and abstract. The main body part has five chapters, within each chapter there is different but interrelated subtopics presented in Figure 1.1.

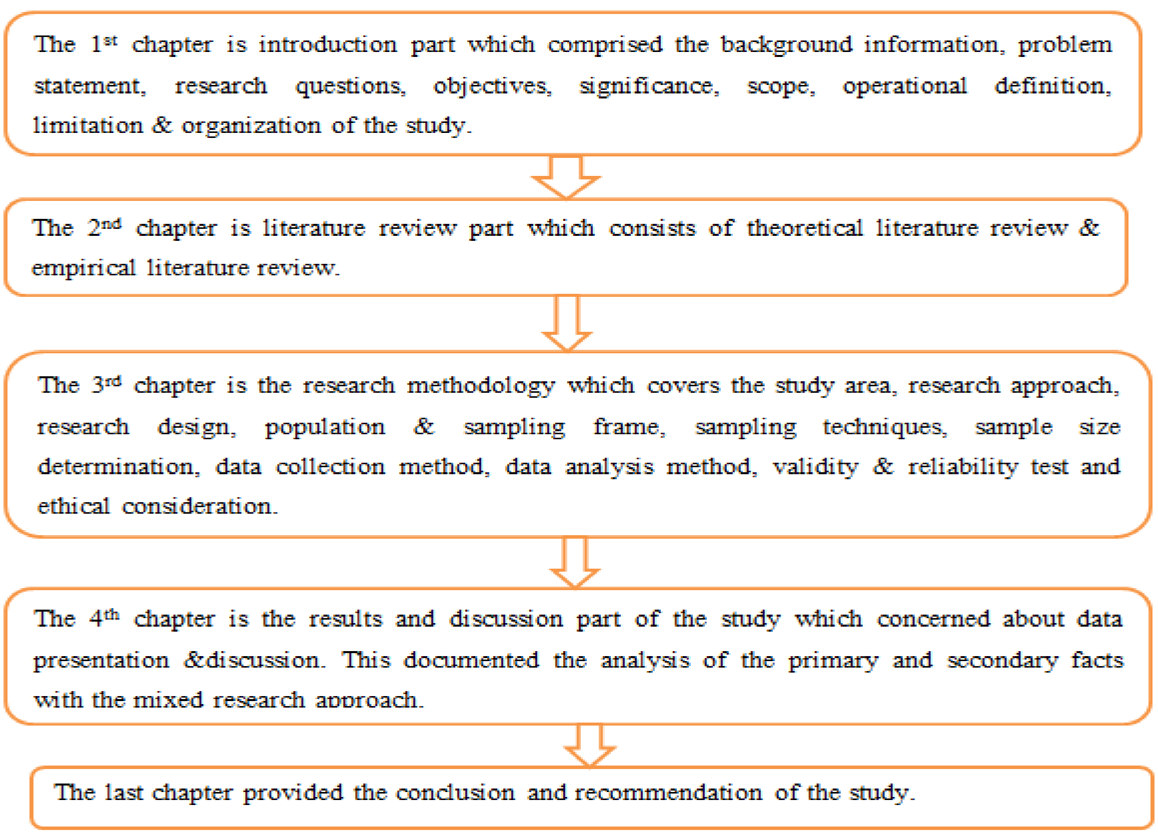

Figure 1. 1: The main body part thesis structures

CHAPTER TWO

2. RELATED LITERATURE REVIEW

2.1.Introduction

This chapter explains the research-related literature review that will be conducted for the research investigation. These include the research theory, concepts, and ideology that exist in relation to the theoretical and empirical issue of the discrepancies between approved design and actual implementation in private residential construction projects of causes, legal and quality impacts, and mitigation techniques. It provides a study of literature from various scientists and authors in the field of private residential construction projects, with a particular emphasis on the disparity between authorized design and actual implementation. It discusses the theoretical, empirical, and conceptual findings of many scholars regarding the disparity between authorized design and actual implementation in private residential construction projects (Yihdego, 2017).

The alignment of approved designs with actual implementation in building projects is crucial for a variety of reasons, including quality, cost effectiveness, safety, and stakeholder satisfaction. This alignment is more than just a procedural necessity; it is a critical component that supports the success and sustainability of building projects. As a result, connecting approved designs with actual execution in construction projects is critical for assuring quality, controlling costs, meeting deadlines, maintaining safety, increasing stakeholder satisfaction, ensuring regulatory compliance, and attaining sustainability objectives. Organizations may reduce risks, enhance project outcomes, and build a culture of excellence in the construction sector by strictly enforcing alignment throughout the process (Alhazmi, 2023; Asmerom, 2021; Choudhry et al., 2017).

It is concerned with a review of related literature obtained from various secondary sources, such as published books, journals, and relevant websites. In this regard, attempts will be made to integrate as many significantly linked literatures as possible by analyzing available documents including points aimed at achieving the research objectives.

2.2.Definition and Importance of Design Approval in Construction Projects

The design approval process is a vital component of construction projects, ensuring that architectural and engineering plans comply with standards, codes, and client expectations. In the context of construction, design approval refers to the formal validation process in which design documents such as drawings, specifications, and plans are examined and approved by key stakeholders prior to the start of construction. This process is divided into several stages, including design submission, stakeholder reviews, feedback loops, and final approvals or permits. Design clearance ensures that the planned construction complies with regulatory standards and satisfies the needs of the client and community (Manzini et al., 2024).

The relevance of design approval in safety is critical in construction, since risk concerns are inherent. Numerous studies have shown that a thorough design approval procedure improves safety outcomes. The early detection of design faults through stringent approvals can help prevent on-site accidents and injuries. The authors suggest that incorporating safety professionals in the design review ensures that safety practices are included into architectural features, promoting a safety culture (Abushark et al., 2015).

The relevance of design approval in adherence to laws, or regulatory compliance in building, is vital for avoiding legal ramifications and ensuring public safety. According to Imrie & Street (2009), the study revealed a detailed analysis of regulatory frameworks and their interactions with design approvals. Their findings show that design approval serves as a compliance gatekeeper, ensuring that plans adhere to local building norms and regulations prior to construction. Furthermore, Schwierking & Anantatmula (2015), found that engaging regulatory organizations during the design approval process promotes teamwork and understanding of applicable regulations, resulting in less delays and reworks later in the building phase. This proactive compliance approach helps to reduce the possibility of fines and project stoppages due to infractions.

The necessity of design approval in quality control is crucial for achieving the expectations of stakeholders such as clients, contractors, and regulatory agencies. According to Yihdego (2017), study indicated that a design approval is a key quality assurance measure. Approved designs are more likely to meet the stipulated criteria, decreasing unpredictability and potential flaws during construction. Design reviews play an important role in generating a clear set of standards that contractors may follow. The study demonstrates how persistent adherence to authorized designs results in improved quality outputs and stakeholder satisfaction. Furthermore, including feedback loops during the design approval phase improves overall project quality by permitting revisions based on stakeholder comments and expert recommendations (Aslam et al., 2019).

2.3.Requirements for Design Approval

The design approval process in building projects is crucial to ensuring that proposed designs comply with safety standards, legal requirements, and stakeholder expectations. This topic investigates the numerous conditions that must be met for design approval, including as legislative frameworks, technical standards, environmental considerations, stakeholder engagement, and quality control procedures. Understanding these requirements helps project managers and architects navigate the approval process and improve the overall success of building projects.

2.3.1. Overview of the different requirements that need to be satisfied for design approval

This topic addresses the many standards that must be met for design approval, with a focus on regulatory, technical, and stakeholder considerations. Understanding these standards is critical for project managers, architects, and stakeholders in the construction and design industries. Building codes are one of the key sets of regulations for design approval. According to Rowan et al. (2023), building codes are created to guarantee the public's safety, health, and well-being by establishing minimum design and construction standards. These rules address structural integrity, fire safety, accessibility, and material selection, all of which must comply with municipal, national, and international laws. Zoning laws govern how property can be used and what kind of structures can be developed in specified regions. According to Domingo et al. (2021), state that zoning restrictions, which govern building height, density, and land-use compatibility, must be followed in order for designs to be approved. A detailed understanding of zoning classifications and regulations is essential for matching proposed designs to regulatory expectations.

A thorough set of design documentation is required to expedite the approval process. According to Olusola et al. (2016), indicates that all architectural drawings, engineering plans, and technical specifications must be supplied. This documentation should describe the design intent and give enough information for reviewers to determine whether the project complies with applicable standards. Designs must also incorporate structural calculations and assessments that show the building's ability to endure natural and man-made loads. According to Khan (2023), extensive engineering assessments are required to assure the design's integrity and safety, and these analyses must adhere to applicable engineering standards.

Engagement with local stakeholders and communities is frequently a need during the design approval process. According to Maddaloni & Sabini (2022), underline the necessity of including community people early in the design process to gain feedback and address problems. This interaction can result in designs that are more in line with community demands, allowing for quicker approval processes. Understanding the individual needs and expectations of clients is critical to securing design approvals. According to Mira-Bonnardel (2004), found that a clear connection between design aim and client needs is required to secure approval. Detailed project specifications presented with design papers facilitate communication and prevent problems later in the process.

Formal review methods are an important component of the design approval system. According to Prieto (2020), a study found that repeated evaluations by regulatory agencies and stakeholders are required to ensure compliance with codes, norms, and laws. Each review stage is designed to identify potential difficulties before construction begins. Post-approval inspections are also necessary to ensure conformity with the approved designs. Examining quality control techniques demonstrates how inspections help to ensure that construction meets authorized plans and appropriate requirements, so preventing future compliance concerns.

Therefore, the design approval process includes a wide range of standards that must be met in order for the project to be completed successfully. These criteria include adhering to regulatory and zoning restrictions, submitting adequate design documents, conducting environmental impact studies, and actively engaging stakeholders. Furthermore, establishing strong quality control methods is critical for enabling compliance and ensuring that projects fulfill set requirements. Understanding these various requirements is critical for successfully navigating the design approval process and avoiding potential issues in building projects.

2.3.2. The role of regulatory bodies, agencies, or local authorities in the approval process

Regulatory entities, agencies, and local governments play an important part in the construction approval process, regulating safety standards, quality assurance, and legal compliance. Regulatory bodies are organizations that create and implement regulations in the construction industry to protect public safety, health, and welfare. According to Kjaer & Vetterlein (2018), these organizations act as gatekeepers in the design approval process by assessing plans, granting permits, and conducting inspections throughout the construction lifetime. Identify numerous key functions of regulatory organizations, including assessing and approving design plans, which means that regulatory agencies evaluate designs for compliance with building regulations, zoning rules, and other related legislation. Issuing building permits, whose approval is reliant on the provided documentation satisfying the specified standards, allowing construction to begin legally. Conducting inspections which is regular inspections during construction ensure ongoing compliance with the approved design and safety requirements.

One of the fundamental functions of regulatory agencies is to ensure public safety and welfare through thorough oversight. According to Nævestad et al. (2021), adherence to building codes is crucial for maintaining structural safety and minimizing dangers associated with construction projects. Their findings demonstrate that failing to follow these standards can result in catastrophic outcomes, emphasizing the significance of regulatory supervision. Regulatory organizations are also responsible for enforcing environmental standards governing how construction operations affect local ecosystems. Regulatory authorities undertake effective environmental evaluations to reduce negative impacts, guaranteeing sustainability and compliance with environmental standards throughout the development process.

Regulatory agencies frequently confront substantial resource limits, such as staffing shortages and budgetary restrictions. According to Schwierking & Anantatmula (2015), these restrictions undermine the effectiveness of regulatory organizations, resulting in lengthier approval processes and project backlogs awaiting reviews and inspections. The complexity and variety of legislation can provide difficulties for both regulatory agencies and project parties. The complexity of legislation may result in misconceptions among parties, complicating the approval process. Because of this complexity, regulatory officials frequently require more training and face greater administrative costs. Political dynamics can have a substantial impact on how regulatory agencies function. According to Short (2021), prevalent political agendas and pressures can influence regulatory decision-making, compromising the integrity of the approval process and leading to inconsistent enforcement of regulations.

The involvement of regulatory organizations in the approval process improves the overall project quality and accountability. According to studies, extensive design reviews and inspections help to ensure compliance with industry standards and building requirements (Kjaer & Vetterlein,

2018. This quality assurance protects the public interest while minimizing the risks associated with potential design flaws. The effectiveness of regulatory authorities has a considerable impact on project delays. The shortened evaluation and approval processes allow for fast project start and completion. On the other hand, delays in the approval process caused by regulatory inefficiencies can result in increased project costs and negative outcomes for stakeholders. The function of regulatory agencies influences stakeholder confidence in the construction process. Findings from Nævestad et al. (2021), reveal that transparent regulatory approaches strengthen confidence among stakeholders, resulting in enhanced community engagement and support for construction initiatives. Stakeholder confidence is critical for successful project delivery and long-term collaboration.

The integration of digital tools and technologies is changing the way regulatory organizations operate. According to Leiringer (2020), indicates that using digital platforms to execute approvals and conduct inspections can increase efficiency and accuracy. These systems decrease paperwork, improve communication, and enable real-time monitoring of project compliance. As the building industry prioritizes sustainability, regulatory bodies are modifying their frameworks to reflect this. According to Deborah Aanuoluwa Soyombo (2024), emphasize that regulatory bodies are establishing new green building standards that incorporate environmental efficiency and resource conservation into the design approval process.

Therefore, regulatory bodies, agencies, and local governments play an important role in the construction approval process by assuring compliance with building rules, maintaining public safety, and enforcing environmental restrictions. Despite hurdles such as limited resources and complex rules, their involvement is critical for improving project quality, protecting community interests, and fostering stakeholder confidence. Continued improvements in digital technologies, combined with a focus on sustainability, will shape the role of regulatory bodies in the future, underlining the importance of continued research and improvement in these critical areas of construction oversight.

2.4.Residential Private Building Approval Process

2.4.1. Specific steps involved in the approval process for residential private buildings

The approval procedure for residential private buildings is a vital step in the construction process, ensuring that new constructions meet safety, regulatory, and community requirements.

Pre-application consultations are frequently the initial stage in the approval process. These consultations allow developers to engage with regulatory bodies and clarify needs and expectations before formally submitting applications. This first involvement helps to uncover potential difficulties and streamlines the subsequent approval process. Local governments, community representatives, and planning officials are common participants in consultations. Their involvement facilitates the early collection of insights and concerns, resulting in more informed decision-making throughout the approval process (Bazen, 2019).

The next stage after completing the pre-application phase is to submit specific plans and paperwork for review. Architectural and engineering drawings, site plans and landscaping designs, structural calculations, and technical specifications for materials and construction procedures are among the most important papers. Documents must show conformity with local building laws, zoning regulations, and sustainable building practices. A well-prepared application can substantially speed up the review process (Aslam et al., 2019).

During the third step of the review process, multiple regulatory agencies analyze the submitted designs for compliance with various rules and standards. Different departments (e.g., planning, engineering, and fire safety) frequently undertake parallel assessments to ensure that all components of the design comply with applicable requirements. In many jurisdictions, public notification regulations mandate that adjacent residents be notified of the proposed project. Public hearings or comment periods may be held, allowing the community to voice its concerns or support. This phase is critical for ensuring transparency in the approval process (Yihdego, 2017).

Once the review procedure is completed, regulatory authorities award a building permit, allowing work to begin. This permit confirms that all essential approvals have been obtained, and the project meets safety and quality criteria. Approval frequently includes specific conditions or adjustments that must be met before building begins. These restrictions frequently involve meeting deadlines, completing additional paperwork needs, or revising design ideas in response to regulatory comments (Kjaer & Vetterlein, 2018).

During the construction phase, regulatory officials must conduct regular inspections to ensure continuous conformity with the approved plans. Inspections are performed to ensure that construction follows the approved plans and satisfies safety and quality standards. After construction is completed, a final inspection is usually required before an occupancy permit is issued. This process ensures that the completed building meets all applicable codes and is safe for habitation (Aslam et al., 2019).

During the construction process, revisions to the initial design may occur owing to unanticipated situations or client requests. Proper change management procedures, including documentation and regulatory clearances for alterations, are crucial for adhering to established design standards. Finally, post-approval monitoring may be performed to ensure that the completed construction meets all standards throughout its life. Studies on post-occupancy evaluations and compliance inspections in constructed environments emphasize the importance of these ongoing commitments (Rahman et al., 2017).

Therefore, the approval process for residential private buildings includes multiple key elements, such as pre-application consultations, design submission, rigorous regulatory evaluations, ongoing construction inspections, and post-approved monitoring. Each phase is critical to ensure that projects meet safety and quality standards while also involving the community and addressing stakeholder concerns. Understanding these procedures allows project teams to more effectively negotiate the intricacies of residential construction, highlighting the need for ongoing research and improvement in the approval processes particular to residential buildings.

2.4.2. Timeframes, review processes, and potential challenges in obtaining design approval

The timeline for gaining design approvals can vary greatly depending on jurisdiction, project complexity, and the regulatory environment. Standard approval timelines might range from a few weeks to many months. Their research found that residential initiatives typically have shorter timescales than bigger commercial endeavors, depending on the appropriateness of documents presented for review and the kind of compliance requirements. Several factors have been identified as influencing design approval timelines, including document completeness, project complexity, and regulatory environment (Rahman et al., 2017).

The design approval review procedure frequently involves several agencies and stakeholders. Different regulatory bodies, such as planning, zoning, and environmental departments, assess submitted designs to ensure compliance. Each department may have its own criteria and evaluation processes, which add to the overall time of the review. Many municipal governments require public notices and community feedback during the design approval process. Public hearings and comment periods are usual practice, allowing residents and community organizations to express their concerns. While this stage encourages transparency, it may increase the overall time necessary for design approval. In some circumstances, regulatory agencies may provide conditional clearances, enabling projects to begin but requiring compliance with prescribed revisions (Schwierking & Anantatmula, 2015).

The intricacy of regulations might create substantial obstacles during the design approval process. According to Yihdego (2017), argues that overlapping jurisdictions, developing construction rules, and uneven standards can lead to stakeholder uncertainty, resulting in approval delays. Effective communication among stakeholders is essential for successful design approval. They discovered that communication breakdowns frequently result in misunderstandings about project expectations and compliance requirements. Poor communication might result in incomplete submissions, demanding further changes and lengthening timescales.

2.4.3. Differences in approval requirements for residential projects compared to commercial or public building

The approval process for building projects is an important step in ensuring compliance with safety, regulatory, and community standards. While certain basic standards for residential constructions are comparable to those for commercial or public buildings, there are considerable variances. Building codes are one of the key regulatory frameworks for construction projects, however residential rules may differ from those for commercial and public buildings. According to Rowan et al. (2023), indicates that residential building rules are more concerned with individual safety and wellbeing, reflecting the concerns of residents in smaller-scale developments. Commercial and public building regulations, on the other hand, place a greater emphasis on public safety and accessibility, and frequently include tighter performance-based requirements. Zoning standards might range greatly between residential and commercial developments due to changes in land use. According to Domingo et al. (2021), residential zoning laws frequently favor low-density development and neighborhood character, whereas commercial projects may be subject to regulations that encourage increased density and mixed-use development. This disparity in zoning restrictions frequently influences the approval process, with residential developments typically having less design constraints than commercial ones.

The level of detail needed in design documentation varies between residential and commercial projects. According to Aslam et al. (2019), suggests that residential projects have less stringent requirements for detailed engineering analyses than commercial projects, which require rigorous documentation due to their complexity. Residential developments may have broader design approval freedom, allowing homeowners to customize their homes more. In contrast, commercial and public projects frequently follow conventional design templates that match regulatory standards and community expectations, resulting in a more stringent approval procedure.

Stakeholder engagement processes range significantly between residential and commercial approvals. Residential developments usually involve direct contact with local communities and individual homeowners, allowing residents to express concerns and influence design changes before the approval process is completed. Commercial projects, on the other hand, may necessitate broader stakeholder discussions due to their potential impact on bigger communities or the public interest, which frequently include public hearings or forums. The interactions between developers and regulatory authorities can also vary. Residential project developers typically have more direct interactions with local authorities, and they frequently benefit from more accessible communication channels. To obtain permissions, commercial developers may have to go through a more bureaucratic process that involves many agencies and a set protocol (Yihdego, 2017).

Commercial and public structures frequently have more extensive and complex approval processes than residential projects. Commercial projects often involve numerous levels of review due to their size, necessitating assessments from a larger number of regulatory agencies to ensure compliance with a broader set of regulations. As a result, industrial projects tend to have longer approval timelines than residential ventures. The frequency and rigor of inspections may vary greatly across the two types of projects. Commercial projects frequently face more demanding inspection standards, which include multiple inspections at various phases of development to guarantee compliance with authorized designs and regulatory requirements. In contrast, inspections for residential projects may be less frequent and less thorough, reflecting the lower complexity and risk profile associated with them developments (Bazen, 2019).

The expenses of gaining permissions can vary significantly. Commercial projects typically have greater compliance expenses, such as permits and application fees, due to their complexity and the amount of documentation necessary. Residential projects often have smaller expenditures, making them more affordable to individual homeowners seeking permission. Financial issues can also influence the approval process in different ways. Commercial projects' extensive financing requirements may cause delays in the approval process, as funding uncertainties may necessitate additional documentation and justification, whereas residential projects frequently use simplified financing methods that do not delay approval (Yihdego, 2017).

2.5.Implementation of Approved Design

2.5.1. Process of translating approved designs into physical construction

Translating approved plans into physical construction is an important stage in the life cycle of any building project. This method consists of several processes that bridge the gap between abstract design concepts and physical structures. The shift from authorized designs to physical construction involves several steps, beginning with the finalization of design documentation and progressing through procurement and construction to project completion. This transition is critical for matching the physical structure with the intended design, assuring compliance with safety and building requirements, and meeting stakeholder expectations. Effective management of this process is critical for project success. A systematic method improves communication, reduces errors, and maximizes resource usage characteristics that are essential for accurately translating concepts into the built environment (Aslam et al., 2019).

A successful translation process starts with detailed structural planning. The importance of creating a detailed construction plan that details the order of tasks, resource allocation, timeframes, and budget management. Such planning helps to guarantee that all project participants are on board with the design criteria from the start. Project scheduling is essential for coordinating the many stages of construction. Create construction schedules that reflect the timing of design-specific tasks. Proper sequencing helps avoid delays and guarantee that construction follows the approved plan (Yihdego, 2017).

The successful translation of designs is significantly dependent on collaboration among numerous stakeholders, including architects, engineers, contractors, and clients. Effective communication and continuing interaction among stakeholders are required to address issues and ambiguities about the design. Construction management software and Building Information Modeling (BIM) technology can help improve communication and collaboration. These solutions enable real-time access to design data, allowing teams to swiftly discover and resolve differences (Aslam et al., 2019).

Quality assurance is essential throughout the construction process to ensure adherence to the authorized plans. Implementing stringent quality control measures, such as inspections and audits, helps guarantee that construction fulfills the requirements and standards. Regular documentation of work progress is required to ensure conformity with the authorized designs. Maintaining accurate records enables rapid identification of discrepancies and prompt corrective action (Rahman et al., 2017).

One of the most difficult aspects of converting approved drawings into physical reality is managing design revisions. Modifications to designs, whether prompted by clients, due to regulatory constraints, or resulting from unforeseen occurrences, can cause considerable disparities throughout construction. The availability of competent labor and supplies can have an impact on how well the design translation process works. Due to resource restrictions, contractors may make compromises that stray from approved plans, jeopardizing project quality and safety. Effective communication is essential in resolving disagreements; yet, difficulties may develop. Communication breakdowns among project stakeholders frequently result in misunderstandings, which lead to variances in how designs are implemented (Tombesi & Whyte, 2013).

2.5.2. Common challenges or gaps that may arise during implementation

One of the most common issues in construction execution is the gap between authorized designs and what is built. Changes made during construction, whether due to client requests, regulatory amendments, or site constraints, might result in major departures from the original design. The report underlines that such inconsistencies can cause uncertainty among contractors, potentially leading to errors in execution. Miscommunication and misunderstandings among project stakeholders such as architects, contractors, and clients sometimes result in disparities. When stakeholders have different interpretations of design intent, it raises the chance of construction errors, lowering project quality (Tombesi & Whyte, 2013).

Labor shortages are a common issue in the construction sector that can impede implementation. Insufficient competent labor might cause hasty construction methods, resulting in workmanship compromises that differ from approved blueprints. According to the study, variations in labor availability can have a significant impact on project schedules and quality. The availability of materials is crucial for successful implementation. Contractors may be forced to replace lower-quality alternatives due to insufficient access to key supplies, which is caused by supply chain interruptions or market instability. Such modifications might cause inconsistencies in the final structure, affecting durability and performance (Gill et al., 2023).

Regulatory compliance is a critical component of construction implementation. According to a study conducted by Rowan et al. (2023), developing building rules or local restrictions throughout the construction process can compel design revisions that were not originally approved, resulting in differences and potential project timeline delays. Inspection delays might potentially exacerbate implementation issues. According to Gashaahun (2020), demonstrated that infrequent or poorly organized regulatory inspections can create bottlenecks in the building process, leading projects to halt and increasing the likelihood of errors.

Effective communication is vital for the successful completion of construction projects. When communication routes are weak or overly bureaucratic, bottlenecks can form, resulting in misunderstandings and errors in design execution. Their findings indicate that creating open channels of communication among all stakeholders is crucial to reducing disparities. Many construction projects require many teams and subcontractors, which complicates the implementation process. Poor team collaboration can result in gaps in understanding design criteria and duties, increasing the chance of errors (Kamal Bahrain et al., 2023).

Inconsistencies in quality control techniques might cause substantial issues during the implementation phase. A lack of robust quality assurance processes might cause deviations to go undetected until the project is done, resulting in costly rework or adjustments after construction. Monitoring compliance with authorized designs can be difficult, especially in large projects. A lack of appropriate monitoring tools can lead to inconsistencies staying undiscovered until they become substantial difficulties, resulting in costly remedial efforts later in the project lifecycle (Rahman et al., 2017).

2.5.3. The importance of adhering to approved designs to ensure project success

Adherence to approved designs in construction projects is crucial for project success, which includes factors such as quality, cost-effectiveness, safety, and customer happiness. Approved designs include specifications and blueprints that have been formally approved by the appropriate regulatory agencies or authorities. These designs provide the fundamental foundation for construction activities, incorporating safety standards, architectural intent, and regulatory compliance needs. Approved designs not only give a road map for building, but also aid in resource allocation, scheduling, and budgeting. Maintaining integrity to the authorized design throughout the construction process is critical to improving project performance (Gazal et al., 2023).

Adherence to authorized designs has a direct impact on construction quality. When builders deviate from approved designs, the quality of materials and craftsmanship declines, leading to structural defects and safety issues. They claim that rigorous adherence to authorized designs is an important quality control strategy that ensures safety and structural integrity. Following approved designs is essential for adhering to building laws and regulations. Deviations can result in regulatory violations, putting not only the building project's safety at risk, but also creating legal liabilities for contractors and developers. Compliance by adherence to authorized designs reduces the possibility of costly penalties and project delays (Alhazmi, 2023).

Non-adherence to authorized designs frequently results in costly rework and modification orders. Differences between designs and implementation typically result in higher expenses for time and materials required to fix faults. The study found that projects that adhere to approved plans had fewer change orders and associated expenditures. Maintaining conformity with authorized designs is also critical to good budget management. Projects that differ from their approved plans frequently encounter unexpected charges, which can strain finances and lead to budget overruns. Project managers can better forecast costs and avoid financial risks by following design specifications (Choudhry et al., 2017).

Following approved designs helps to keep project timetables on track. Deviations from designs might result in considerable delays due to the requirement for redesigns, re-evaluations, and additional approvals. Keeping construction in line with authorized blueprints can help to expedite operations and complete projects on time. Integrating approved designs into project delivery systems, such as Integrated Project Delivery (IPD), improves collaboration and decreases inconsistencies. When all parties have a shared understanding of the approved design, accountability improves and project schedules are met (Choudhry et al., 2017).

Adherence to authorized designs is critical for satisfying client expectations and assuring satisfaction. According to Aslam et al. (2019), emphasizes that clients are more likely to be satisfied when the requirements indicated in the authorized designs are met throughout the construction phase. This satisfaction builds trust and can lead to future collaborative initiatives.

Projects that follow authorized designs are more likely to comply with community standards and expectations. According to Rahman et al. (2017), have shown that ensuring design integrity and transparency in the approval process increases community acceptability of new developments, ultimately contributing to project success over time.

2.6.Factors Affecting Implementation Gaps

The primary factors affecting the implementation gap between approved designs and actual construction were explored in private home construction projects. The researchers discovered the factors contributing to the variance between approved designs and actual implementation in the existing literature and, as a result, compiled a list of the factors affecting implementation gaps between approved designs and actual construction in private residential construction projects. A variety of variables can be identified. These variables can be classified into numerous groups based on their nature and the parameters they influence, as shown in table 2.1. This classified list is a source of organized information that may be used to propose effective strategies and best practices to minimize or eliminate the gap between approved designs and their implementation in order to improve project outcomes and efficiency.

Table 2. 1: The factors affecting implementation gap b/n approved designs & actual construction

R. No	The factors affecting implementation gaps b/n approved designs & actual construction	**References**				
		(Yihd ego,	(Asla m et	(Rah man	(Alha zmi,	(Cho udhry

		2017)	al., 2019)	et al., 2017)	2023)	et al., 2017)
1	Poor communication among stakeholders (architects, contractors, and clients) leads to misunderstandings during implementation.	✓		✓		
2	Inadequate documentation and unclear design specifications contribute to construction errors.	✓	✓	✓		✓
3	Design changes made after project approval create discrepancies between plans and actual construction.		✓		✓	✓
4	Resource limitations (such as labor shortages and material availability) affect adherence to the approved designs.	✓				✓
5	Changes in regulatory requirements that occur during construction lead to non-compliance with approved designs.	✓	✓		✓	
6	Complexity of design elements results in challenges during the implementation process.	✓	✓	✓	✓	✓
7	Lack of rigorous quality assurance practices during construction leads to discrepancies.	✓	✓	✓		✓
8	Differences in stakeholder expectations lead to variances during construction.	✓		✓		✓
9	Inadequate training and knowledge among workers regarding the approved designs contribute to implementation gaps.	✓	✓		✓	
10	Cultural and contextual factors unique to Addis Ababa influence how designs are interpreted and executed.	✓	✓			✓
11	Lack of strict enforcement of building codes and regulations by authorities	✓	✓		✓	
12	Inadequate supervision by qualified professionals (architects/engineers) on site	✓	✓		✓	✓
13	Use of unqualified or inexperienced construction labor	✓	✓	✓		
14	Shortage or poor quality of building materials	✓		✓		✓
15	Cost overruns and budget limitations		✓		✓	✓

16	Changes requested by clients during construction (without proper revision process)	✓	✓	✓	✓	✓
17	Corruption or bribery during inspection processes	✓	✓	✓		✓
18	Lack of advanced technologies (BIM, digital tools) in design and implementation	✓	✓	✓	✓	
19	Inefficiencies Project Management	✓	✓		✓	✓
20	Inadequate project planning	✓	✓	✓	✓	✓
21	Unforeseen site conditions	✓	✓	✓	✓	
22	Changes in project scope	✓	✓	✓	✓	✓

Source**:** Authors compiled through literature

In summary, the study of factors influencing the implementation gaps between approved designs and actual construction in private residential projects includes a wide range of variables such as design quality, communication effectiveness, construction implementation, regulatory and legal compliance, project management practices, and client satisfaction aspects. Understanding the interplay of these variables is critical for determining the core causes of disparities and establishing solutions to close implementation gaps.

2.7.Legal and Quality Impacts of Discrepancies on Construction Projects

The key legal and quality impacts of discrepancies on construction projects between approved designs and actual implementation were investigated in private residential construction projects. The researchers discovered discrepancies between approved designs and actual implementation in the existing literature and, as a result, compiled a list of analyzing the legal and quality impacts of discrepancies on construction projects between approved designs and actual implementation, several specific variables can be identified. These variables can be categorized into two primary groups based on their influence on the legal impacts, and quality impacts as shown in table 2.2.

Table 2. 2: The legal and quality impacts of discrepancies on construction projects

Impacts Categories	The legal and quality impacts of discrepancies on construction projects	**Reference**			
		(Milion et al.,	(Eon et al.,	(Aslam et al.,	(Yihdego,

		2021)	2020)	2019)	2017)
Legal Impacts	Legal liabilities for non-compliance with regulations	✓	✓	✓	✓
	Increased risk of litigation from clients or stakeholders	✓	✓	✓	✓
	Non-compliance with building codes, regulations and standards	✓	✓		✓
	Legal disputes between clients and contractors	✓	✓	✓	
	Legal penalties and fines imposed by authorities	✓	✓	✓	✓
	Delays in project completion due to legal disputes	✓	✓	✓	✓
	Revocation of building permits and orders to stop construction	✓	✓	✓	
	Difficulty in obtaining occupancy permits	✓	✓	✓	✓
	Increased liability and insurance claims	✓		✓	✓
Quality Impacts	Loss of trust and reputation among clients and partners	✓	✓		✓
	Compromised safety standards leading to potential hazards			✓	✓
	Decreased overall quality of construction	✓	✓	✓	
	Compromised structural integrity of the building	✓		✓	✓
	Reduced durability and lifespan of the structure	✓	✓	✓	✓
	Higher maintenance costs and frequent repairs	✓		✓	✓
	Poor functionality and usability of the building	✓	✓		✓
	Aesthetic deficiencies and compromised appearance	✓		✓	✓
	Reduced market value of the property		✓	✓	✓
	Negative impact on reputation of contractors/architects	✓	✓	✓	✓

Source**:** Authors compiled through literature

In summary, when examining the implications of discrepancies between approved designs and actual implementation as built conditions have understanding these variables are crucial for stakeholders involved in G+3 and above private residential construction projects in Addis Ababa. By addressing both legal and quality impacts associated with discrepancies between approved designs and actual implementation, stakeholders can better manage risks, ensure compliance, enhance overall project outcomes, and design mitigation strategies to reduce the negative effects of discrepancies on project outcomes.

2.8.Strategies and Best Practices in Avoiding Discrepancies for minimizing gaps between approved designs and implementation

The effective strategies and best practices to minimize or eliminate the gap between approved designs and their implementation were investigated in private residential construction projects. The researchers discovered discrepancies between approved designs and actual implementation in the existing literature and so compiled a list of exploring strategies and best practices in avoiding discrepancies for minimizing gaps between approved designs and implementation, several key variables can be identified. These variables can help in formulating effective strategies and practices aimed at reducing discrepancies and enhancing the alignment between approved designs and actual construction. The variables can be categorized into several groups based on their focus area, as shown in table 2.3.

Table 2. 3: Strategies and best practices in avoiding discrepancies

Strategies & best practices in avoiding discrepancies	**References**		
	(Alhazmi, 2023)	(Guadalupe, 2020)	(Choudhry et al., 2017)
Strengthening and consistent enforcement of building codes and regulations	✓	✓	✓
Mandating and enforcing comprehensive on-site supervision	✓	✓	✓
Promoting and ensuring the use of quality and certified building materials	✓	✓	✓
Implementing thorough project planning and scheduling	✓		✓
Providing training and capacity building for construction workers	✓	✓	
Utilizing Building Information Modeling (BIM) and digital tools		✓	✓
Establishing a formal change management process for client requests	✓	✓	✓

Regular quality control and quality assurance inspections	✓	✓	✓
Promoting ethical practices and transparency in construction contracts	✓	✓	✓
Establishing an effective mechanism to handle complaints and disputes	✓		✓
Involving clients in regular progress meetings and design reviews	✓	✓	
Enhanced communication and collaboration among stakeholders	✓	✓	✓
Engaging experienced contractors and subcontractors	✓	✓	✓
Engaging qualified and experienced professionals for design and oversight	✓	✓	✓
Encouraging stakeholder involvement throughout the project	✓		✓
Implementing feedback mechanisms for continuous improvement	✓	✓	✓

Source**:** Authors compiled through literature

In summary, when identifying strategies and best practices for avoiding discrepancies and minimizing gaps between approved designs and implementation, key variables include design documentation quality, communication effectiveness, project management capabilities, resource availability, technology utilization, and quality control practices. These variables serve as core aspects for developing methods to reduce differences and ensure project success. By identifying and resolving these issues, stakeholders can improve the alignment between authorized designs and actual implementation.

2.9.Empirical Literature Review

Several studies have identified key factors that influence the design approval process in construction projects. According to Tilley & McFallan (2000), emphasized that the importance of high-quality design documentation in facilitating timely approvals. Their study indicated that detailed and clear documentation reduces misunderstandings and misinterpretations by regulatory authorities, resulting in fewer delays during the approval process. According to

Dwivedi & Dwivedi (2021), highlighted that the significance of early stakeholder involvement in the design approval process. Their study findings suggested that engaging all relevant stakeholders, including regulatory bodies, architects, and clients, from the planning phase leads to smoother approvals and better alignment with community expectations.

Several studies have found important aspects influencing the design approval process in construction projects. According to Tilley & McFallan (2000), emphasized that the necessity of high-quality design documentation in ensuring quick approvals. Their research found that extensive and precise documentation lowers misunderstandings and misinterpretations by regulatory authorities, resulting in fewer delays throughout the clearance process. According to Dwivedi & Dwivedi (2021), emphasizes that the need of early stakeholder involvement in the design approval process. Their study found that involving all key stakeholders, including regulatory agencies, architects, and clients, early in the planning process results in smoother approvals and better alignment with community expectations. According to Yihdego (2017), study indicated that evaluated the influence of strict regulatory requirements on the design approval process. The study discovered that tight standards while necessary to ensure safety and quality, can lead to increased complexity and longer approval times.

Several studies have also addressed the obstacles experienced during the design approval process. According to Maier, A. M., Eckert, C. M., & Clarkson (2021), a study highlighted communication obstacles as a major difficulty affecting design approvals. The study found that misconceptions between architects and regulatory agencies frequently lead to design alterations and delayed approvals. According to Kjaer & Vetterlein (2018),a study looked into the resource constraints faced by regulatory authorities in various countries. The study revealed that insufficient staffing and funds contribute to inefficient design review processes, resulting in backlogs and longer approval timelines. According to Child & Rodrigues (2010), underlined the impact of political dynamics on the design approval process. Their findings suggested that political forces can influence regulatory decision-making, resulting in varying approval standards for similar projects.

Numerous studies have emphasized the importance of design documentation quality in successful implementation. According to Tilley & McFallan (2000), discovered that clear, thorough, and precise architectural and engineering drawings enabled effective communication among stakeholders and resulted in a greater percentage of successful implementation. According to their findings, projects with adequate documentation suffered fewer discrepancies during implementation. Effective communication is critical to ensuring that all stakeholders understand the design objective. According to (Yihdego, 2017), highlighted that frequent and open communication among architects, engineers, contractors, and clients was critical in preventing misunderstandings. The study discovered that projects that held regular coordination meetings had better alignment between authorized plans and actual construction. The level of stakeholder involvement has a considerable impact on the implementation of authorized designs. According to (Dwivedi & Dwivedi, 2021), indicated that early engagement of stakeholders during the design phase resulted in a smoother implementation process. Their empirical investigation found that including clients and community leaders assisted in addressing potential concerns that could lead to design deviations during the construction process.

Many studies have found that the quality and clarity of design documentation play an important influence in determining differences. According to (Akampurira & Windapo, 2016), insufficient documentation might lead to different interpretations among stakeholders, resulting in construction variations. Their empirical findings showed that projects with full and precise plans had fewer discrepancies than those with unclear or insufficient documentation. According to (Yihdego, 2017), highlights that complicated designs have a larger probability of inconsistencies. The study discovered that intricate design aspects frequently necessitate more thorough attention during implementation, and without proper oversight, the possibility of alternative interpretations increases. If this complexity is not managed properly, it may result in problems throughout the construction phase.

Effective communication is critical for ensuring that the design objective and the actual construction process are aligned. According to (Norouzi et al., 2015), a study found that inadequate communication among architects, engineers, and contractors is a significant driver to differences. According to their findings, misunderstandings about design criteria are frequently the result of limited or confusing communication channels. According to (Choudhry et al., 2017), indicates that the absence of structured feedback channels might result in unresolved questions and misalignments with design requirements. The study stressed the importance of regular feedback loops in identifying potential disparities before they lead to building problems.

Employee skill gaps can have a substantial influence on implementation fidelity. According to (Rahman et al., 2017), revealed that a shortage of competent personnel frequently results in rushed work or reliance on less-experienced people, increasing the chance of errors that differ from approved designs. According to (Yihdego, 2017), examined how material shortages can cause contractors to make substitutes or compromises that differ from approved plans. Their empirical findings revealed that resource restrictions frequently result in decisions that prioritize speed above adherence to the original design standards.

Regulatory changes might have a direct influence on implementation disparities. According to (Partial, 2019), this study found that shifting local building rules or construction restrictions can cause architects and contractors to change their designs to comply with new standards. This adaptation may result in disparities if communication about the changes is not well managed. Effective inspections are critical for guaranteeing conformity to approved designs. According to (S. Khan et al., 2021), identified that poor inspection systems frequently allow differences to go undetected until later phases of construction. Their findings suggested that regular inspections and quality control procedures could reduce the likelihood of large deviations from design.

The use of technology, such as Building Information Modeling (BIM), has been shown to assist eliminate inconsistencies. According to (Molla et al., 2020), found that projects use BIM enable improved visualization and communication among stakeholders, resulting in fewer misconceptions and implementation problems. According to (Partial, 2019), indicated that poor data management methods, such as insufficient tracking of project modifications and communications, might result in disparities. Their study stressed the need of using digital data management technologies to guarantee that all stakeholders are up to date on the newest design information.

The discrepancies between approved designs and the actual physical condition of buildings, known as as-built conditions, have garnered increasing attention in the construction industry. This empirical literature review synthesizes key findings from various studies that examine the legal and quality impacts of these discrepancies on existing private residential construction projects. Understanding these impacts is crucial for stakeholders aiming to ensure compliance, safety, and overall project success (Eon et al., 2020). Numerous studies highlight that discrepancies often lead to violations of building codes and regulations. According to Fakunle et al. (2020), emphasize that when constructions deviate from approved designs, this can result in legal liabilities, such as fines or enforcement actions by regulatory authorities. Their study found that compliance challenges frequently arise in residential projects, leading to disputes that can prolong project timelines and add financial burdens. Discrepancies can expose contractors and developers to increased liability and litigation risks. According to Gamage (2023), indicates that when building owners face safety issues or construction defects stemming from design discrepancies, they may pursue legal action against contractors and architects. The study highlights that such litigation not only affects financial stability but also damages the reputations of involved parties.

A study by Choudhry et al. (2017), revealed that significant discrepancies between approved designs and actual constructions may lead regulatory agencies to issue stop-work orders until compliance is achieved. These orders not only delay project completion but also incur additional costs for remediation that can significantly impact the project's budget and timeline. Quality issues arising from design discrepancies can compromise the structural integrity of buildings. According to Milion et al. (2021), reported empirical evidence that deviations from approved designs can lead to safety risks and structural failures. They noted that discrepancies affect how buildings respond to environmental loads, potentially endangering occupants.

According to Eon et al. (2020), indicates that discrepancies often lead to an increased frequency of defects, resulting in higher long-term maintenance and repair costs. The study emphasizes that buildings constructed with significant discrepancies require more frequent interventions to address issues, detracting from overall quality and functionality. Discrepancies can also adversely affect energy efficiency and sustainability of residential buildings. According to Yihdego (2017), highlighted that designs that do not adhere to energy compliance standards can lead to higher operational costs and diminished occupant comfort. Ineffective insulation or poor design execution arising from discrepancies can increase utilities costs for homeowners.

Studies indicate that homeowners are significantly impacted by discrepancies in design and implementation. A survey conducted by Rahman et al. (2017), found that homeowners express dissatisfaction when their expectations, as laid out in approved designs, are not met in the final construction. This dissatisfaction can lead to strained relationships between clients and contractors. The implications of discrepancies extend to financial considerations, affecting property values and overall investment returns. According to Asmerom (2021), illustrates that buildings with significant discrepancies may face lower market valuations, affecting the ability of owners to leverage properties for loans or sales. Investors might also experience lower profitability as a result of increased expenditures related to discrepancies.

The literature suggests that robust communication strategies play a pivotal role in mitigating legal and quality impacts stemming from discrepancies. According to Aslam et al. (2019), advocate for the establishment of clear documentation protocols and regular stakeholder meetings to ensure that design intentions are accurately interpreted and executed. Implementing rigorous quality assurance practices, including regular inspections and peer reviews, can help detect discrepancies early in the construction process. According to Yihdego (2017), demonstrate that proactive quality control measures improve project outcomes by verifying compliance with approved designs and rectifying deviations before they escalate.

According to (Oluwatosi, 2024), study indicated that the findings on strategies and best practices for reducing disparities in construction design execution identifies several critical areas for improvement. Effective communication, extensive design review processes, structured change management, proper resource allocation, ongoing workforce training, and strong quality assurance techniques emerge as essential components for reducing discrepancies and improving project performance. Integrating these tactics into construction practices can improve alignment between authorized plans and actual implementation, resulting in successful project outcomes.

Residential private construction projects pose specific problems and opportunities that are distinct from commercial or public development initiatives. Focusing on residential building enables researchers and practitioners to investigate specific dynamics such as design approval, implementation, stakeholder engagement, and project performance. Empirical research from residential private construction projects provide light on the dynamics of design approval, implementation issues, stakeholder participation, financial implications, and developing trends. Summarizing these data lays the framework for future study that will delve further into the unique complexity of home building. Continued emphasis on simplified design approvals, good communication, proactive financial management, and creative methods will help to improve outcomes in this industry (Rani & Singh, 2020).

2.10. Gap of Study

The main research gaps in the study will be able to include:

- Limited local contextual studies which is while numerous studies address the causes of discrepancies in construction on a global scale, there is a lack of focused research that specifically examines the unique contextual factors contributing to variance in Addis Ababa. Localized studies are critical to understand how cultural, economic, climatic, and regulatory conditions in Addis Ababa influence the adherence to approved designs.

- Lack of empirical evidence on legal impacts is a dearth of empirical studies that specifically assess the legal implications of discrepancies between approved designs and actual implementation in the context of residential construction projects in Addis Ababa. Previous research may touch on legal compliance generally, but detailed examinations of the outcomes of non-compliance due to design discrepancies such as penalties, litigations, or formal disputes are limited.

- Quality assessment methodologies which is while the impacts of quality resulting from discrepancies are acknowledged, there is a gap in methodologies for assessing quality impacts in private residential projects specifically. Enhanced frameworks and metrics for evaluating how discrepancies influence construction quality and subsequent building performance in the context of Addis Ababa have not been fully developed or standardized in existing literature.

- Insufficient evaluation of existing practices which is very few studies have critically evaluated the effectiveness of currently employed strategies to minimize design discrepancies; limited stakeholder engagement strategies is a gap in knowledge about how best to engage all stakeholders in the development and implementation of equity-driven initiatives; and neglect of technological innovations which is the potential role of technological advancements and digital tools in bridging the design-implementation gap has not been thoroughly researched.

Therefore, these identified research gaps provide a roadmap for future studies and investigations related to the causes of variance, legal and quality impacts and effective strategies to minimize the gap between approved designs and their implementation on private residential construction projects in Addis Ababa. By addressing these gaps, researchers can focus on addressing them to provide a more comprehensive understanding of the issues surrounding design implementation on private residential construction projects in Addis Ababa.

2.11. Conceptual Framework of the Study

The study was introduce a conceptual framework that effective strategies and best practices to minimize the gap between approved designs and their implementation in order to improve project outcomes and efficiency on above G+3 existing private residential construction projects before 5 years completed in Addis Ababa. In more detail, the conceptual framework of the study wills effective strategies and best practices to minimize the gap between approved designs and their implementation between five categories research variables (constructs): stakeholder engagement and communication; change management process; regulatory compliance and quality assurance; project planning and resource management; and feedback and continuous improvement are independent variable; and minimizing the gaps between approved designs and their implementation and ensuring successful project execution is dependent variable. The dependent variable will be develop effective strategies and best practices to minimize the gap between approved designs and their implementation in order to improve project outcomes and efficiency on the above G+3 existing private residential construction projects before 5 years completed in Addis Ababa. As illustrated in figure 2.1 below as follow (Asmerom, 2021):

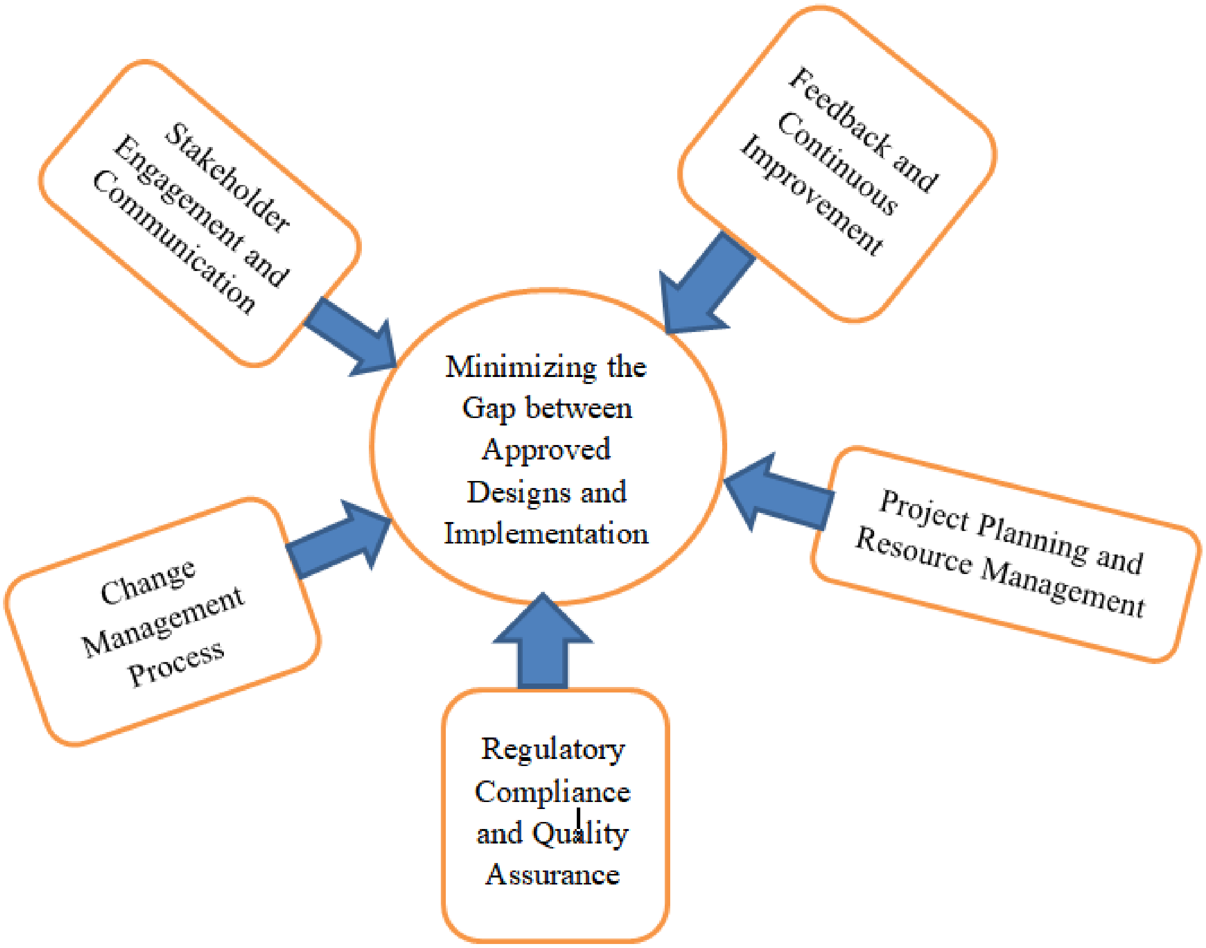

Figure 2. 1: Conceptual framework for effective strategies to minimize the gap between approved designs and their implementation

Source: researcher's own conceptualization

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1.Introduction

This chapter covers the research approach that was employed in the research study. These include the study area, research approach, research design, study population and sampling frame, sampling technique, sample size determination, data collection method, process of data analysis techniques, questionnaire reliability and validity tests, and ethical considerations. The collected data was analyzed using a fuzzy TOPSIS approach to prioritize the causes, impacts and strategies. The research methodology adopted quantitative research approach is the recommended research strategy.

3.2.Study Area

The study area focuses on the discrepancies between approved designs and actual implementation in the context of private residential construction projects, specifically G+3 (ground plus three stories) and above buildings, completed before five years in Addis Ababa, Ethiopia. This research was examining various dimensions of the construction process, regulatory frameworks, stakeholder engagement, and the impact of these discrepancies on project performance outcomes. The study was focuses on identifying the causes of variance, the legal and quality impacts of discrepancies, and strategies and best practice for improvement. The study was include private residential construction projects located in different sub-cities of Addis Ababa, and accomplished through the projects completed in Addis Ababa before five years, as well as the data collection was focus exclusively on existing buildings that are above G+3, located within Addis Ababa.

G+3 and above structures, due to their height and complexity, require strict adherence to design specifications to ensure structural integrity and occupant safety. By focusing on these discrepancies, the study can shed light on potential risks associated with non-compliance and suggest measures to mitigate them. The spatial description of the study area graphically is presented in the Figure 3.1, as shown below within the context of the Addis Ababa city map.

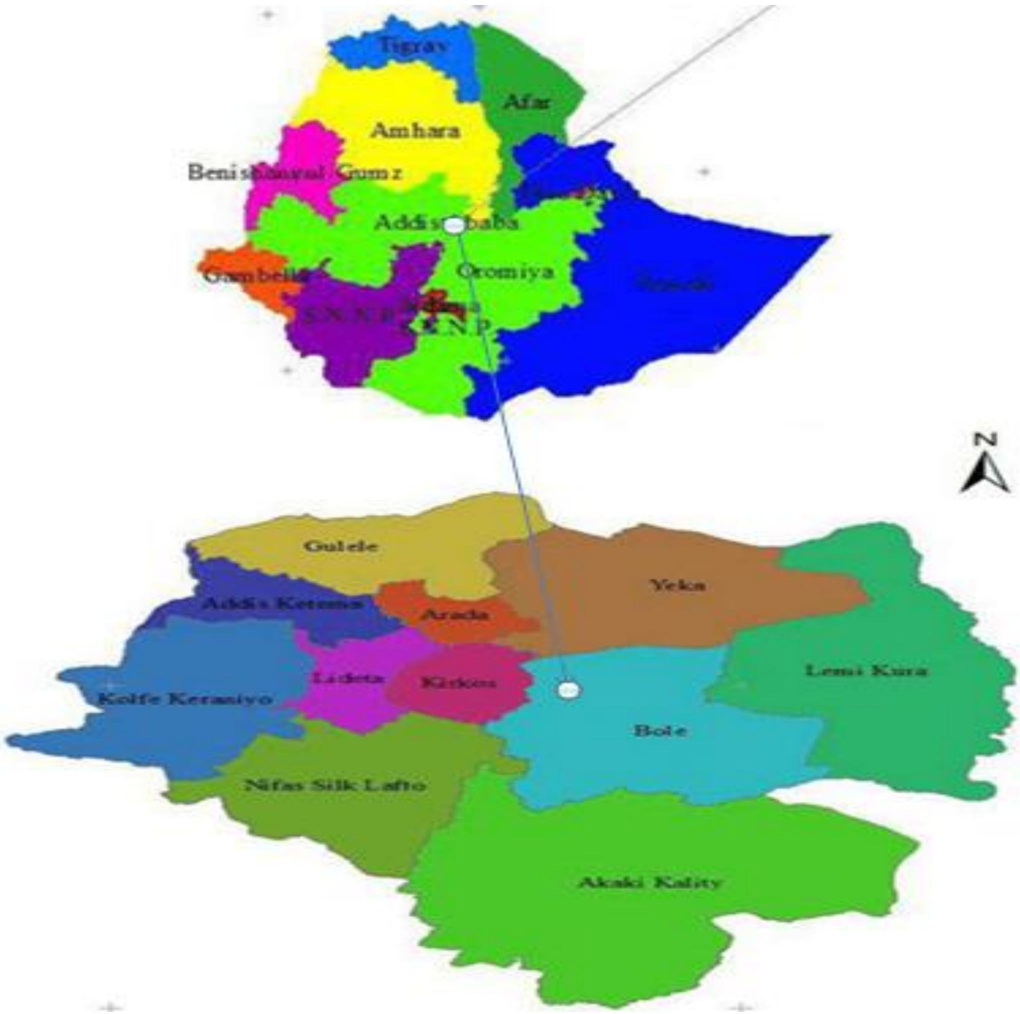

Figure 3. 1: Map of Addis Ababa City

Source: Addis Ababa city Municipal

3.3.Research Approach

The term "research approach" refers to the general strategy or plan used by a researcher to conduct the study. It defines the overall framework and process for data collection and analysis. This study was used a quantitative-methodologies approach to data gathering and analytic methods. This technique would enable a thorough study of the causes and effects of the gap between approved designs and actual implementation and developing strategies to minimize implementation gap on private residential construction projects in Addis Ababa. A quantitative - methods approach was used, which includes quantitative procedures. This allows for a more comprehensive knowledge by evaluating numerical data and getting detailed insights from stakeholders.

The structured research approach would aid in efficiently exploring the study's objectives regarding the discrepancies between approved designs and actual implementation on private residential construction projects in Addis Ababa. Using a quantitative methodologies, the study would able to get a comprehensive understanding of causes of variance, legal and quality impacts, and develop practical measures to improve project results and efficiency in the local construction sector.

3.4.Research design

Research design entails selecting the suitable methodology, data gathering methods, and developing a plan (framework) for data analysis. The research plan was used a quantitative methodologies approach to collect data from various sources. Based on the study's research objectives, a quantitative methods approach was used, descriptive research types linked with the study's unique goals. Using these approaches, this study would be able to identify relevant causes, analyze legal and quality impacts, and proposed effective strategies aimed at improving construction project outcomes in Addis Ababa.

To collect information, a descriptive research design was employed, with the goal of identify the causes of variance, assessing the legal and quality impacts of discrepancies, and developing effective strategies and best practices to minimize the gap between approved designs and actual implementation in order to improve project outcomes and efficiency in Addis Ababa.

The use of a fuzzy TOPSIS-approach to prioritize and evaluate these factors, as it seeks to provide a detailed and systematic analysis. Overall, the study seeks to analyze the causes, legal and quality impacts, and strategies to minimize the gap between approved designs and actual implementation in order to improve project outcomes and efficiency in Addis Ababa. The purpose of this study is to give a full knowledge of how these inconsistencies affect overall project performance, indicating areas for improvement and appropriate mitigation techniques.

3.5.Population and Sampling Frame

The term "population" refers to the total collection of people or items that match a specific set of criteria and are interesting to the researcher. The target populations were includes all G+3 and above private residential construction projects completed in the last five years in Addis Ababa that have been registered under GC-1 up to GC-5, and BC-1 up to BC-5 categories by the Addis

Ababa City Construction Bureau. This demographic is critical for understanding the implications of differences between approved designs and actual construction practices. The major target populations in this study are architects and designers, project managers, contractors, subcontractors, quantity surveyors, clients/homeowners, and regulatory bodies.

The sampling frame is a list or description of the population from which a sample was selected for the research study. The sampling frame was consist of the list of above G+3 residential construction projects completed in the last five years, and contractor registered under the classifications GC-1 up to GC-5, and BC-1 up to BC-5 categories with the Addis Ababa City Construction Bureau. The sampling frame was including a compiled list of all above G+3 projects and contractors categorized by GC-1 up to GC-5, and BC-1 up to BC-5; and the key stakeholders associated including architects and engineers, clients/homeowners and regulatory officials.

Therefore, the demographic and sample frame for this study the size of target population frame consists of a total 1462 private residential construction projects (number of building) was developed to ensure a thorough evaluation of the cause and effects of the discrepancies between approved designs and actual implementation above G+3 private residential construction projects in Addis Ababa. Using a stratified and random sample technique, the study would collect important views from a varied range of stakeholders, allowing for a complete understanding of the implications and potential options for improving construction procedures. This method would help to improve project outcomes and alignment between design and implementation.

3.6.Sampling Technique

The most acceptable sample approach for this investigation was a hybrid of stratified sampling and simple random sampling technique. A stratified sampling technique was best suited for a quantitative method research design aimed to analyze various aspects, such as the causes of variance, legal and quality impacts of discrepancies, and effective strategies to improve project outcomes and efficiency on private residential construction projects in Ethiopia, specifically in Addis Ababa. The stratified sampling technique is a probability sampling technique that divides the private residential construction projects professional into strata based on factors such as contractors categorized by GC-1 up to GC-5 and BC-1 up to BC-5; architects and consultant; clients/homeowners; regulatory officials; and other relevant experts involved in the implementation of large-scale private residential construction projects randomly choose participants from the private residential construction projects within each stratum to ensure appropriate representation. It divides populations into strata depending on key criteria and then randomly selects participants from each stratum.

Simple random Sampling is a probability sampling strategy in which each element of the population has an equal and independent chance of being included in the sample, i.e. a sample was chosen at random. It is the process of picking a sample by taking a subject that is chosen for a specific purpose rather than based on level or region. In this study, the size of target population frame consists of a total 3248 private residential construction projects professional i.e. for contractors categorized by GC-1 up to GC-5, and BC-1 up to BC-5 = 848; for architects and consultants = 496; for clients/homeowners = 1462 and for regulatory officials = 442 are considered to be in the population frame. Simple random sampling is the basic sampling technique where select a group of subjects (a sample) for study from a larger group (a population).

By using a combination of these sampling techniques, the study can ensure that it captures a comprehensive range of perspectives and experiences relevant to analyze and assess the impact of the gap between approved designs and actual implementation on construction projects in Addis Ababa.

3.7.Sample size determination

Sample size determination is the process of selecting representative units of a construction parties for the study in research investigation. It is important to ensure that the sample size is large enough to provide reliable and valid results for the study. The sample size of total sampling frame was drawn to make the required number of respondents (representatives). The data gathering through this technique should be more representative and reliable.

Therefore, this research paper was considers the respondents as sample representative; the following equation 3.1 was used to determine the sample size of a simple random sampling technique from target population frame (Lombeso, 2018):

$$n = \frac{NZ^2 Pq}{e^2(N-1) + Z^2 Pq} \qquad 3.1$$

Where; n is the desired sample size, N is the size of target population, Z is the standard normal deviate usually set at 1.645 for 90% confidence level, P is a proportion of target population have a specific characteristics (if no estimate available set at 50%), q is one minus P and e is acceptable sample error.

To calculate the sample size of respondents using equation 3.1, as shown below:

$$n = \frac{NZ^{2}Pq}{e^{2}(N-1)+Z^{2}pq} = \frac{3248(1.645)^{2}(0.5)(0.5)}{(0.1)^{2}(3248-1)+(1.645)^{2}(0.5)(0.5)} \approx 82$$

Therefore, the sample size is selected 82 respondents.

The sampling frame for this stratified sampling technique would include a list of all contractors classified as GC-1 through GC-5 and BC-1 through BC-5, architects and consultants, clients/homeowners, and regulatory officials in the population under examination. This list could come from professionals, government agencies, clients, or other sources.

To conduct a survey of professionals in private residential construction projects, the researchers separate the population by profession (contractors, architects and consultants, clients/homeowners, and regulatory officials). The researcher calculated the sample size using the population proportions for these professions, which are 848, 496, 1462, and 442, respectively. To ensure good representation of responder proportions, the sample size of 82 was calculated as follows:

Contractors = $\frac{(82)(848)}{3248} = 21$ respondents

Architects and Consultants = $\frac{(82)(496)}{3248} = 13$ respondents

Clients/homeowners = $\frac{(82)(1462)}{3248} = 37$ respondents

Regulatory officials = $\frac{(82)(442)}{3248} = 11$ respondents.

By selecting respondents at random from each profession, you ensure that the sample accurately represents the population's professional composition and gives trustworthy estimates for each.

3.8.Data Type and Source

The data types for this study were including quantitative data. Quantitative data were collected through surveys and questionnaires with likert scale questions assessing the frequency of various causes of discrepancies and their associated legal and quality impacts; and the effectiveness of various strategies on project outcomes on private residential construction projects in Addis Ababa. This would provide detailed information on the specific causes of variance, the legal and quality impacts of discrepancies, and the strategies for minimizing these gaps in existing private residential construction projects.

The study was used both primary and secondary data. To obtain sufficient and relevant data that helps to answer the research questions and achieve research objectives, quantitative data were collected from different primary and secondary sources. The primary sources of data were employees (professionals) on the private residential construction projects stakeholders such as all contractors categorized by GC-1 up to GC-5, and BC-1 up to BC-5; and architects and consultants, clients/homeowners and regulatory officials in Addis Ababa. The secondary sources of data were also exploited to conduct the study. Relevant books, text books, journals, organization's past and current written documents on the relevant issues were used. Moreover, available organizational documents such as structure, accessible project documents including agreement project profile, plans and reports were also reviewed.

3.9.Data Collection Method

This research was conducted using a variety of data collection approaches. Both primary and secondary data have been collected. The researcher collects primary data from respondents through self-administered surveys/questionnaires.

The researcher collect secondary data from published and unpublished documents, maps, plans, standard documents, statistical information, and other related material obtained from various sources. This entails performing a thorough literature analysis to acquire existing knowledge and research on the effects of variations between authorized plans and actual implementation on private residential construction projects.

The major instruments for collecting primary data from target respondents were a questionnaire. The researcher was designing and distributing questionnaires to a sample of above G+3 existing private residential construction projects in Addis Ababa stakeholders, including architects and consultants, contractors (project managers, subcontractors, and quantity surveyors), clients/homeowners and regulatory authorities. The questionnaire would include specific questions related to the key causes of variance between approved designs and actual implementation, legal and quality impacts of discrepancies between approved designs and actual implementation, and effective strategies to minimize the gap between approved designs and implementation in order to improve project outcomes and efficiency in Addis Ababa.

The questionnaire has two sections. The first section of the questionnaire is collects information about the respondents' backgrounds. The second section question number-1 of the questionnaire is gathers information about the causes of variance between approved designs and actual implementation on private residential construction projects in Addis Ababa. The second section question number-2 of the questionnaire is gathers information about the legal and quality impacts of discrepancies between approved designs and actual implementation on private residential construction projects in Addis Ababa. The second section question number-3 of the questionnaire is gathers information about the effective strategies and best practices to minimize the gap between approved designs and actual implementation in order to improve project outcomes and efficiency on private residential construction projects in Addis Ababa.

3.10. Data analysis Method

Based on the specific objectives of the study, the following data analysis methods would be able to consider using a Fuzzy TOPSIS technique to prioritize the causes of variance, legal and quality impacts and effective strategies: Descriptive statistics was used to summarize and describe the quantitative data collected through surveys regarding the consequences of discrepancies. This method is calculating a Fuzzy TOPSIS technique to prioritize the survey responses about the causes of variance, legal and quality impacts of discrepancies between approved designs and actual implementation, and effective strategies to minimize the gap between approved designs and actual implementation in order to improve project outcomes and efficiency.

Data collected from the first section of the questionnaire (respondent's profile), which included respondents' age range, gender, educational background, job title/position/current role, work experience, and organization type, were analyzed descriptively using frequency, charts, and percentages in appendix A.

Fuzzy TOPSIS technique Analysis

Data collected from the second section question number-1 in appendix A, which is the causes of variance between approved designs and actual implementation on private residential construction projects in Addis Ababa of the questionnaire is analyzed by closeness coefficient technique was used to determine the relative of the causes of variance between approved designs and actual implementation using the following a 5-point likert Fuzzy function scale, as shown in table 3.1.

Table 3. 1: Fuzzy function scale causes of variance b/n approved designs & actual implementation

Linguistic scales for causes of variance	Number	Triangular Fuzzy Number
Not Important	1	(1, 1, 3)
Slightly Important	2	(1, 3, 5)
Moderately Important	3	(3, 5, 7)
Important	4	(5, 7, 9)
Extremely Important	5	(7, 9, 9)

Source: (Kore et al., 2017)

Data collected from the second section question number-2 in appendix A, which is the legal and quality impacts of discrepancies between approved designs and actual implementation on private residential construction projects in Addis Ababa of the questionnaire is analyzed by closeness coefficient technique was used to determine the relative most significant legal and quality impacts of discrepancies using the following a 5-point likert Fuzzy function scale, as shown in table 3.2.

Table 3. 2: Fuzzy function scale legal and quality impacts of discrepancies b/n approved designs & actual implementation

Linguistic scales for impacts of legal & quality	Number	Triangular Fuzzy Number
Very low impact	1	(1, 1, 3)
low impact	2	(1, 3, 5)
Moderate impact	3	(3, 5, 7)

High impact	4	(5, 7, 9)
Very High impact	5	(7, 9, 9)

Source: (Kore et al., 2017)

Data collected from the second section question number-3 in appendix A, which is the effective strategies and best practices to minimize the gap between approved designs and actual implementation in order to improve project outcomes and efficiency in Addis Ababa of the questionnaire is also analyzed by closeness coefficient technique was used to determine the relative of the most effective strategies and best practices to improve project outcomes and efficiency using the following a 5-point likert Fuzzy function scale, as shown in table 3.3.

Table 3. 3: Fuzzy function scale effective strategies and best practices to minimize the gap b/n approved designs & actual implementation

Linguistic scales for effective strategies and best practices	**Number**	**Triangular Fuzzy Number**
Not Effective	1	(1, 1, 3)
Slightly Effective	2	(1, 3, 5)
Moderately Effective	3	(3, 5, 7)
Effective	4	(5, 7, 9)
Extremely Effective	5	(7, 9, 9)

Source: (Kore et al., 2017)

Let's look at how the Fuzzy TOPSIS method can be used into the framework design for discrepancy between approved design and actual implementation.

The key integration fuzzy TOPSIS techniques steps are:

Step 1: Identification of decision criteria

Step 2: Establish Fuzzy Sets and Membership Functions

Step 4: Calculate Fuzzy positive and Negative-Ideal Solutions.

Step 5: Determine the Closeness coefficient to Ideal Solution

Step 6: Ranking and prioritization

The fuzzy TOPSIS decision matrix must be built using the linguistic elements specified for rating the options according to expert standards. Linguistic variables are adjectives that describe parameters or alternatives. Fuzzy numbers are convex and normal subsets of the discourse universe (x). In every linguistic scale, linguistic variables are represented by a collection of fuzzy integers. These fuzzy numbers, like the one illustrated in the universe of discourse x, exhibit both convexity and normality properties. The following steps may be done to establish data analysis approaches for this study on discrepancy between approved design and actual implementation using a fuzzy TOPSIS approach:

Step 1: Understand the Fuzzy TOPSIS approach techniques. This approach is used to determine the best alternative among a set of options by considering both the positive and negative aspects of each alternative.

Step 2: Define the criteria that is identify the criteria that was used to evaluate the causes of variance, legal and quality impacts of discrepancies, and effective strategies to minimize the gap between approved designs and actual implementation in order to improve project outcomes and efficiency.

Step 3: Develop a decision matrix that is create a decision matrix that includes the identified criteria and the performance scores of each alternative (e.g., causes, impacts, and strategies) based on these criteria. The scores should be assigned using fuzzy numbers to account for uncertainty and imprecision in the data. The fuzzy decision matrix for each choice is generated by translating the linguistic concepts into triangular fuzzy integers.

Step 4: Create a fuzzy combined decision matrix that incorporates the defined criteria and the performance ratings of each alternative using the obtained combined triangular fuzzy numbers.

$X = \left(a_{ij}, b_{ij}, c_{ij}\right) \quad where, a_{ij} = \min(a_{ij}^{k}), \quad b_{ij} = \frac{1}{k}\sum_{k=1}^{k} b_{ij}^{k} \quad and\ c_{ij} = \max\left(c_{ij}^{k}\right)$ and k is number of respondents.

Step 5: Calculate the weighted normalized decision matrix, which normalizes the decision matrix to ensure that all criteria are on the same scale before assigning weights to each criterion based on the relative importance. The weighted normalized fuzzy decision matrix can be calculated using expert judgment or analytical methods by:

$$r_{ij} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*} \right) and\ c_j^* = \max(c_{ij})$$

Step 6: Determine the fuzzy positive ideal solution (FPIS) and the fuzzy negative ideal solution (FNIS). Determine the FPIS and FNIS for each criterion, which represent the best and worst performance levels for each criterion.

$$A^+ = (r_1^+, r_2^+, r_3^+), \quad where\ r_j^+ = \max(r_{i3}^+)\ and \quad A^- = (r_1^-, r_2^-, r_3^-), \quad where\ r_j^- = \min(r_{i3}^-)$$

Step 7: Calculate the fuzzy closeness coefficient, which is the distance between each alternative and the FPIS and FNIS in order to determine their relative closeness to the ideal solution. This will help to rank the alternatives based on their overall performance. Calculate the Euclidean distance between each choice from fuzzy positive (A+) and negative (A-) using

$$d_i^+ = \sqrt{\frac{1}{3}(a_i - a_1)^2 + (b_i - b_1)^2 + (c_i - c_1)^2} \quad where,\ A^+ = (a_1, b_1, c_1)$$

$$d_i^- = \sqrt{\frac{1}{3}(a_i - a_1)^2 + (b_i - b_1)^2 + (c_i - c_1)^2} \quad where,\ A^- = (a_1, b_1, c_1),$$

Then calculate the closeness coefficient CC_i of the alternatives are calculated using

$$CC_i = \frac{d_i^-}{d_i^+ + d_i^-}$$

Step 8: Rank the alternatives according to their fuzzy closeness coefficients. The options with the highest closeness coefficient are considered the best answer.

Step 9: Interpret and analyze the fuzzy TOPSIS analysis results to determine the most significant causes of variance, legal and quality impacts of discrepancies, and effective strategies and best practices to minimize the gap between approved designs and actual implementation in order to improve project outcomes and efficiency in Addis Ababa.

By using a combination of these data analysis techniques, researchers was develop a comprehensive understanding the underlying factors contributing to discrepancies, quantify the consequences of these discrepancies on project outcomes, and facilitate the development of effective strategies and best practices to enhance alignment between approved designs and actual implementation in Addis Ababa's private residential construction projects. By utilizing these varied analysis fuzzy methods, the research aims to provide meaningful insights that can lead to improved project performance and efficiency.

3.11. Study Variable

Several key study variables can be identified. These variables encompass various dimensions related to causes, impacts and strategies for mitigating discrepancies in construction projects. In more detail, the study variables of causes of variance, legal and quality impacts of discrepancies and effective strategies and best practices to minimize the gap between approved designs and actual implementation have two categories research variables (constructs):

Independent variables are:

- Stakeholder engagement and communication
- Change management process
- Regulatory compliance and quality assurance
- Project planning and resource management and
- Feedback and continuous improvement

Dependent variables are:

- Legal Impacts
- Quality Impacts
- Client satisfaction

Key Considerations for All Variables:

- Operationalization: Clearly define how each variable was measured (e.g., specific rating scales, checklists, specific units for costs, areas, etc.).
- Data collection method: Clearly specify what data collection methods were used to measure all variables (surveys, checklists, document analysis, interviews, case study).
- Context: Remember that all these variables should be assessed in the context of existing private residential construction projects.
- Consistency: Ensure consistency in measurement and data collection across all projects.

By structuring study variables this way, the study would be able to comprehensively address the research questions, from exploring the causes of discrepancies to evaluating strategies for minimizing the gap and improving project outcomes. This study was provides a well-organized framework that can generate meaningful insights.

3.12. Validity and Reliability

Validity and reliability are concepts used to evaluate the quality of research and they indicate how well a method, technique, or test measures something. According to Stilwell & Hoskins (2013), study indicated that the reliability and validity are two main criteria for determining data quality control where validity presumes reliability. Validity refers to accuracy or truthfulness of a study's results, while reliability refers to the consistency or stability of those results over time and across different situations. Both validity and reliability are important considerations in research design and data analysis.

3.12.1. Validity of the research method

Validity refers to the degree to which a study measures what it is intended to measure. In other words, a study is valid if it accurately reflects the concept or phenomenon being studied. The validity of the questionnaire data depends in a crucial way on the ability and willingness of the respondents to provide the information requested. The questionnaire employ will be adapted from reviewed literatures and similar study instruments and made suit for the existing research environment. Furthermore the questionnaires will be adapted pilot test by advisors, professionals from the area and experts to be validated. Overall, the researchers aim to maximize the validity of their studies by using appropriate measures, controlling for confounding variables, and ensuring that their findings can be generalized to other populations or settings.

Conducting sensitivity analysis using Pearson correlation to examine the causes of variance between approved designs and actual implementations provides valuable insights into which factors significantly influence outcomes. By focusing on variables with significant correlations ($p < 0.05$), organizations can prioritize interventions aimed at minimizing discrepancies, ultimately leading to more successful project outcomes in appendix F.

By employing sensitivity analysis alongside Pearson correlation, organizations can gain valuable insights into the relationship between discrepancies in approved designs and actual implementations with respect to legal and quality outcomes. Identifying significant correlations allows for targeted interventions to mitigate risks, enhance compliance, and improve overall project quality. This analytical approach not only supports informed decision-making but also fosters a culture of continuous improvement within project management practices in appendix G.

By applying sensitivity analysis in conjunction with Pearson correlation, organizations can effectively check the validity of their project outcomes concerning discrepancies between approved designs and actual implementations. The identification of significant correlations provides a foundation for developing targeted strategies aimed at minimizing gaps. Implementing effective communication, robust review processes, quality control measures, and data-driven decision-making can significantly enhance project efficiency, reduce legal risks, and improve overall outcomes. Continuous improvement through feedback loops ensures that organizations adapt and evolve their practices for sustained success in appendix H.

In this way, the study was structured to clearly and accurately answer the desired purpose (research question). The instrument's similarity with other discrepancy between approved design and actual implementation in private residential construction projects (cause, effect and mitigation strategies) measurement scales, detailed reviewed literatures of the constructs/concepts identified by the variables in the two parts of the questionnaires, advisor's review and comments in the process that follow a formal statistical/scientific approach in answering the research questions ensured that the study approach and the measurement instrument fulfilled all.

Triangulation refers to the methodological practice of using multiple data collection methods or sources to enhance the credibility and validity of research findings. In the context of evaluating discrepancies between approved designs and actual implementation in private residential construction projects in Addis Ababa, triangulation is particularly valuable. By employing a combination of quantitative and qualitative data collection methods such as questionnaires, interviews, and case studies researchers can gain a holistic understanding of the causes, effects, and potential mitigation strategies associated with such discrepancies.

The integration of these multiple methods through triangulation provides several distinct advantages: By cross-verifying findings from different data sources, the research can establish more robust conclusions about the causes and impacts of discrepancies. If multiple sources yield consistent findings, confidence in those results is amplified. Each method captures different dimensions of the research question, facilitating a more comprehensive understanding of the complexities involved in addressing discrepancies. Quantitative data can reveal patterns, while qualitative data provides context and meaning. Triangulation allows for the exploration of relationships among various variables, such as the interplay between causes of discrepancies, the effects on project performance, and the effectiveness of mitigation strategies.

3.12.2. Reliability of Questionnaire

Reliability refers to the consistency or stability of a study's results over time and across different situations. A study was reliable if it produces consistent results when repeated under similar conditions. To ensure the reliability of a questionnaire, it is important to use standardized questions, clear instructions, and a consistent format. Additionally, pilot testing the questionnaire on a small sample would help identify any issues with the questions or format before administering it to a larger sample. Overall, a reliable questionnaire is essential for obtaining accurate and trustworthy data for research purposes.

Cronbach's alpha coefficient is a statistical measure that assesses the internal consistency of questionnaire reliability was tested. It indicates how closely related a set of items are as a group, and how would they measure the same underlying construct. A high Cronbach's alpha coefficient (typically above 0.7) suggests that the questionnaire is reliable and consistent in measuring what it is intended to measure. However, it is important to note that reliability is just one aspect of questionnaire validity, and other factors such as content validity and construct validity were considered.

Data collected from the respondent's profile of the questionnaire reliability is test participants personal characteristics regarding the test environment and condition of the participants can contribute to whether or not a test is effectively reliable. Simple random sampling and stratified sampling technique is that the researcher exercises for target population selection on the informant's reliability and competency. This is a relevant concern especially regarding key informants on whom much of the data quality rest.

Data collected from the causes of variance between approved designs and actual implementation, from the legal and quality impacts of discrepancies between approved designs and actual implementation, and from the effective strategies and best practices to minimize the gap between approved designs and their implementation in order to improve project outcomes and efficiency of the questionnaires, internal consistency reliability is tested by Cronbach's alpha coefficient in rated on a five point likert the response scale. Reliability tested using Cronbach's alpha values for the items in each construct. Cronbach's alpha requires only a single test administration to provide a unique estimate of the reliability.

The test of reliability, the equation 3.2 is used to determine the Cronbach's alpha as shown below (Namdeo & Rout, 2016):

$$\alpha = \left(\frac{k}{k-1}\right)\left(\frac{S_T{}^2 - \sum S_i{}^2}{S_T{}^2}\right) \quad \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \quad 3.2$$

Where; α is the cronbach alpha coefficient, K is the number of items, S_i^2 is the variance of i^{th} item and S_i^2 is the variance of total score formed by summing items.

The interpretation of Cronbach's alpha is the range of Cronbach's alpha normally is between 0 and 1. Guide line provided by them to assess the reliability of any data as shown in Table 3.4.

Table 3. 4: Guideline for assessing reliability results

S. No	Range	Reliability
1	0.9 and above	Excellent
2	0.7 – 0.9	High
3	0.5 – 0.7	Moderate
4	0.5 and below	Low

Source: (Perry R. Hinton & Brownlow, 2014)

Results of Reliability Analysis

Prior to completing an analysis based on the questionnaire responses, Cronbach analysis was performed to determine the internal consistency of the questions using a five-point Likert scale. The Cronbach Alpha test that demonstrates the reliability of the questionnaire and the results of the reliability test that was conducted on the causes of variance between approved designs and actual implementation; the legal & quality impacts of discrepancies b/n approved designs & actual implementation; and effective strategies & best practices to minimize the gap b/n approved designs & actual implementation in order to improve project outcomes & efficiency in Addis Ababa is represented in the Table 3.5, as shown below.

Table 3. 5: Result of Reliability test

Reliability Statistics	Cronbach's Alpha	No of Items
The causes of variance between approved designs and actual implementation.	0.753	22
The legal & quality impacts of discrepancies b/n approved designs & actual implementation.	0.777	22
The effective strategies & best practices to minimize the gap b/n approved designs & actual implementation in order to improve project outcomes & efficiency	0.883	16
Overall	0.811	60

Source**:** Researcher survey data analysis

The findings show that the 60 items in the causes of variance, legal & quality impacts of discrepancies, effective strategies and best practices to minimize the gap b/n approved designs & actual implementation in Addis Ababa are connected. There is internal coherence among the elements. Because the data collected was based on five Likert-scales, Cronbach's Alpha was utilized to ensure the research's reliability, and all components were high or close to one. The aggregate Cronbach Alpha rating for the 60 items is 0.811, indicating that the data is very reliable. As a result, the researchers conclude that both the test and the questions were reliable.

3.13. Ethical consideration

This study raised some ethical concerns. When designing and administering a questionnaire, it is critical to consider ethical standards such as informed consent, confidentiality, and privacy. The research participants were thoroughly informed about the study's goal, rights, and how their data would be utilized. Furthermore, research participants were given the option of declining participation or withdrawing from the study at any moment without penalty. It is also critical to safeguard the confidentiality and privacy of research participants by securely storing data and using anonymous or pseudonymous identifiers. Finally, the researcher ensured that the study's potential benefits outweighed any risks or harm to participants.

The research does not identify any participants by name, and information confidentiality is ensured. The other ethical aspect for this research is to ensure that the findings are not detrimental to participants. The author may not knowingly misreport findings that might be detrimental to the participants.

CHAPTER FOUR

4. RESULTS AND DISCUSSIONS

4.1. Introduction

The results and discussion is the most important part of the study. This chapter is structured according to research objective and presents the findings. The important finding results were directly linked to investigate and evaluate the discrepancy between approved design and actual implementation in Addis Ababa private residential construction projects: cause, effect and mitigation strategies. The information collected through survey questionnaires, interviews and case study are analyzed within the framework of the study objectives. The analysis was carried out using fuzzy TOPSIS techniques to prioritize the causes of variance, legal and quality impacts, and effective strategies to minimize the gap between approved designs and actual implementation in order to improve project outcomes and efficiency in Addis Ababa. Accordingly, interpretations and discussions were presented on the basis of the findings. Hence, this chapter seeks to discuss the implications of the findings in relation to the research objectives that were set out in the introduction and the results are presented.

Relevant data were gathered through questionnaires distributed to target respondents, from various project reports and documents. A total of 93 questionnaires were distributed to the respondents. However, 82 questionnaires were collected and had usable responses rate of approximately 88%, interview, case study and relevant documents have been also reviewed. Considering the difficulty of collecting data, an 88% response rate was reasonably very good which the results show in Table 4.1 is as follows.

Table 4. 1: Frequency distribution of sample respondent's rate

No of distributed questionnaires distributed and returned		Response rate (%)
Distributed	Returned	
93	82	88.17%

Source: Researcher survey data result

4.2. General Information of Respondent's

This section presents a summarized result of the educational statuses of the respondents. The main purpose of the educational statuses analysis in this research is to describe the characteristics of the respondents so that the analysis could be more meaningful. Educational statuses of the sample of the respondents have been presented on following Table 4.2, as shown below.

Table 4. 2: Education level of Respondents

Education level of Respondents	Frequency	Percent	Cumulative Percent
Below Diploma	11	13.4	13.4
Diploma	16	19.5	32.9
BSc / BA	32	39.0	72.0
MSC / MA	14	17.1	89.0
PhD & above	9	11.0	100.0
Total	82	100.0	

Source: Researcher survey data result

According to Table 4.2 above, it was indicated that the highest educational level of the respondents the first degree and diploma. The majority of the respondents 32 (39.0%) are first degree holders, followed by 16 (19.5%) of the respondents who are diploma holders, 14 (17.1%) of the respondents are second degree holders, 11 (13.4%) of the respondents are below diploma holders and 9 (11.0%) of the respondents are third degree holders. This implied that more than 55 (67.1%) of the respondents are first degree and above holders which are the inclusive groups of key personals at top level responsible for developing effective strategies and best practices to minimize the gap between approved designs and actual implementation. Therefore, high educated respondents were key role players in providing adequate and relevant data which determine the research result rationally and logically.

The study sought to find out the job title/role in firm employed of respondents and the responses were analyzed as shown in Table 4.3 below.

Table 4. 3: Job Title of respondents

Job Title	Frequency	Percent	Cumulative Percent
Architect	15	18.3	18.3
Engineer	16	19.5	37.8
Contractor	14	17.1	54.9
Project manager	17	20.7	75.6
Regulatory official	11	13.4	89.0
Others	9	11.0	100.0
Total	82	100.0	

Source: Researcher survey data result

With regard to the job title/role in firm employed by the respondents, 17 (20.7%) were project managers, 16 (19.5%) were engineers, 15 (18.3%) were Architect, 14 (17.1%) were contractor, 11 (13.4%) were Regulatory official, and 9 (11.0%) were others. This shows that the respondents enhance the study's comprehensiveness, ensuring that a variety of perspectives are included in understanding the discrepancies between approved designs and actual implementation in construction projects. By analyzing data from stakeholders with different roles, the study aims to identify broader issues and effective strategies to address these discrepancies, ultimately contributing to improved practices in the construction industry in Addis Ababa.

The frequency according to Figure 4.1, 13 (15.9%) of respondents have less than 5 years of work experience, 25 (30.5%) of respondents have years of work experience between 5 and 10 years old, 33 (40.2%) of respondents have years of work experience between 11 and 15 years old, and 11 (13.4%) of respondents have years of work experience greater than 15 years old. The outcomes of the respondent's year of work experience are presented in Figure 4.1 below.

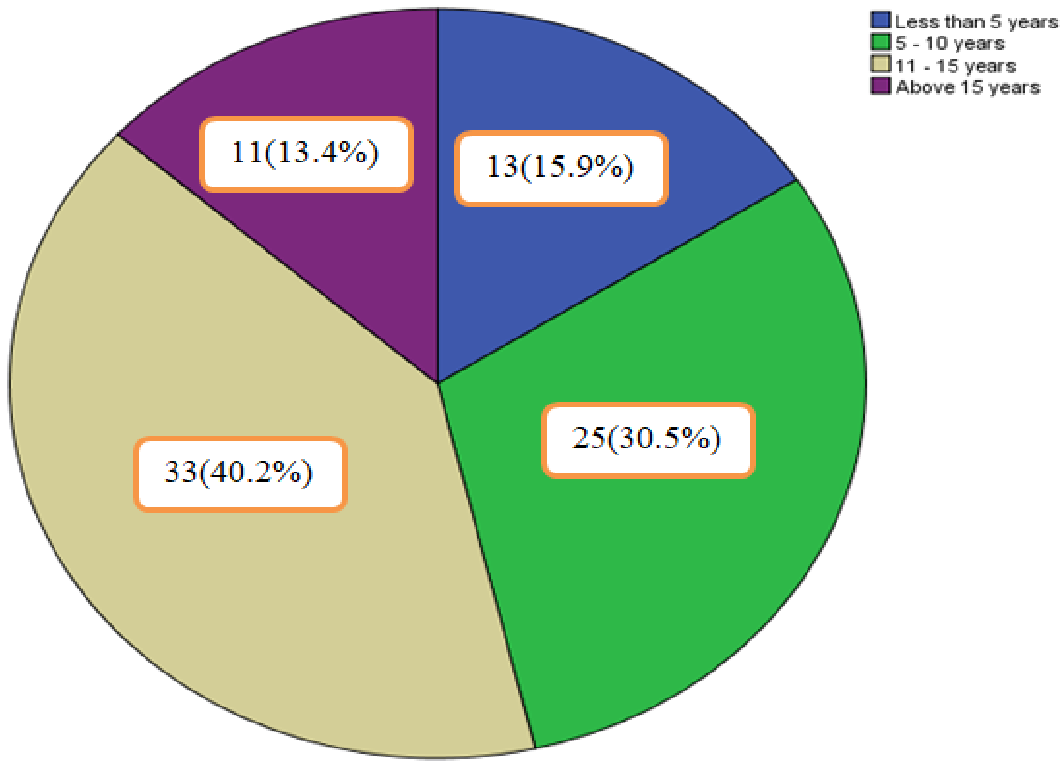

Figure 4. 1: Respondents work experience

Source: Researcher survey data result

According to above analysis from Figure 4.1, it was indicated that, the work experience of respondents, most often 33 (40.2%) have work experience of 10 - 15 years; 25 (30.5%) of respondents have work experience of 5 - 10 years; 13 (15.9%) of respondents have less than 5-years work experience; and 11 (13.4%) of the respondents had greater than 15 years' work experience. Majority of the respondents 69 (84.1%) have work experience of five years and above of as related to approved design and actual implementation on the construction industry. Therefore, respondents with more years of experience in discrepancy between approved design and actual implementation were found helpful for the study because their huge experience and knowledge about their organization characteristics and ritual habit will makes the results of the study sounder and more acceptable.

This section presents a summarized result of the demographics of the respondents which includes the education level and working experiences. The main purpose of the demographic analysis in this research is to describe the characteristics of the respondents so that the analysis could be more meaningful. Moreover, 67% of the respondents have educational qualification of first degree and above; more than 84% of the respondents have work experience of more than 5 years related to discrepancy between approved design and actual implementation on the construction industry. Therefore, respondents with more years of work experience in the construction industry and adequate level of education were found helpful for the study because their huge experience and knowledge about their organization characteristics and ritual habit will makes the results of the study sounder and more acceptable.

4.3. The Causes of Variance between Approved Designs and Actual Implementation

Assess the causes of variance between approved designs and actual implementation on private residential construction projects in Addis Ababa. A fuzzy TOPSIS-approach can be used to evaluate multiple alternatives against the selected criteria. In this section, the TOPSIS method in the fuzzy environment is described. Based on the TOPSIS method to obtain the judgment of respondents in each alternative importance weighting scale is required. This weighting scale is considered a linguistic variable. The linguistic terms are converted into triangular fuzzy numbers to construct the fuzzy decision matrix of each alternative see in Appendix C.

The result of combined triangular fuzzy numbers, a normalized fuzzy decision matrix and fuzzy closeness coefficient display as shown in Table 4. 4.

Table 4. 4: closeness coefficient of causes of variance b/n approved designs & actual implementation

Causes of variance b/n approved designs & actual implementation	Combined triangular fuzzy no	Normalized fuzzy decision matrix	closeness coefficient			
			d_i^+	d_i^-	CC_i	Rank
Poor communication among stakeholders (architects, contractors, and clients) leads to misunderstandings during implementation.	(1, 7.049, 9)	(0.111, 0.783, 1)	0.000	0.112	1.000	1
Inadequate documentation and unclear design specifications contribute to construction errors.	(1, 5.488, 9)	(0.111, 0.609, 1)	0.100	0.012	0.107	19
Design changes made after project approval create discrepancies between plans and actual construction	(1, 6.683, 9)	(0.111, 0.743, 1)	0.023	0.089	0.795	2
Resource limitations (such as labor shortages and material availability) affect	(1, 5.609, 9)	(0.111, 0.623, 1)	0.092	0.020	0.179	15

adherence to the approved designs.						
Changes in regulatory requirements that occur during construction lead to non-compliance with approved designs.	(1, 5.927, 9)	(0.111, 0.659, 1)	0.071	0.041	0.366	14
Complexity of design elements results in challenges during the implementation process.	(1, 5.512, 9)	(0.111, 0.612, 1)	0.099	0.013	0.116	18
Lack of rigorous quality assurance practices during construction leads to discrepancies.	(1, 5.976, 9)	(0.111, 0.664, 1)	0.068	0.044	0.393	13
Differences in stakeholder expectations lead to variances during construction.	(1, 6.219, 9)	(0.111, 0.691, 1)	0.053	0.059	0.527	8
Inadequate training and knowledge among workers regarding the approved designs contribute to implementation gaps.	(1, 6.317, 9)	(0.111, 0.702, 1)	0.046	0.066	0.589	6
Cultural and contextual factors unique to Addis Ababa influence how designs are interpreted and executed.	(1, 5.463, 9)	(0.111, 0.607, 1)	0.101	0.011	0.098	20
Lack of strict enforcement of building codes and regulations by authorities	(1, 6.659, 9)	(0.111, 0.739, 1)	0.025	0.087	0.777	3
Inadequate supervision by qualified professionals (architects/engineers) on site	(1, 5.293, 9)	(0.111, 0.588, 1)	0.112	0.000	0.000	22
Use of unqualified or inexperienced construction labor	(1, 5.609, 9)	(0.111, 0.623, 1)	0.092	0.020	0.179	15
Shortage or poor quality of building materials	(1, 6.341, 9)	(0.111, 0.705, 1)	0.045	0.067	0.598	4
Cost overruns and budget limitations	(1, 6.146, 9)	(0.111, 0.683, 1)	0.058	0.054	0.482	10
Changes requested by clients during construction (without proper revision process)	(1, 5.609, 9)	(0.111, 0.623, 1)	0.092	0.020	0.179	15
Corruption or bribery during inspection processes	(1, 6.098, 9)	(0.111, 0.678, 1)	0.060	0.052	0.464	11
Lack of advanced technologies (BIM, digital tools) in design and implementation	(1, 5.439, 9)	(0.111, 0.604, 1)	0.103	0.009	0.080	21
Inefficiencies Project Management	(1, 6.073, 9)	(0.111, 0.675, 1)	0.062	0.050	0.446	12
Inadequate project planning	(1, 6.341, 9)	(0.111, 0.705, 1)	0.045	0.067	0.598	4
Unforeseen site conditions	(1, 6.219, 9)	(0.111, 0.691, 1)	0.053	0.059	0.527	8
Changes in project scope	(1, 6.244, 9)	(0.111, 0.694, 1)	0.051	0.061	0.545	7
A^{+}		(0.111, 0.783, 1)				

A^-		(0.111, 0.588, 1)				

Source: Researcher survey data result

As the results of the study shown above it clear indicates that the dominant top five most causes of variance between approved designs and actual implementation on private residential construction projects in Addis Ababa using Fuzzy TOPSIS approach: are poor communication among stakeholders (architects, contractors, and clients) leads to misunderstandings during implementation with closeness coefficient value 1.000; design changes made after project approval create discrepancies between plans and actual construction with closeness coefficient value 0.795; lack of strict enforcement of building codes and regulations by authorities with closeness coefficient value 0.777; inadequate project planning with closeness coefficient value 0.598; and shortage or poor quality of building materials with closeness coefficient value 0.598.

The highest closeness coefficient underscores that poor communication among stakeholders including architects, contractors, and clients is a critical factor leading to variances. Misunderstandings can arise from vague instructions, lack of clarity in design intent, or failure to convey changes effectively. This breakdown in communication can result in construction that does not align with the approved designs, as stakeholders may interpret plans differently or fail to address important details. To mitigate this issue, establishing clear communication channels, regular meetings, and collaborative tools can enhance understanding and alignment among all parties involved.

Design changes that occur after project approval are another significant cause of discrepancies. Clients may request alterations based on evolving needs, aesthetic preferences, or budget constraints. However, these changes can disrupt the implementation process if not managed properly. The high closeness coefficient indicates a strong relationship between this factor and variance. To minimize its impact, it is essential to have a formal change management process that evaluates the implications of changes on timelines, costs, and overall design integrity before approval.

The enforcement of building codes and regulations plays a crucial role in ensuring that construction aligns with approved designs. A lack of strict oversight by authorities can lead to deviations from standards, resulting in variances. This factor’s closeness coefficient suggests that improving regulatory enforcement could significantly reduce discrepancies. Authorities should prioritize regular inspections and compliance checks, ensuring that contractors adhere to both safety standards and design specifications.

Inadequate project planning can lead to unforeseen challenges during construction, contributing to variances from approved designs. Poorly defined project scopes, unrealistic timelines, or insufficient resource allocation can hinder effective implementation. The closeness coefficient indicates a moderate relationship with variance causes, suggesting that enhancing project planning methodologies such as detailed scheduling, risk assessments, and resource management can help align actual construction more closely with approved designs.

The availability and quality of building materials directly impact construction outcomes. A shortage of materials or the use of substandard products can lead to compromises in design execution, resulting in variances from approved plans. The equal closeness coefficient with inadequate project planning highlights that both factors are interconnected; poor planning may exacerbate material shortages or lead to hasty procurement decisions that compromise quality. Addressing this issue requires establishing reliable supply chains and quality assurance processes to ensure that materials meet project specifications.

According to Yihdego (2017), study found that the major causes of variance between approved designs and actual implementation are: lack of participatory planning session using a staff both from the project design and implementing team; lack of planning based on realistic market price assessment of products and services; lack of managing projects with planned time, activity & resource schedule; preparation of project plan bases on realistic manpower, time and other resource requirements; top leadership commitment and support; and lack of stakeholder motivation and engagement. Therefore, once again this study finding is coincides with (Yihdego, 2017).

According to Choudhry et al. (2017), indicate that the provision of incomplete data to designers, lack of interest by approving authorities to carefully check the design, and owner-proposed changes due to financial problems are the top three important causes of discrepancies between approved designs and actual implementation. Therefore, this study also more or less coincide with to (Choudhry et al., 2017)

In generally the most significant causes of variance between approved designs and actual implementation in private residential construction projects in Addis Ababa point to systemic issues primarily rooted in communication and planning practices. By focusing on improving stakeholder collaboration, managing design changes effectively, enforcing regulations rigorously, enhancing project planning processes, and ensuring material quality, stakeholders can work towards minimizing discrepancies and achieving successful project outcomes.

4.4. The Legal and Quality Impacts of Discrepancies between Approved Designs and Actual Implementation

Assessment of the legal and quality impacts of discrepancies between approved designs and actual implementation on private residential construction projects in Addis Ababa at the major attribute level. This study aims to investigate the legal and quality impacts of discrepancies between approved designs and actual implementation on private residential construction projects in Addis Ababa. The overview evaluation was conducted using a fuzzy TOPSIS-approach, and respondents were asked to rate which aspects of discrepancies between approved designs and actual implementation on private residential construction projects were considered. A fuzzy TOPSIS-approach can be used to evaluate multiple alternatives against the selected criteria. In this section, the TOPSIS method in the fuzzy environment is described. Based on the TOPSIS techniques to obtain the judgment of respondents in each alternative importance weighting scale is required. This weighting scale is considered a linguistic variable. The linguistic terms are converted into triangular fuzzy numbers to construct the fuzzy decision matrix of each alternative see in Appendix D.

The result of combined triangular fuzzy numbers, a normalized fuzzy decision matrix and fuzzy closeness coefficient display as shown in Table 4. 5.

Table 4. 5: Closeness coefficient of the legal and quality impacts of discrepancies between approved designs and actual implementation

Impacts	The legal and quality impacts of discrepancies between approved designs and actual implementation	Combined triangular fuzzy no	normalized fuzzy decision matrix	closeness coefficient			
				d_i^+	d_i^-	CC_i	Rank
	Legal liabilities for non-compliance with regulations	(1, 6.683, 9)	(0.111, 0.743, 1)	0.0202	0.0537	0.7267	5
	Increased risk of litigation	(1, 6.317, 9)	(0.111, 0.702, 1)	0.0439	0.0300	0.4059	12

Legal	from clients or stakeholders						
	Non-compliance with building codes, regulations and standards	(1, 6.707, 9)	(0.111, 0.745, 1)	0.0191	0.0548	0.7415	3
	Legal disputes between clients and contractors	(1, 6.317, 9)	(0.111, 0.702, 1)	0.0439	0.0300	0.4059	12
	Legal penalties and fines imposed by authorities	(1, 6.219, 9)	(0.111, 0.691, 1)	0.0502	0.0237	0.3207	15
	Delays in project completion due to legal disputes	(1, 5.854, 9)	(0.111, 0.650, 1)	0.0739	0.0000	0.0000	22
	Revocation of building permits and orders to stop construction	(1, 6.122, 9)	(0.111, 0.680, 1)	0.0566	0.0173	0.2341	19
	Difficulty in obtaining occupancy permits	(1, 6.098, 9)	(0.111, 0.678, 1)	0.0577	0.0162	0.2192	20
	Increased liability and insurance claims	(1, 6.073, 9)	(0.111, 0.675, 1)	0.0595	0.0144	0.1949	21
	Discrepancies between approved design & actual construction affect the owner's to secure loans from financial institutions	(1, 6.561, 9)	(0.111, 0.729, 1)	0.0283	0.0456	0.6171	7
	Discrepancies between approved design and actual construction have an impact on the loan process	(1, 6.463, 9)	(0.111, 0.718, 1)	0.0346	0.0393	0.5318	8
	Due to the difference between the approved design & the actual construction, the construction project will suffer financially	(1, 6.341, 9)	(0.111, 0.705, 1)	0.0421	0.0318	0.4303	10
Quality	Loss of trust and reputation among clients and partners	(1, 6.244, 9)	(0.111, 0.694, 1)	0.0485	0.0254	0.3437	14
	Compromised safety standards leading to potential hazards	(1, 7.000, 9)	(0.111, 0.778, 1)	0.0000	0.0739	1.0000	1
	Decreased overall quality of construction	(1, 6.707, 9)	(0.111, 0.745, 1)	0.0191	0.0548	0.7415	3
	Compromised structural integrity of the building	(1, 6.902, 9)	(0.111, 0.767, 1)	0.0064	0.0675	0.9134	2
	Reduced durability and lifespan of the structure	(1, 6.683, 9)	(0.111, 0.743, 1)	0.0202	0.0537	0.7267	5
	Higher maintenance costs and frequent repairs	(1, 6.341, 9)	(0.111, 0.705, 1)	0.0421	0.0318	0.4303	10

	Poor functionality and usability of the building	(1, 6.390, 9)	(0.111, 0.71, 1)	0.0393	0.0346	0.4682	9
	Aesthetic deficiencies and compromised appearance	(1, 6.171, 9)	(0.111, 0.686, 1)	0.0531	0.0208	0.2815	18
	Reduced market value of the property	(1, 6.219, 9)	(0.111, 0.691, 1)	0.0502	0.0237	0.3207	15
	Negative impact on reputation of contractors/architects	(1, 6.195, 9)	(0.111, 0.688, 1)	0.0520	0.0219	0.2963	17
	A^{+}		(0.111, 0.778, 1)				
	A^{-}		(0.111, 0.65, 1)				

Source: Researcher survey data result

Hence, it could be concluded from analysis of the responses using Fuzzy TOPSIS approach that the most dominant impacts of discrepancies between approved designs and actual implementation on private residential construction projects in Addis Ababa are Compromised safety standards leading to potential hazards in quality impact with closeness coefficient value of 1.000; Compromised structural integrity of the building in quality impact with closeness coefficient value of 0.9134; Decreased overall quality of construction in quality impact with closeness coefficient value of 0.7415; Non-compliance with building codes, regulations and standards in legal impact with closeness coefficient value of 0.7415; Legal liabilities for non-compliance with regulations in legal impact with closeness coefficient value of 0.7267; and Reduced durability and lifespan of the structure in quality impact with closeness coefficient value of 0.7267.

The highest impact arises from compromised safety standards, which can lead to severe hazards for occupants and the surrounding community. This discrepancy can result from using substandard materials, inadequate construction practices, or deviations from safety regulations. The implications are critical, as they can lead to accidents, injuries, or even fatalities, emphasizing the need for strict adherence to approved designs.

Following closely is the compromise of structural integrity. This issue can manifest in various ways, such as insufficient load-bearing capacity or failure to withstand environmental stresses (e.g., earthquakes or heavy rains). When structural integrity is compromised, it poses a long-term risk to the safety of the building and its inhabitants, potentially leading to catastrophic failures.

Discrepancies can lead to a general decline in construction quality. This decrease can affect aesthetic aspects, functionality, and performance of the building. Poor quality can result in higher maintenance costs and a shorter lifespan for the building, ultimately affecting the value of the property.

Failure to comply with established building codes and regulations is a significant legal impact. Non-compliance can result in fines, penalties, or orders to rectify issues, which can delay project completion and increase costs. It also undermines public trust in the construction industry and regulatory bodies.

Legal liabilities arise when discrepancies result in non-compliance with regulations. Stakeholders, including contractors and developers, may face lawsuits or claims for damages if the construction does not meet legal standards. This can lead to financial losses and reputational damage.

Finally, discrepancies often lead to reduced durability and lifespan of structures. When materials and methods deviate from approved designs, the resulting buildings may not withstand wear and tear over time. This reduction in durability necessitates more frequent repairs and renovations, increasing the overall cost of ownership for residents.

According to Asmerom (2021), study indicated that in general delay in the project, increase in project cost and demolition and rework were identified as the impact of discrepancies between approved designs and actual implementations. Therefore, the finding of this study is also inline and complements with (Asmerom, 2021).

According to Mbatha (2021), indicated that the biggest impact of discrepancies between approved designs and actual implementations on construction projects are the loss of profitability and perhaps business viability, and delays in project delivery. Therefore, this study also more or less coincide with (Mbatha, 2021).

In generally, discrepancies between approved designs and actual implementations in residential construction projects in Addis Ababa have far-reaching impacts that compromise safety, structural integrity, quality, legal compliance, and durability. Addressing these discrepancies through better oversight, adherence to regulations, and quality control measures is essential to ensure safe and sustainable construction practices in the region.

4.5. The Effective Strategies and Best Practices to Minimize the Gap between Approved Designs and Actual Implementation

Each variable's contribution to the overall strategies was evaluated, and the attributes were ranked according to the respondents' perceived criticality. This was done and analyzed using the fuzzy TOPSIS-approach by triangular fuzzy number to compute the rankings of 16 common effective strategies & best practices to minimize the gap between approved designs & actual implementation in order to improve project outcomes and efficiency on private residential construction projects in Addis Ababa. A fuzzy TOPSIS-approach can be used to evaluate multiple alternatives against the selected criteria. In this section, the TOPSIS method in the fuzzy environment is described. Based on the TOPSIS method to obtain the judgment of respondents in each alternative importance weighting scale is required. The linguistic terms are converted into triangular fuzzy numbers to construct the fuzzy decision matrix of each alternative see in Appendix E.

The result of combined triangular fuzzy numbers, a normalized fuzzy decision matrix and fuzzy closeness coefficient display as shown in Table 4. 6.

Table 4. 6: Closeness coefficient of Effective strategies & best practices to minimize the gap between approved designs & actual implementation

Effective strategies & best practices to minimize the gap between approved designs & actual implementation	Combined triangular fuzzy no	Normalized fuzzy decision matrix	closeness coefficient			
			d_i^+	d_i^-	CC_i	Rank
Strengthening and consistent enforcement of building codes and regulations	(1, 8.244, 9)	(0.111, 0.916, 1)	0.000	0.161	1.000	1
Mandating and enforcing comprehensive on-site supervision	(1, 7.634, 9)	(0.111, 0.848, 1)	0.039	0.122	0.758	3
Promoting and ensuring the use of quality and certified building materials	(1, 7.756, 9)	(0.111, 0.862, 1)	0.031	0.129	0.801	2
Implementing thorough project planning and scheduling	(1, 6.439, 9)	(0.111, 0.715, 1)	0.116	0.045	0.279	13
Providing training and capacity building	(1, 6.609, 9)	(0.111, 0.734, 1)	0.105	0.056	0.348	9

for construction workers						
Utilizing Building Information Modeling (BIM) and digital tools	(1, 6.634, 9)	(0.111, 0.737, 1)	0.103	0.058	0.360	8
Establishing a formal change management process for client requests	(1, 7.024, 9)	(0.111, 0.780, 1)	0.079	0.083	0.516	5
Regular quality control and quality assurance inspections	(1, 7.561, 9)	(0.111, 0.840, 1)	0.044	0.117	0.727	4
Promoting ethical practices and transparency in construction contracts	(1, 6.268, 9)	(0.111, 0.696, 1)	0.127	0.034	0.211	15
Establishing an effective mechanism to handle complaints and disputes	(1, 5.732, 9)	(0.111, 0.637, 1)	0.161	0.000	0.000	16
Involving clients in regular progress meetings and design reviews	(1, 6.805, 9)	(0.111, 0.756, 1)	0.092	0.069	0.429	7
Enhanced communication and collaboration among stakeholders	(1, 6.488, 9)	(0.111, 0.721, 1)	0.113	0.048	0.298	12
Engaging experienced contractors and subcontractors	(1, 6.609, 9)	(0.111, 0.734, 1)	0.105	0.056	0.348	9
Engaging qualified and experienced professionals for design and oversight	(1, 6.561, 9)	(0.111, 0.729, 1)	0.108	0.053	0.329	11
Encouraging stakeholder involvement throughout the project	(1, 6.341, 9)	(0.111, 0.705, 1)	0.122	0.039	0.242	14
Implementing feedback mechanisms for continuous improvement	(1, 6.902, 9)	(0.111, 0.767, 1)	0.086	0.075	0.466	6
A^{+}		(0.111, 0.916, 1)				
A^{-}		(0.111, 0.637, 1)				

Source: Researcher survey data result

Based on the Fuzzy TOPSIS technique obtained in the above Table 4.6, relatively the following strategies were identified in Addis Ababa that is relevant to minimize the gap between approved designs & actual implementation in order to improve project outcomes and efficiency in chronological order. Thus, top five effective strategies & best practices to minimize the gap between approved designs & actual implementation in order to improve project outcomes and efficiency on private residential construction projects in Addis Ababa are strengthening and consistent enforcement of building codes and regulations with closeness coefficient value of 1.000; promoting and ensuring the use of quality and certified building materials with closeness coefficient value of 0.801; mandating and enforcing comprehensive on-site supervision with closeness coefficient value of 0.758; regular quality control and quality assurance inspections with closeness coefficient value of 0.727; and establishing a formal change management process for client requests with closeness coefficient value of 0.516.

Minimizing the gap between approved designs and actual implementation is crucial for achieving successful project outcomes in private residential buildings. This discussion examines five key strategies and best practices that contribute to improved project efficiency, reduced costs, and enhanced quality.

Strengthening and consistent enforcement of building codes and regulations is the first strategy that is, building codes and regulations serve as the foundational framework for safe and quality construction. By strengthening these codes and ensuring consistent enforcement, stakeholders can create a more reliable environment for construction practices. This includes regular updates to codes based on technological advancements and safety standards, as well as rigorous inspections to ensure compliance. Strengthened regulations can deter substandard practices and encourage adherence to approved designs, ultimately improving the safety and quality of residential projects.

Promoting and ensuring the use of quality and certified building materials is the second strategy that is, the materials used in construction play a vital role in the durability and performance of residential buildings. By promoting the use of high-quality, certified materials, stakeholders can significantly reduce the risk of discrepancies between approved designs and actual implementations. This involves establishing partnerships with reputable suppliers, educating contractors about material specifications, and implementing verification processes to ensure that only approved materials are used. Ensuring quality materials not only enhances structural integrity but also contributes to long-term sustainability.

Mandating and enforcing comprehensive on-site supervision is the third strategy that is, effective on-site supervision is essential for maintaining alignment between design intentions and construction practices. By mandating comprehensive supervision by qualified personnel, stakeholders can ensure that construction processes adhere closely to approved designs. This supervision should include regular communication between architects, engineers, and contractors to address any issues as they arise. A strong supervisory presence can facilitate immediate corrections, reduce misunderstandings, and enhance accountability among all parties involved.

Regular quality control and quality assurance inspections is the fourth strategy that is, implementing a robust quality control (QC) and quality assurance (QA) framework is critical for identifying discrepancies early in the construction process. Regular inspections at various stages of construction can help verify that work aligns with approved designs and specifications. These inspections should be conducted by independent third-party inspectors to ensure objectivity. By prioritizing QC and QA, stakeholders can detect potential issues before they escalate, thus improving overall project outcomes and reducing costly rework.

Establishing a formal change management process for client requests is the fifth strategy that is, changes requested by clients during the construction phase can often lead to deviations from approved designs. Establishing a formal change management process allows for a structured approach to evaluating, approving, and implementing client requests while maintaining design integrity. This process should include thorough documentation, impact assessments, and clear communication with all stakeholders. By managing changes effectively, projects can remain aligned with original design intentions while accommodating client needs, ultimately enhancing satisfaction without compromising quality.

In generally, the gap between approved designs and actual implementation in private residential buildings can significantly impact project outcomes and efficiency. By adopting effective strategies such as strengthening building codes, promoting quality materials, enforcing on-site supervision, conducting regular inspections, and establishing formal change management processes, stakeholders can work collaboratively to minimize discrepancies. These strategies not only enhance the safety and quality of residential buildings but also foster a culture of accountability and continuous improvement within the construction industry. As stakeholders prioritize adherence to approved designs through these best practices, they contribute to the development of sustainable, durable, and high-quality living environments that meet the needs of homeowners while ensuring compliance with regulatory standards.

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

5.1.Conclusions

This study main objective was to investigate the cause and effects of the gap between approved designs and actual implementation and developing strategies to minimize implementation gap on private residential construction projects in Addis Ababa. The specific objectives included to identify the causes of variance between approved designs and actual implementation, to assess the legal and quality impacts of discrepancies between approved designs and actual implementation, and to developing effective strategies and best practices to minimize the gap between approved designs and actual implementation in order to improve project outcomes and efficiency on private residential construction projects in Addis Ababa. With this in mind, the conclusion specifically presents the major findings obtained based on the data analyzed. Therefore, the researcher has drawn the conclusion as follows:

The variances between approved designs and actual implementations in private building projects stem from multiple interconnected factors, each impacting the project's overall success. By recognizing the main causes are poor communication among stakeholders; design changes made after project approval; lack of strict enforcement of building codes and regulations; inadequate project planning; and shortage or poor quality of building materials. Addressing these dominant causes of variance requires a multifaceted approach that emphasizes communication, change management, regulatory compliance, thorough planning, and material quality assurance. By prioritizing these areas, stakeholders in private residential construction projects in Addis Ababa can enhance alignment between approved designs and actual implementation, ultimately leading to more successful project outcomes.

The discrepancies between approved designs and actual implementations in residential construction projects in Addis Ababa have far-reaching impacts that compromise safety, structural integrity, quality, legal compliance, and durability. Addressing these discrepancies through better oversight, adherence to regulations, and quality control measures is essential to ensure safe and sustainable construction practices in the region.

The effective strategies and best practices identified for minimizing the gap between approved designs and actual implementation are essential for improving project outcomes and efficiency in existing private residential buildings. Strengthening building code enforcement, ensuring material quality, mandating comprehensive supervision, conducting regular quality inspections, and establishing formal change management processes collectively contribute to enhanced alignment between design and construction. By adopting these practices, construction firms in Addis Ababa can significantly reduce discrepancies, promote safety, and ultimately deliver higher-quality residential projects that meet the expectations of clients and regulatory standards.

5.2.Recommendations

Recommendations for effective implementation of potential solutions and strategies to minimize the gap between approved designs & actual implementation in order to improve project outcomes and efficiency in Addis Ababa:

- ❖ Enhanced regulatory training which is implement ongoing training programs for stakeholders, including contractors and project managers, to ensure they are fully aware of local building codes, regulations, and standards.
- ❖ Regular compliance audits which is establish a routine compliance audit process where qualified professionals periodically review construction sites to ensure adherence to approved designs and municipal codes.
- ❖ Contingency plans for legal issues which are create a framework for addressing potential legal challenges that may arise from discrepancies.
- ❖ Implementation of rigorous safety standards which is strengthening safety protocols by integrating comprehensive safety assessments at all construction phases.
- ❖ Quality assurance programs which are establish and enforce rigorous quality assurance programs that include systematic inspections and checks designed to verify the structural integrity of buildings throughout the construction process.
- ❖ Long-term performance monitoring which is incorporates systems for long-term monitoring of structural performance post-construction.
- ❖ Materials certification processes which are ensure that all materials used in construction meet quality and safety standards.
- ❖ Strengthening building codes and enforcement which is collaborate with local regulatory bodies to continuously update and enforce building codes.

- ❖ Promotion of quality and certified materials which is encouraging the use of certified and tested construction materials through regulations and procurement policies.
- ❖ Mandating comprehensive on-site supervision which is designate trained supervisors who are responsible for ensuring compliance with approved designs at all stages of construction.
- ❖ Regular quality control inspections which are schedule consistent quality control inspections throughout the construction process.
- ❖ Formal change management process which is establish a formal process for managing changes to designs, ensuring all modifications are appropriately documented, reviewed, and communicated to relevant parties.

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Appendix

Appendix A: Survey Questionnaire

Adama Science and Technology University

College of Civil Engineering and Architecture

Department of Civil Engineering

Questionnaire survey for thesis paper on the discrepancy between approved design and actual implementation in Addis Ababa private residential construction projects: cause, effect and mitigation strategies

Dear/Sir;

The purpose of this questionnaire is to collect data for the research study entitled **"discrepancy between approved design and actual implementation in Addis Ababa private residential construction projects: cause, effect and mitigation strategies"** as a fulfillment of the requirement for the Degree of Master of Science in department of Civil Engineering. Thus, your genuine, professional opinion and timely responses are vital to determine the success of this study. Please note that the information you provide will only be used for academic purpose and all the information revealed will be kept confidential. To this end, you are kindly requested to contribute your own share by filling in the questionnaires honestly and responsibly for further recommendations to improve similar works in the future. Thank you in advance for your cooperation!!!

If you need further explanation, you can contact me through the address indicated below:

Wesenu Kefyalew, Mobile Number: +2519-12-219522

Email: wesenukk@gmail.com

General Instruction:

- No need of writing your name/address.
- To those questions with alternatives mark your response on the space provided by putting " ✓ "
- For any additional option or explanation you are kindly requested to write briefly on the space provided.

Part One: - General information about the respondents

1. Age Range:
   a. 18 – 28 years b. 29 – 38 years c. 39 – 48 years d. Above 48 years old
2. Gender:
   a. Male b. Female
3. Educational background:
   a. Below Diploma b. Diploma c. BSc/BA d. MSc/MA e. PhD & above
4. Job Title/Position/current role:
   a. Architect b. Engineer c. Contractor d. Project manager e. Regulatory official f. Other
5. Years of professional work Experience? (estimate)
   a. Less than 5 years b. 5 - 10 years c. 11 - 15 years d. above 15 years
6. Organization Type:
   a. Private firms b. Public Organizations c. NGOs d. other sectors

Part Two: - Discrepancy between Approved Design & Actual Implementation in Addis Ababa

1. To what extent are you agreeing with the causes of variance between approved designs and actual implementation on private residential construction projects in Addis Ababa? Please indicate the most significant causes of variance by making on the appropriate box using the following a 5-point likert importance weighting scale:

Linguistic scales for causes of variance	Number	Triangular Fuzzy Number
Not Important	1	(1, 1, 3)
Slightly Important	2	(1, 3, 5)
Moderately Important	3	(3, 5, 7)
Important	4	(5, 7, 9)
Extremely Important	5	(7, 9, 9)

R. No	The causes of variance between approved designs and actual implementation	1	2	3	4	5
1	Poor communication among stakeholders (architects, contractors, and clients) leads to misunderstandings during implementation.					
2	Inadequate documentation and unclear design specifications contribute					

	to construction errors.					
3	Design changes made after project approval create discrepancies between plans and actual construction.					
4	Resource limitations (such as labor shortages and material availability) affect adherence to the approved designs.					
5	Changes in regulatory requirements that occur during construction lead to non-compliance with approved designs.					
6	Complexity of design elements results in challenges during the implementation process.					
7	Lack of rigorous quality assurance practices during construction leads to discrepancies.					
8	Differences in stakeholder expectations lead to variances during construction.					
9	Inadequate training and knowledge among workers regarding the approved designs contribute to implementation gaps.					
10	Cultural and contextual factors unique to Addis Ababa influence how designs are interpreted and executed.					
11	Lack of strict enforcement of building codes and regulations by authorities					
12	Inadequate supervision by qualified professionals (architects/engineers) on site					
13	Use of unqualified or inexperienced construction labor					
14	Shortage or poor quality of building materials					
15	Cost overruns and budget limitations					
16	Changes requested by clients during construction (without proper revision process)					
17	Corruption or bribery during inspection processes					
18	Lack of advanced technologies (BIM, digital tools) in design and implementation					
19	Inefficiencies Project Management					

20	Inadequate project planning					
21	Unforeseen site conditions					
22	Changes in project scope					

2. To what extent are you agree with the legal and quality impacts of discrepancies between approved designs and actual implementation on private residential construction projects in Addis Ababa? Please indicate the most significant impacts of legal and quality by making on the appropriate box using the following a 5-point likert importance weighting scale:

Linguistic scales for impacts of legal & quality	**Number**	**Triangular Fuzzy Number**
Very low impact	1	(1, 1, 3)
low impact	2	(1, 3, 5)
Moderate impact	3	(3, 5, 7)
High impact	4	(5, 7, 9)
Very High impact	5	(7, 9, 9)

R. No	**The legal and quality impacts of discrepancies between approved designs and actual implementation**	**1**	**2**	**3**	**4**	**5**
	Legal Impacts:					
1	Legal liabilities for non-compliance with regulations					
2	Increased risk of litigation from clients or stakeholders					
3	Non-compliance with building codes, regulations and standards					
4	Legal disputes between clients and contractors					
5	Legal penalties and fines imposed by authorities					
6	Delays in project completion due to legal disputes					
7	Revocation of building permits and orders to stop construction					
8	Difficulty in obtaining occupancy permits					
9	Increased liability and insurance claims					
10	Discrepancies between approved design & actual construction affect the owner's to secure loans from financial institutions					
11	Discrepancies between approved design and actual construction					

	have an impact on the loan process					
12	Due to the difference between the approved design & the actual construction, the construction project will suffer financially					
	Quality Impacts:					
13	Loss of trust and reputation among clients and partners					
14	Compromised safety standards leading to potential hazards					
15	Decreased overall quality of construction					
16	Compromised structural integrity of the building					
17	Reduced durability and lifespan of the structure					
18	Higher maintenance costs and frequent repairs					
19	Poor functionality and usability of the building					
20	Aesthetic deficiencies and compromised appearance					
21	Reduced market value of the property					
22	Negative impact on reputation of contractors/architects					

3. To what extent are you agree with the effective strategies and best practices to minimize the gap between approved designs and their implementation in order to improve project outcomes and efficiency in Addis Ababa? Please indicate the most effective strategies and best practices by making on the appropriate box using the following a 5-point likert importance weighting scale:

Linguistic scales for effective strategies and best practices	**Number**	**Triangular Fuzzy Number**
Not Effective	1	(1, 1, 3)
Slightly Effective	2	(1, 3, 5)
Moderately Effective	3	(3, 5, 7)
Effective	4	(5, 7, 9)
Extremely Effective	5	(7, 9, 9)

R. No	**Effective strategies & best practices to minimize the gap between approved designs & actual implementation in order to improve project outcomes and efficiency**	**1**	**2**	**3**	**4**	**5**

1	Strengthening and consistent enforcement of building codes and regulations					
2	Mandating and enforcing comprehensive on-site supervision					
3	Promoting and ensuring the use of quality and certified building materials					
4	Implementing thorough project planning and scheduling					
5	Providing training and capacity building for construction workers					
6	Utilizing Building Information Modeling (BIM) and digital tools					
7	Establishing a formal change management process for client requests					
8	Regular quality control and quality assurance inspections					
9	Promoting ethical practices and transparency in construction contracts					
10	Establishing an effective mechanism to handle complaints and disputes					
11	Involving clients in regular progress meetings and design reviews					
12	Enhanced communication and collaboration among stakeholders					
13	Engaging experienced contractors and subcontractors					
14	Engaging qualified and experienced professionals for design and oversight					
15	Encouraging stakeholder involvement throughout the project					
16	Implementing feedback mechanisms for continuous improvement					

Appendix B: Interview Questions

1. In your experience, what are the most common reasons for discrepancies you observe between approved designs and actual implementations in construction projects?
2. How do communication practices among stakeholders (architects, contractors, clients) contribute to discrepancies between approved designs and actual construction?
3. Have you encountered any specific challenges related to client changes or requests that deviate from the approved designs? If so, can you elaborate?
4. What impact do you believe discrepancies between approved designs and actual implementation has on project?
5. How do discrepancies between approved designs and actual implementation influence the overall quality of the completed projects?
6. Are there legal consequences that have arisen from discrepancies between approved designs and actual implementation in your projects? If so, please describe them.
7. What strategies or practices have you found to be effective in minimizing discrepancies between approved designs and actual implementation?
8. How important is regular oversight and monitoring during the construction process to prevent discrepancies? Can you provide examples?
9. What recommendations would you make to improve communication and collaboration among project stakeholders to align better with approved designs?

Appendix C: The linguistic terms are converted into triangular fuzzy numbers for causes

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22
D1	(5, 7, 9)	1	5	4	4	1	3	4	5	4	3	3	4	5	1	3	4	4	3	2	1	3
D2	(3, 5, 7)	5	3	5	4	3	5	4	4	5	5	4	5	4	4	3	5	5	3	3	2	4
D3	(5, 7, 9)	3	3	4	2	3	5	2	4	3	5	4	4	5	3	3	3	3	2	2	3	1
D4	(5, 7, 9)	4	5	5	3	4	4	3	4	5	4	4	5	2	2	3	5	5	1	4	5	2
D5	(5, 7, 9)	4	4	5	5	5	5	5	5	5	5	4	5	4	5	4	5	5	2	1	4	5
D6	(7, 9, 9)	4	3	5	4	3	4	4	2	4	3	4	5	5	3	5	4	4	1	5	3	3
D7	(1, 3, 5)	5	4	5	4	4	5	5	4	4	5	5	5	5	5	2	4	4	4	2	4	4
D8	(5, 7, 9)	4	4	5	4	5	5	4	5	3	4	2	5	4	4	4	5	3	5	2	2	3
D9	(7, 9, 9)	4	3	5	4	3	4	4	2	4	3	4	5	4	3	5	4	4	2	3	3	4
D10	(7, 9, 9)	3	4	4	5	5	3	3	3	4	3	5	4	5	3	5	5	4	2	4	4	1
D11	(5, 7, 9)	4	5	5	4	4	5	5	4	5	5	5	5	4	4	4	5	5	3	1	2	2
D12	(5, 7, 9)	5	4	5	4	3	4	2	3	4	4	4	5	5	4	4	3	4	3	2	1	5
D13	(7, 9, 9)	3	4	2	3	2	5	4	4	4	4	4	2	4	4	5	4	4	3	3	2	4
D14	(5, 7, 9)	4	5	4	4	5	3	5	5	5	4	5	4	4	5	4	4	5	3	4	4	3
D15	(7, 9, 9)	4	5	5	5	3	4	2	3	4	5	4	5	3	4	5	4	4	3	4	3	3
D16	(5, 7, 9)	5	2	5	5	4	4	3	4	5	2	5	5	4	4	4	5	5	1	3	4	2
D17	(5, 7, 9)	2	4	4	4	3	4	4	3	4	4	3	4	5	3	4	2	4	2	3	3	2
D18	(5, 7, 9)	5	5	5	3	3	4	3	3	4	5	4	5	2	5	3	3	4	3	2	3	1
D19	(7, 9, 9)	4	5	3	3	3	3	4	4	4	2	3	3	3	4	4	3	4	3	2	3	2
D20	(1, 3, 5)	4	4	4	3	1	4	5	5	4	3	4	4	3	4	5	5	4	1	2	3	3
D21	(5, 7, 9)	5	4	2	2	3	3	4	2	3	5	2	2	3	5	2	2	3	3	2	4	3
D22	(7, 9, 9)	4	5	3	3	2	2	4	3	5	4	3	3	3	4	3	3	5	2	3	5	4
D23	(1, 3, 5)	4	4	3	2	3	3	5	4	4	4	1	3	3	4	3	3	4	3	4	1	4
D24	(3, 5, 7)	5	5	2	2	2	5	4	4	4	5	1	2	1	5	3	3	4	2	3	4	4
D25	(5, 7, 9)	4	4	2	3	2	5	5	5	5	4	3	2	2	2	3	4	5	5	4	2	3
D26	(7, 9, 9)	5	4	3	2	2	3	4	2	4	5	3	3	3	3	3	3	4	1	3	5	2
D27	(3, 5, 7)	2	5	1	1	1	1	4	4	4	4	1	1	3	4	1	1	4	3	1	2	4
D28	(7, 9, 9)	4	2	1	2	2	2	5	4	5	5	1	1	5	5	2	2	5	4	3	2	1
D29	(5, 7, 9)	5	4	5	3	3	3	2	5	4	2	3	5	4	4	3	2	4	2	4	3	5
D30	(5, 7, 9)	4	3	5	2	3	3	5	2	4	5	3	5	4	4	3	3	4	3	4	5	1
D31	(7, 9, 9)	5	3	3	3	5	3	4	4	4	4	3	3	5	3	3	3	4	2	3	4	2
D32	(5, 7, 9)	2	4	3	4	3	3	3	5	3	4	1	3	4	5	1	3	3	2	2	3	4
D33	(7, 9, 9)	3	3	4	3	3	3	3	5	4	5	5	4	5	4	3	4	4	4	3	1	5
D34	(5, 7, 9)	3	3	4	5	5	4	3	4	3	3	4	4	5	3	4	5	3	1	1	1	2
D35	(5, 7, 9)	5	3	2	3	3	4	1	4	4	4	3	2	3	4	2	4	4	3	3	3	2
D36	(5, 7, 9)	2	2	3	3	3	3	3	5	2	2	3	3	4	3	3	3	2	5	3	2	4
D37	(7, 9, 9)	3	3	3	3	3	4	2	4	3	3	4	3	4	2	5	5	3	2	4	4	5
D38	(1, 3, 5)	3	2	3	4	2	2	3	5	1	3	3	3	4	3	3	3	1	4	4	5	3
D39	(5, 7, 9)	3	2	4	5	5	4	2	4	1	2	4	4	5	2	3	4	1	2	2	3	3
D40	(7, 9, 9)	4	3	5	5	5	5	2	4	3	2	5	5	2	3	5	5	3	3	2	2	2
D41	(1, 3, 5)	3	2	3	3	3	4	2	3	3	3	2	3	3	3	3	3	3	3	2	4	1

D42	(3, 5, 7)	1	1	3	5	5	5	1	4	1	1	4	3	3	1	5	4	1	2	2	3	4
D43	(5, 7, 9)	2	2	3	5	5	5	2	5	1	1	4	3	5	1	4	4	1	5	5	2	3
D44	(3, 5, 7)	2	3	3	5	5	5	3	2	3	5	4	3	2	3	4	4	3	1	4	3	3
D45	(5, 7, 9)	3	2	1	1	1	1	3	3	3	5	1	1	3	3	1	2	3	3	3	4	3
D46	(7, 9, 9)	3	3	1	5	5	1	5	3	3	3	4	1	3	3	4	4	3	4	2	2	2
D47	(3, 5, 7)	3	4	2	4	4	2	3	3	1	3	3	2	3	3	3	4	1	3	2	4	2
D48	(7, 9, 9)	4	3	3	5	3	3	3	3	5	4	2	3	4	4	2	5	5	4	2	2	2
D49	(3, 5, 7)	5	5	4	4	3	4	5	3	4	4	3	4	3	5	4	2	4	3	4	3	1
D50	(3, 5, 7)	4	3	5	3	3	4	3	1	3	2	4	5	1	3	3	3	3	2	1	3	1
D51	(3, 5, 7)	3	3	3	3	3	3	3	2	3	3	3	3	2	3	4	3	3	1	4	3	5
D52	(7, 9, 9)	5	3	4	3	1	4	3	3	4	3	4	4	2	5	5	5	4	2	4	3	3
D53	(5, 7, 9)	3	4	2	2	3	3	2	4	3	3	2	2	5	1	2	2	3	3	2	3	3
D54	(5, 7, 9)	4	5	3	3	2	2	5	5	4	4	3	3	4	4	3	3	4	3	2	3	2
D55	(7, 9, 9)	5	5	3	2	3	3	5	2	5	5	1	3	4	5	3	3	5	4	2	2	2
D56	(5, 7, 9)	3	3	2	2	2	5	3	4	2	3	1	2	5	4	3	3	2	3	3	4	2
D57	(7, 9, 9)	4	5	2	3	2	5	5	5	4	3	3	2	4	5	3	4	4	2	3	4	4
D58	(5, 7, 9)	4	5	3	2	2	3	5	5	4	3	3	3	5	5	3	3	4	2	3	2	4
D59	(5, 7, 9)	4	5	1	1	1	1	5	4	4	3	1	1	5	5	1	1	4	3	2	3	4
D60	(5, 7, 9)	2	1	1	2	2	2	1	4	1	1	1	1	3	2	2	2	1	2	2	2	3
D61	(7, 9, 9)	4	5	5	3	3	3	5	5	4	1	3	5	4	5	3	2	4	4	2	3	3
D62	(5, 7, 9)	4	4	5	2	3	3	4	4	3	2	3	5	4	4	3	3	3	5	2	2	3
D63	(3, 5, 7)	5	5	3	3	5	3	3	5	2	3	3	3	4	3	3	3	2	3	2	4	2
D64	(7, 9, 9)	4	4	3	4	3	3	5	4	1	2	1	3	5	2	1	3	1	2	2	1	2
D65	(5, 7, 9)	4	5	4	3	3	3	5	4	2	2	5	4	2	5	3	4	2	1	2	3	2
D66	(5, 7, 9)	5	5	4	5	5	4	4	3	1	3	4	4	3	4	4	5	1	2	2	3	3
D67	(7, 9, 9)	4	4	2	3	3	4	3	4	2	4	3	2	3	3	2	4	2	3	3	2	3
D68	(5, 7, 9)	4	5	3	3	3	3	5	5	4	1	3	3	5	5	3	3	4	3	3	3	3
D69	(7, 9, 9)	5	5	3	3	3	4	4	2	3	2	4	3	2	4	5	5	3	3	3	4	4
D70	(5, 7, 9)	4	4	3	4	2	2	3	3	2	3	3	3	3	3	3	3	2	2	3	3	4
D71	(5, 7, 9)	4	5	4	5	5	4	5	3	1	1	4	4	3	2	3	4	1	2	4	4	5
D72	(5, 7, 9)	5	4	5	5	5	5	4	3	2	2	5	5	3	5	5	5	2	2	4	2	3
D73	(7, 9, 9)	4	5	3	3	3	4	3	3	1	3	2	3	4	4	3	3	1	2	4	2	2
D74	(1, 3, 5)	4	4	3	5	5	5	5	3	2	2	4	3	3	3	5	4	2	4	5	2	1
D75	(7, 9, 9)	5	4	3	5	5	5	4	1	4	2	4	3	1	2	4	4	4	3	4	3	2
D76	(5, 7, 9)	4	5	3	5	5	5	3	2	3	3	4	3	2	5	4	4	3	2	3	3	2
D77	(5, 7, 9)	4	5	1	1	1	1	5	3	2	4	1	1	2	4	1	2	1	1	2	4	3
D78	(5, 7, 9)	5	5	1	5	5	1	4	4	1	1	4	1	5	3	4	4	2	5	1	5	3
D79	(5, 7, 9)	4	4	2	4	4	2	3	5	2	2	3	2	4	2	3	4	3	4	3	2	5
D80	(5, 7, 9)	4	5	3	5	3	3	5	2	1	3	2	3	4	5	2	5	2	2	4	1	3
D81	(5, 7, 9)	5	3	2	4	5	2	4	4	4	2	1	2	5	3	4	4	1	3	4	3	3
D82	(5, 7, 9)	4	4	4	4	3	4	5	5	3	3	3	4	4	3	4	2	3	2	3	5	2

Appendix D: The linguistic terms are converted into triangular fuzzy numbers for impacts

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22
D1	(1, 3, 5)	3	5	5	5	5	3	4	2	5	4	2	5	5	5	2	2	2	2	4	4	5
D2	(7, 9, 9)	4	5	4	4	5	5	5	4	4	5	4	5	4	4	4	5	4	3	4	3	4
D3	(7, 9, 9)	4	4	4	5	4	3	3	5	4	3	4	4	4	4	3	4	4	3	2	3	4
D4	(7, 9, 9)	5	5	4	2	4	4	5	2	5	4	5	4	4	5	3	4	5	2	4	3	4
D5	(7, 9, 9)	2	5	5	4	5	5	5	4	5	4	4	4	5	2	3	3	4	5	4	4	5
D6	(7, 9, 9)	4	5	2	5	4	4	4	5	3	4	4	4	2	4	3	4	4	3	4	5	4
D7	(5, 7, 9)	5	5	4	5	5	4	4	5	4	5	3	5	4	5	5	4	3	5	5	4	4
D8	(7, 9, 9)	5	5	5	4	5	4	5	4	5	2	4	4	5	5	3	5	4	4	2	4	3
D9	(7, 9, 9)	4	5	2	4	3	4	4	4	3	4	5	4	2	4	3	4	5	2	4	5	2
D10	(1, 3, 5)	4	4	3	5	4	5	5	5	5	5	3	3	3	4	3	4	3	2	5	4	4
D11	(5, 7, 9)	5	5	4	4	4	4	5	4	4	5	4	4	5	5	5	5	4	5	5	5	5
D12	(7, 9, 9)	4	5	3	5	4	4	3	5	3	4	4	5	2	4	4	4	4	4	4	3	3
D13	(7, 9, 9)	5	2	4	4	5	3	4	4	2	4	5	5	4	5	4	5	5	4	4	3	4
D14	(5, 7, 9)	3	4	5	4	2	4	4	4	5	5	2	4	5	4	5	4	2	4	5	4	4
D15	(7, 9, 9)	4	5	3	3	3	5	4	3	3	4	5	3	2	4	4	4	5	5	4	4	5
D16	(3, 5, 7)	3	5	4	4	3	5	5	4	4	5	4	3	3	3	5	4	4	2	5	4	4
D17	(5, 7, 9)	4	4	3	5	5	4	2	5	3	3	4	3	4	4	4	4	4	4	4	3	5
D18	(1, 3, 5)	2	5	3	2	2	3	3	2	3	4	5	2	3	5	4	3	5	5	4	2	3
D19	(3, 5, 7)	3	3	4	3	3	3	3	3	3	3	4	3	4	2	4	5	4	2	3	3	4
D20	(3, 5, 7)	1	4	5	3	3	3	5	3	1	4	4	2	5	3	5	4	4	3	4	3	3
D21	(1, 3, 5)	1	2	2	3	3	2	2	3	3	2	5	2	3	3	2	4	5	4	3	4	3
D22	(1, 3, 5)	3	3	3	3	4	3	3	3	2	3	4	3	4	3	4	5	4	3	2	5	4
D23	(3, 5, 7)	3	3	4	3	3	2	3	3	3	1	5	2	3	4	5	4	5	4	3	2	4
D24	(1, 1, 3)	1	2	4	1	1	2	3	1	2	1	2	1	3	5	2	4	2	5	4	4	5
D25	(1, 1, 3)	1	2	5	2	2	3	4	2	2	3	4	2	4	2	3	5	4	3	4	5	4
D26	(7, 9, 9)	3	3	2	3	2	2	3	3	2	3	5	3	5	4	4	4	5	4	4	5	5
D27	(7, 9, 9)	3	1	4	3	3	1	1	3	1	1	4	2	5	5	3	4	4	3	4	4	5
D28	(3, 5, 7)	5	5	4	5	4	4	2	3	5	5	5	3	4	5	4	4	5	3	5	4	3
D29	(3, 5, 7)	5	3	5	4	4	4	2	1	4	4	2	4	4	4	5	3	2	4	4	5	4
D30	(7, 9, 9)	5	5	2	4	5	4	3	5	5	4	3	4	5	4	3	4	3	5	4	4	4
D31	(3, 5, 7)	5	4	4	5	2	4	3	4	5	5	3	4	4	5	4	3	3	2	3	3	4
D32	(7, 9, 9)	5	4	5	4	4	5	3	4	5	2	5	4	5	4	5	5	5	4	4	4	3
D33	(5, 7, 9)	4	5	5	5	5	2	4	4	5	4	4	4	4	5	4	3	4	4	5	4	2
D34	(5, 7, 9)	5	4	4	5	5	4	5	4	5	5	5	5	4	4	4	4	5	5	3	3	3
D35	(7, 9, 9)	5	5	4	3	4	5	4	5	4	5	5	2	4	4	3	5	5	4	4	4	3
D36	(5, 7, 9)	2	5	5	4	4	5	3	4	5	4	4	4	4	3	4	2	4	4	3	3	3
D37	(7, 9, 9)	4	3	4	4	5	4	5	4	5	4	3	5	5	4	4	4	3	3	3	2	2
D38	(7, 9, 9)	5	4	5	4	4	4	3	3	2	5	5	5	3	5	5	5	5	4	3	3	3
D39	(3, 5, 7)	5	4	4	5	5	5	4	4	4	4	4	4	5	2	4	5	4	5	2	3	3
D40	(5, 7, 9)	4	4	4	2	3	4	5	5	5	5	5	4	4	3	4	4	5	3	3	3	3
D41	(5, 7, 9)	5	5	3	3	4	5	3	5	5	4	3	5	4	3	5	4	3	4	2	3	4

D42	(5, 7, 9)	3	2	4	3	3	3	4	4	4	4	4	4	5	3	4	5	4	4	2	3	3
D43	(7, 9, 9)	4	3	5	5	4	4	4	3	5	3	4	5	4	3	5	4	4	5	3	1	1
D44	(1, 3, 5)	2	3	2	2	2	3	4	3	3	4	4	3	5	3	4	5	4	2	2	4	3
D45	(3, 5, 7)	3	5	3	3	3	4	2	3	4	5	4	4	4	4	4	4	4	5	3	3	4
D46	(3, 5, 7)	3	2	3	3	1	2	4	2	2	2	3	3	4	5	4	3	3	4	4	2	4
D47	(7, 9, 9)	2	3	3	3	1	3	4	3	3	3	4	4	4	2	4	4	4	4	4	4	5
D48	(1, 3, 5)	2	3	3	4	3	1	5	2	3	3	3	2	5	4	3	3	3	5	4	3	4
D49	(3, 5, 7)	3	3	3	3	3	1	2	2	2	3	2	3	2	5	5	2	2	4	4	3	3
D50	(3, 5, 7)	1	4	1	1	1	3	3	3	2	3	3	1	4	5	4	3	3	4	5	4	3
D51	(3, 5, 7)	1	3	2	2	1	3	3	2	3	3	5	1	5	4	4	2	5	5	4	4	3
D52	(5, 7, 9)	5	1	3	2	3	1	5	1	1	1	5	3	2	4	5	3	5	4	4	5	4
D53	(7, 9, 9)	5	5	4	5	4	4	2	5	5	4	3	4	3	5	4	3	3	5	3	4	4
D54	(3, 5, 7)	5	4	5	4	4	4	3	4	5	5	1	4	4	4	4	1	1	2	4	5	4
D55	(5, 7, 9)	5	4	2	4	5	5	3	4	5	2	5	5	5	5	4	5	5	5	5	4	5
D56	(7, 9, 9)	5	5	4	5	2	2	3	4	5	4	3	4	4	4	4	4	3	3	5	4	2
D57	(1, 3, 5)	5	4	5	4	4	4	4	4	5	5	4	4	4	4	5	5	4	4	4	3	3
D58	(5, 7, 9)	4	5	5	5	5	5	3	5	4	5	5	5	3	3	4	5	5	5	3	4	3
D59	(7, 9, 9)	5	5	4	5	5	5	1	4	5	4	3	4	4	4	4	4	3	2	3	5	5
D60	(7, 9, 9)	5	3	4	3	4	4	2	4	5	4	5	5	4	5	3	3	5	4	3	2	2
D61	(5, 7, 9)	2	4	5	4	4	4	2	3	2	5	4	5	5	2	4	5	4	5	2	3	3
D62	(5, 7, 9)	4	4	4	4	5	5	3	4	4	4	3	3	4	3	5	4	3	5	3	3	3
D63	(7, 9, 9)	5	4	5	4	4	4	3	5	5	5	2	4	4	3	3	5	2	4	2	3	3
D64	(5, 7, 9)	5	5	4	5	5	5	3	5	5	4	5	4	5	3	4	3	5	4	2	3	4
D65	(7, 9, 9)	4	2	4	2	3	3	4	4	4	4	3	4	4	3	4	4	3	5	3	3	3
D66	(5, 7, 9)	5	3	3	3	4	4	5	3	5	3	4	5	5	3	5	4	4	4	2	1	1
D67	(5, 7, 9)	3	3	4	3	3	3	4	3	3	4	3	2	4	1	2	4	3	5	1	2	2
D68	(3, 5, 7)	4	5	5	5	4	4	3	3	4	5	3	3	4	2	5	4	3	4	2	3	2
D69	(5, 7, 9)	2	2	2	2	2	2	5	2	2	2	3	3	4	3	4	3	3	3	3	4	5
D70	(7, 9, 9)	3	3	3	3	3	3	3	3	3	3	1	5	4	3	4	4	1	4	2	5	4
D71	(1, 3, 5)	3	3	3	3	1	1	4	2	3	3	3	2	3	4	5	3	3	3	5	2	4
D72	(3, 5, 7)	2	3	3	3	1	1	5	2	2	3	2	3	5	5	4	2	2	2	4	4	5
D73	(3, 5, 7)	2	4	3	4	3	3	3	3	2	3	3	3	4	2	4	3	3	3	4	5	4
D74	(3, 5, 7)	3	3	3	3	3	3	4	2	3	3	2	3	4	4	5	5	2	2	4	5	5
D75	(7, 9, 9)	1	5	1	1	1	4	4	5	5	4	2	4	5	5	4	5	2	3	4	4	5
D76	(3, 5, 7)	1	4	2	2	1	4	4	4	5	5	2	4	4	5	5	3	2	3	5	4	3
D77	(5, 7, 9)	5	4	3	2	3	5	2	4	5	2	1	5	4	4	2	1	1	1	4	5	4
D78	(7, 9, 9)	5	5	4	5	4	2	4	4	5	4	2	4	5	4	4	2	2	1	4	4	4
D79	(7, 9, 9)	5	4	5	4	4	4	4	4	5	5	5	4	4	5	5	5	5	4	3	5	4
D80	(5, 7, 9)	5	5	2	4	5	5	5	5	4	5	4	4	4	4	4	3	4	4	4	4	5
D81	(5, 7, 9)	5	5	4	5	2	5	4	4	5	4	5	5	4	5	4	4	5	5	5	4	2
D82	(7, 9, 9)	5	3	5	4	4	4	2	4	5	4	5	2	3	4	3	5	5	4	5	3	3

Appendix E: The linguistic terms are converted into triangular fuzzy numbers for strategies

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
D1	(7, 9, 9)	4	4	4	4	5	3	4	5	4	5	5	4	5	4	5
D2	(5, 7, 9)	5	4	4	3	4	5	5	4	4	5	4	5	4	4	5
D3	(7, 9, 9)	4	5	5	5	5	5	4	4	5	5	4	2	4	5	5
D4	(5, 7, 9)	4	5	4	3	4	3	4	5	2	5	4	4	5	2	5
D5	(5, 7, 9)	5	5	4	4	5	4	5	4	4	5	4	5	4	4	5
D6	(7, 9, 9)	3	5	4	5	4	5	5	5	5	4	5	5	5	5	4
D7	(5, 7, 9)	4	5	5	4	4	5	4	5	5	5	4	4	5	5	5
D8	(7, 9, 9)	5	4	2	4	5	5	4	3	4	5	4	4	3	4	5
D9	(7, 9, 9)	5	5	4	5	2	5	5	4	4	2	3	5	4	4	2
D10	(5, 7, 9)	4	5	5	4	4	5	4	4	5	4	4	4	4	5	4
D11	(7, 9, 9)	4	4	5	5	5	4	5	4	4	5	5	5	4	4	5
D12	(5, 7, 9)	5	4	4	5	5	5	4	5	5	5	5	4	5	5	5
D13	(7, 9, 9)	4	5	4	3	4	5	4	2	3	4	4	4	2	3	4
D14	(7, 9, 9)	5	5	5	4	4	3	3	3	4	5	3	3	3	4	5
D15	(7, 9, 9)	5	4	4	4	5	4	4	3	3	3	3	4	3	3	3
D16	(7, 9, 9)	4	5	5	4	4	5	5	5	4	4	3	5	5	4	4
D17	(7, 9, 9)	5	3	4	5	5	5	4	2	2	2	2	2	2	2	2
D18	(7, 9, 9)	4	4	4	2	3	4	3	3	3	3	3	3	3	3	3
D19	(5, 7, 9)	4	4	3	3	4	5	3	3	1	3	2	4	5	4	5
D20	(7, 9, 9)	5	3	4	3	3	3	3	3	1	2	2	5	4	4	5
D21	(7, 9, 9)	3	3	5	4	5	4	5	5	5	5	5	2	4	5	5
D22	(7, 9, 9)	4	4	2	5	4	4	5	4	3	4	3	4	5	2	5
D23	(7, 9, 9)	4	5	5	2	4	5	5	4	4	5	4	5	4	4	5
D24	(7, 9, 9)	4	5	4	4	5	4	5	4	5	5	5	5	5	5	4
D25	(5, 7, 9)	5	5	4	5	4	4	5	4	3	4	2	4	5	5	5
D26	(7, 9, 9)	4	5	4	5	5	5	4	5	5	3	4	4	3	4	5
D27	(5, 7, 9)	4	5	4	4	5	5	5	4	4	5	5	5	4	4	2
D28	(7, 9, 9)	5	4	5	4	3	4	5	4	3	4	5	4	4	5	4
D29	(7, 9, 9)	5	5	4	5	4	4	4	3	2	5	4	5	4	4	5
D30	(5, 7, 9)	4	5	4	4	4	5	4	4	5	3	4	4	5	5	5
D31	(7, 9, 9)	4	4	3	5	4	4	5	5	3	4	5	4	2	3	4
D32	(5, 7, 9)	5	4	4	4	5	5	5	5	4	4	4	3	3	4	5
D33	(7, 9, 9)	4	5	5	4	2	3	4	4	3	4	5	4	3	3	3
D34	(7, 9, 9)	5	5	5	3	3	4	5	3	3	4	4	5	5	4	4
D35	(7, 9, 9)	5	4	4	4	3	3	3	3	3	3	3	2	2	2	2
D36	(5, 7, 9)	4	5	3	5	5	4	4	3	1	4	4	3	3	3	3
D37	(7, 9, 9)	5	4	3	2	2	4	3	2	3	3	3	3	3	1	3
D38	(7, 9, 9)	4	4	3	3	3	3	3	3	2	2	2	3	3	1	2
D39	(5, 7, 9)	4	4	2	3	3	4	3	2	3	3	3	3	4	3	2
D40	(7, 9, 9)	4	3	3	3	3	3	4	2	2	5	2	3	3	3	3

D41	(7, 9, 9)	4	4	2	3	4	3	4	3	2	5	3	1	1	1	1
D42	(5, 7, 9)	5	5	2	3	3	3	3	2	2	3	3	2	2	1	1
D43	(7, 9, 9)	4	4	3	1	1	3	4	1	1	1	1	3	2	3	5
D44	(5, 7, 9)	4	3	2	4	5	4	5	5	5	5	5	4	5	3	5
D45	(7, 9, 9)	4	5	5	5	4	4	5	4	3	4	3	4	5	4	5
D46	(5, 7, 9)	4	5	4	2	4	5	5	4	4	5	4	5	4	4	5
D47	(7, 9, 9)	5	5	4	4	5	3	5	4	5	5	5	2	4	5	5
D48	(7, 9, 9)	4	5	4	5	4	4	5	4	3	4	2	4	5	2	5
D49	(5, 7, 9)	4	5	4	5	5	5	4	5	5	3	4	5	4	4	5
D50	(7, 9, 9)	5	4	5	4	5	5	5	4	4	5	5	5	5	5	4
D51	(7, 9, 9)	5	5	4	4	3	4	5	4	3	4	5	4	5	5	5
D52	(3, 5, 7)	4	5	4	5	4	4	4	3	2	5	4	4	3	4	5
D53	(5, 7, 9)	4	4	3	4	4	5	4	4	5	3	4	5	4	4	2
D54	(7, 9, 9)	5	4	4	5	4	4	5	5	3	4	5	4	4	5	4
D55	(5, 7, 9)	4	5	5	4	5	5	5	5	4	4	4	5	4	4	5
D56	(7, 9, 9)	5	5	5	4	2	3	4	4	3	4	5	4	5	5	5
D57	(7, 9, 9)	5	4	4	3	3	4	5	3	3	4	4	4	2	3	4
D58	(5, 7, 9)	4	5	3	4	3	3	3	3	3	3	3	3	3	4	5
D59	(7, 9, 9)	5	3	3	5	5	4	4	3	1	4	4	4	3	3	3
D60	(7, 9, 9)	4	4	3	2	2	2	4	2	3	3	3	5	5	4	4
D61	(7, 9, 9)	4	4	2	3	3	3	3	3	2	2	2	2	2	2	2
D62	(7, 9, 9)	4	3	3	3	3	3	3	2	3	3	3	3	3	3	3
D63	(7, 9, 9)	3	3	2	3	3	3	4	2	2	5	2	3	3	1	3
D64	(5, 7, 9)	4	4	2	3	4	3	3	3	2	5	3	3	3	1	2
D65	(7, 9, 9)	3	4	3	3	3	3	3	2	2	3	3	3	4	3	2
D66	(7, 9, 9)	5	3	2	1	1	3	4	1	1	1	1	3	3	3	3
D67	(5, 7, 9)	4	3	1	2	2	3	4	2	2	2	1	1	1	1	1
D68	(5, 7, 9)	4	3	2	3	2	3	5	4	5	4	5	5	5	5	5
D69	(7, 9, 9)	4	5	3	4	5	4	5	5	4	4	5	4	3	4	3
D70	(5, 7, 9)	4	5	2	5	4	4	5	2	4	5	5	4	4	5	4
D71	(7, 9, 9)	4	5	5	2	4	5	5	4	5	2	5	4	4	5	4
D72	(5, 7, 9)	4	5	4	4	5	3	5	5	4	4	5	4	5	4	4
D73	(5, 7, 9)	5	5	4	5	4	4	5	5	5	5	4	5	2	4	5
D74	(7, 9, 9)	4	5	4	5	5	5	4	4	5	5	5	4	4	5	2
D75	(5, 7, 9)	4	5	4	4	5	5	5	4	3	4	5	4	5	4	4
D76	(7, 9, 9)	5	4	5	4	3	4	5	5	4	4	2	3	5	5	5
D77	(7, 9, 9)	5	5	4	5	4	4	4	4	4	5	4	4	4	5	5
D78	(7, 9, 9)	4	5	4	4	4	5	4	5	4	4	5	5	4	3	4
D79	(5, 7, 9)	4	4	3	5	4	4	5	4	5	5	5	5	5	4	4
D80	(7, 9, 9)	5	4	4	4	5	5	5	4	2	3	4	4	4	4	5
D81	(5, 7, 9)	4	5	5	4	2	3	4	3	3	4	5	3	5	4	4
D82	(7, 9, 9)	5	5	5	3	3	4	5	4	3	3	3	3	4	5	5

Appendix F: The correlation for causes of variance

Correlations

		Poor communication among stakeholders (architects, contractors, and clients) leads to misunderstandings during implementation.	Inadequate documentation and unclear design specifications contribute to construction errors.	Design changes made after project approval create discrepancies between plans and actual construction.	Resource limitations (such as labor shortages and material availability) affect adherence to the approved designs.	Changes in regulatory requirements that occur during construction lead to non-compliance with approved designs.	Complexity of design elements results in challenges during the implementation process.	Lack of rigorous quality assurance practices during construction leads to discrepancies.	Differences in stakeholder expectations lead to variances during construction.	Inadequate training and knowledge among workers regarding the approved designs contribute to implementation gaps.	Cultural and contextual factors unique to Addis Ababa influence how designs are interpreted and executed.	Lack of strict enforcement of building codes and regulations by authorities	Inadequate supervision by qualified professionals (architects/engineers) on site	Use of unqualified or inexperienced construction labor	Shortage or poor quality of building materials	Cost overruns and budget limitations	Changes requested by clients during construction (without proper revision process)	Corruption or bribery during inspection processes	Lack of advanced technolog es (BIM, digital tools) in design an implemen ation
Poor communication among stakeholders (architects, contractors, and clients) leads to misunderstandings during implementation.	Pearson Correlation	1	0.123	0.112	-0.019	0.013	-0.018	-0.074	-0.004	-0.114	0.180	-0.018	0.056	-0.019	0.154	0.024	0.085	0.110	0.03
	Sig. (2-tailed)		0.272	0.316	0.867	0.905	0.874	0.509	0.969	0.309	0.106	0.874	0.615	0.867	0.168	0.830	0.447	0.323	0.78
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Inadequate documentation and unclear design specifications contribute to construction errors.	Pearson Correlation	0.123	1	.389**	0.211	-0.027	0.096	0.083	.320**	-0.207	.279*	0.137	0.103	0.211	-0.172	.477**	0.071	0.127	-0.06
	Sig. (2-tailed)	0.272		0.000	0.057	0.811	0.392	0.460	0.003	0.062	0.011	0.221	0.359	0.057	0.122	0.000	0.525	0.254	0.53
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Design changes made after project approval create discrepancies between plans and actual construction.	Pearson Correlation	0.112	.389**	1	0.063	-0.088	-0.089	-0.064	.535**	0.006	0.181	0.123	-0.001	0.063	-0.123	.421**	-0.063	-0.053	-0.13
	Sig. (2-tailed)	0.316	0.000		0.572	0.433	0.429	0.565	0.000	0.957	0.103	0.272	0.994	0.572	0.271	0.000	0.575	0.635	0.23
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Resource limitations (such as labor shortages and material availability) affect adherence to the approved designs.	Pearson Correlation	-0.019	0.211	0.063	1	.383**	.289**	.516**	-0.007	-0.041	.252*	0.039	.601**	1.000**	0.042	0.120	.443**	.389**	0.05
	Sig. (2-tailed)	0.867	0.057	0.572		0.000	0.008	0.000	0.953	0.714	0.023	0.725	0.000	0.000	0.709	0.283	0.000	0.000	0.63
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Changes in regulatory requirements that occur during construction lead to non-compliance with approved designs.	Pearson Correlation	0.013	-0.027	-0.088	.383**	1	.716**	.381**	-0.106	-0.079	-0.208	-.296**	.577**	.383**	0.046	-0.215	.534**	.650**	-0.04
	Sig. (2-tailed)	0.905	0.811	0.433	0.000		0.000	0.000	0.343	0.478	0.061	0.007	0.000	0.000	0.684	0.053	0.000	0.000	0.67
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Complexity of design elements results in	Pearson Correlation	-0.018	0.096	-0.089	.289**	.716**	1	.334**	-0.122	-0.073	-.227*	-.260*	.479**	.289**	0.055	-0.212	.421**	.479**	0.03

challenges during the implementation process.	Sig. (2-tailed)	0.874	0.392	0.429	0.008	0.000		0.002	0.275	0.517	0.040	0.018	0.000	0.008	0.624	0.056	0.000	0.000	0.79
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Lack of rigorous quality assurance practices during construction leads to discrepancies.	Pearson Correlation	-0.074	0.083	-0.064	.516**	.381**	.334**	1	-0.136	-0.052	0.098	0.071	.457**	.516**	-0.153	-0.009	.495**	.492**	-0.08
	Sig. (2-tailed)	0.509	0.460	0.565	0.000	0.000	0.002		0.224	0.640	0.383	0.528	0.000	0.000	0.169	0.939	0.000	0.000	0.46
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Differences in stakeholder expectations lead to variances during construction.	Pearson Correlation	-0.004	.320**	.535**	-0.007	-0.106	-0.122	-0.136	1	0.028	.285**	0.146	-0.089	-0.007	0.053	.437**	-0.076	-0.064	-0.21
	Sig. (2-tailed)	0.969	0.003	0.000	0.953	0.343	0.275	0.224		0.802	0.010	0.190	0.427	0.953	0.639	0.000	0.495	0.569	0.05
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Inadequate training and knowledge among workers regarding the approved designs contribute to implementation gaps.	Pearson Correlation	-0.114	-0.207	0.006	-0.041	-0.079	-0.073	-0.052	0.028	1	0.041	-0.124	-0.047	-0.041	.434**	-0.020	-0.142	-0.029	0.08
	Sig. (2-tailed)	0.309	0.062	0.957	0.714	0.478	0.517	0.640	0.802		0.713	0.265	0.678	0.714	0.000	0.858	0.203	0.795	0.42
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Cultural and contextual factors unique to Addis Ababa influence how designs are interpreted and executed.	Pearson Correlation	0.180	.279*	0.181	.252*	-0.208	-.227*	0.098	.285**	0.041	1	.524**	0.074	.252*	0.021	.376**	0.082	0.015	-0.19
	Sig. (2-tailed)	0.106	0.011	0.103	0.023	0.061	0.040	0.383	0.010	0.713		0.000	0.508	0.023	0.851	0.000	0.462	0.895	0.08
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Lack of strict enforcement of building codes and regulations by authorities	Pearson Correlation	-0.018	0.137	0.123	0.039	-.296**	-.260*	0.071	0.146	-0.124	.524**	1	-0.124	0.039	-0.029	.356**	-.222*	-0.077	-0.06
	Sig. (2-tailed)	0.874	0.221	0.272	0.725	0.007	0.018	0.528	0.190	0.265	0.000		0.268	0.725	0.797	0.001	0.045	0.491	0.58
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Inadequate supervision by qualified professionals (architects/engineers) on site	Pearson Correlation	0.056	0.103	-0.001	.601**	.577**	.479**	.457**	-0.089	-0.047	0.074	-0.124	1	.601**	-0.075	-0.071	.659**	.615**	0.01
	Sig. (2-tailed)	0.615	0.359	0.994	0.000	0.000	0.000	0.000	0.427	0.678	0.508	0.268		0.000	0.501	0.526	0.000	0.000	0.87
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Use of unqualified or inexperienced construction labor	Pearson Correlation	-0.019	0.211	0.063	1.000**	.383**	.289**	.516**	-0.007	-0.041	.252*	0.039	.601**	1	0.042	0.120	.443**	.389**	0.05
	Sig. (2-tailed)	0.867	0.057	0.572	0.000	0.000	0.008	0.000	0.953	0.714	0.023	0.725	0.000		0.709	0.283	0.000	0.000	0.63
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Shortage or poor quality of building materials	Pearson Correlation	0.154	-0.172	-0.123	0.042	0.046	0.055	-0.153	0.053	.434**	0.021	-0.029	-0.075	0.042	1	-0.056	-0.103	-0.089	.246
	Sig. (2-tailed)	0.168	0.122	0.271	0.709	0.684	0.624	0.169	0.639	0.000	0.851	0.797	0.501	0.709		0.620	0.357	0.426	0.02
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Cost overruns and budget limitations	Pearson Correlation	0.024	.477**	.421**	0.120	-0.215	-0.212	-0.009	.437**	-0.020	.376**	.356**	-0.071	0.120	-0.056	1	-0.104	-0.082	-0.13
	Sig. (2-tailed)	0.830	0.000	0.000	0.283	0.053	0.056	0.939	0.000	0.858	0.000	0.001	0.526	0.283	0.620		0.354	0.463	0.23
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Changes requested by clients during construction (without proper revision process)	Pearson Correlation	0.085	0.071	-0.063	.443**	.534**	.421**	.495**	-0.076	-0.142	0.082	-.222*	.659**	.443**	-0.103	-0.104	1	.564**	0.01
	Sig. (2-tailed)	0.447	0.525	0.575	0.000	0.000	0.000	0.000	0.495	0.203	0.462	0.045	0.000	0.000	0.357	0.354		0.000	0.93

	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Corruption or bribery during inspection processes	Pearson Correlation	0.110	0.127	-0.053	.389**	.650**	.479**	.492**	-0.064	-0.029	0.015	-0.077	.615**	.389**	-0.089	-0.082	.564**	1	-0.02
	Sig. (2-tailed)	0.323	0.254	0.635	0.000	0.000	0.000	0.000	0.569	0.795	0.895	0.491	0.000	0.000	0.426	0.463	0.000		0.86
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Lack of advanced technologies (BIM, digital tools) in design and implementation	Pearson Correlation	0.030	-0.069	-0.133	0.053	-0.047	0.030	-0.081	-0.215	0.089	-0.193	-0.062	0.017	0.053	.246*	-0.133	0.010	-0.020	
	Sig. (2-tailed)	0.787	0.536	0.232	0.639	0.674	0.792	0.468	0.052	0.428	0.082	0.581	0.878	0.639	0.026	0.232	0.931	0.860	
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Inefficiencies Project Management	Pearson Correlation	0.114	-0.007	-0.087	-0.032	-0.078	-0.013	-0.187	-0.057	.326**	-0.090	-0.001	-0.148	-0.032	.559**	-0.048	-0.169	-0.049	.475*
	Sig. (2-tailed)	0.306	0.949	0.435	0.774	0.487	0.906	0.092	0.610	0.003	0.422	0.991	0.185	0.774	0.000	0.668	0.129	0.663	0.00
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Inadequate project planning	Pearson Correlation	0.030	0.090	-0.040	.256*	0.053	0.082	-0.001	0.010	0.104	0.167	0.109	-0.021	.256*	.474**	0.019	-0.157	0.038	.242
	Sig. (2-tailed)	0.786	0.422	0.719	0.020	0.634	0.466	0.990	0.927	0.353	0.134	0.328	0.854	0.020	0.000	0.867	0.159	0.731	0.02
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Unforeseen site conditions	Pearson Correlation	-0.114	-0.207	0.006	-0.041	-0.079	-0.073	-0.052	0.028	1.000**	0.041	-0.124	-0.047	-0.041	.434**	-0.020	-0.142	-0.029	0.08
	Sig. (2-tailed)	0.309	0.062	0.957	0.714	0.478	0.517	0.640	0.802	0.000	0.713	0.265	0.678	0.714	0.000	0.858	0.203	0.795	0.42
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Changes in project scope	Pearson Correlation	0.181	.258*	0.216	.270*	-0.171	-.233*	0.118	.274*	0.038	.949**	.519**	0.140	.270*	0.018	.382**	0.076	0.039	-0.17
	Sig. (2-tailed)	0.104	0.019	0.051	0.014	0.124	0.035	0.289	0.013	0.734	0.000	0.000	0.210	0.014	0.874	0.000	0.496	0.730	0.11
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8
Tota	Pearson Correlation	0.188	.378**	.267*	.706**	.400**	.355**	.457**	.257*	.241*	.496**	.219*	.573**	.706**	.327**	.323**	.442**	.521**	0.14
	Sig. (2-tailed)	0.009	0.000	0.015	0.000	0.000	0.001	0.000	0.020	0.029	0.000	0.048	0.000	0.000	0.003	0.003	0.000	0.000	0.02
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	8

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix G: The correlation for impacts of discrepancies

Correlations

		Legal liabilities for non-compliance with regulations	Increased risk of litigation from clients or stakeholders	Non-compliance with building codes, regulations and standards	Legal disputes between clients and contractors	Legal penalties and fines imposed by authorities	Delays in project completion due to legal disputes	Revocation of building permits and orders to stop construction	Difficulty in obtaining occupancy permits	Increased liability and insurance claims	Discrepancies between approved design & actual construction affect the owner's to secure loans from financial institutions	Discrepancies between approved design and actual construction have an impact on the loan process	Due to the difference between the approved design & the actual construction, the construction project will suffer financially	Loss of trust and reputation among clients and partners	Compromised safety standards leading to potential hazards	Decreased overall quality of construction	Compromised structural integrity of the building	Reduced durability and lifespan of the structure	Higher maintenance costs and frequent repairs
Legal liabilities for non-compliance with regulations	Pearson Correlation	1	.475**	.242*	0.089	.246*	.348**	.297**	-0.020	.502**	.276*	0.126	0.183	.501**	0.039	0.077	0.005	0.179	0.183
	Sig. (2-tailed)		0.000	0.029	0.428	0.026	0.001	0.007	0.860	0.000	0.012	0.260	0.101	0.000	0.727	0.493	0.965	0.108	0.101
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
Increased risk of litigation from clients or stakeholders	Pearson Correlation	.475**	1	.320**	.326**	.559**	.634**	.425**	-0.049	.445**	.522**	.292**	0.166	.546**	-0.075	.232*	0.127	0.134	0.166
	Sig. (2-tailed)	0.000		0.003	0.003	0.000	0.000	0.000	0.663	0.000	0.000	0.008	0.136	0.000	0.503	0.036	0.256	0.231	0.136
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
Non-compliance with building codes, regulations and standards	Pearson Correlation	.242*	.320**	1	0.104	.474**	.384**	.622**	0.038	.545**	.551**	.599**	0.050	.356**	-0.013	0.136	0.046	-0.022	0.050
	Sig. (2-tailed)	0.029	0.003		0.353	0.000	0.000	0.000	0.731	0.000	0.000	0.000	0.656	0.001	0.906	0.224	0.681	0.847	0.656
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
Legal disputes between clients and contractors	Pearson Correlation	0.089	.326**	0.104	1	.434**	.422**	0.205	-0.029	0.054	.286**	.278*	0.059	.228*	0.123	-0.144	0.092	0.147	0.059
	Sig. (2-tailed)	0.428	0.003	0.353		0.000	0.000	0.064	0.795	0.631	0.009	0.011	0.599	0.039	0.271	0.197	0.409	0.187	0.599
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
Legal penalties and fines imposed by authorities	Pearson Correlation	.246*	.559**	.474**	.434**	1	.646**	.340**	-0.089	.461**	.406**	.395**	0.092	.457**	0.000	0.010	0.086	0.055	0.092
	Sig. (2-tailed)	0.026	0.000	0.000	0.000		0.000	0.002	0.426	0.000	0.000	0.000	0.411	0.000	1.000	0.927	0.445	0.623	0.411
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
Delays in project completion due to legal disputes	Pearson Correlation	.348**	.634**	.384**	.422**	.646**	1	.508**	-0.030	.475**	.407**	.307**	0.212	.509**	0.081	-0.063	-0.027	0.204	0.212
	Sig. (2-tailed)	0.001	0.000	0.000	0.000	0.000		0.000	0.788	0.000	0.000	0.005	0.055	0.000	0.468	0.572	0.809	0.066	0.055
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82

Revocation of building permits and orders to stop construction	Pearson Correlation	.297**	.425**	.622**	0.205	.340**	.508**	1	-0.002	.611**	.603**	.542**	0.179	.482**	0.050	-0.124	0.054	.250*	0.179
	Sig. (2-tailed)	0.007	0.000	0.000	0.064	0.002	0.000		0.982	0.000	0.000	0.000	0.108	0.000	0.655	0.267	0.629	0.024	0.108
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
Difficulty in obtaining occupancy permits	Pearson Correlation	-0.020	-0.049	0.038	-0.029	-0.089	-0.030	-0.002	1	-0.013	0.046	0.151	0.061	0.087	0.140	-0.069	0.117	0.085	0.061
	Sig. (2-tailed)	0.860	0.663	0.731	0.795	0.426	0.788	0.982		0.911	0.680	0.175	0.588	0.435	0.211	0.536	0.296	0.445	0.588
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
Increased liability and insurance claims	Pearson Correlation	.502**	.445**	.545**	0.054	.461**	.475**	.611**	-0.013	1	.556**	.486**	0.106	.460**	0.054	-0.012	-0.039	.231*	0.106
	Sig. (2-tailed)	0.000	0.000	0.000	0.631	0.000	0.000	0.000	0.911		0.000	0.000	0.344	0.000	0.630	0.917	0.726	0.036	0.344
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
Discrepancies between approved design & actual construction affect the owner's to secure loans from financial institutions	Pearson Correlation	.276*	.522**	.551**	.286**	.406**	.407**	.603**	0.046	.556**	1	.460**	-0.069	.513**	.234*	0.120	-0.022	-0.029	-0.069
	Sig. (2-tailed)	0.012	0.000	0.000	0.009	0.000	0.000	0.000	0.680	0.000		0.000	0.537	0.000	0.034	0.282	0.842	0.799	0.537
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
Discrepancies between approved design and actual construction have an impact on the loan process	Pearson Correlation	0.126	.292**	.599**	.278*	.395**	.307**	.542**	0.151	.486**	.460**	1	0.017	.379**	0.027	-0.039	0.188	0.142	0.017
	Sig. (2-tailed)	0.260	0.008	0.000	0.011	0.000	0.005	0.000	0.175	0.000	0.000		0.877	0.000	0.813	0.727	0.090	0.203	0.877
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
Due to the difference between the approved design & the actual construction, the construction project will suffer financially	Pearson Correlation	0.183	0.166	0.050	0.059	0.092	0.212	0.179	0.061	0.106	-0.069	0.017	1	-0.042	-0.142	-0.003	0.035	.416**	1.000**
	Sig. (2-tailed)	0.101	0.136	0.656	0.599	0.411	0.055	0.108	0.588	0.344	0.537	0.877		0.706	0.205	0.978	0.754	0.000	0.000
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
Loss of trust and reputation among clients and partners	Pearson Correlation	.501**	.546**	.356**	.228*	.457**	.509**	.482**	0.087	.460**	.513**	.379**	-0.042	1	0.135	0.069	0.158	0.093	-0.042
	Sig. (2-tailed)	0.000	0.000	0.001	0.039	0.000	0.000	0.000	0.435	0.000	0.000	0.000	0.706		0.228	0.536	0.157	0.405	0.706
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
Compromised safety standards leading to potential hazards	Pearson Correlation	0.039	-0.075	-0.013	0.123	0.000	0.081	0.050	0.140	0.054	.234*	0.027	-0.142	0.135	1	-0.102	0.000	0.059	-0.142
	Sig. (2-tailed)	0.727	0.503	0.906	0.271	1.000	0.468	0.655	0.211	0.630	0.034	0.813	0.205	0.228		0.361	1.000	0.598	0.205
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82

Decreased overall quality of construction	Pearson Correlation	0.077	.232*	0.136	-0.144	0.010	-0.063	-0.124	-0.069	-0.012	0.120	-0.039	-0.003	0.069	-0.102	1	0.035	-0.176	-0.003
	Sig. (2-tailed)	0.493	0.036	0.224	0.197	0.927	0.572	0.267	0.536	0.917	0.282	0.727	0.978	0.536	0.361		0.754	0.114	0.978
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
Compromised structural integrity of the building	Pearson Correlation	0.005	0.127	0.046	0.092	0.086	-0.027	0.054	0.117	-0.039	-0.022	0.188	0.035	0.158	0.000	0.035	1	0.111	0.035
	Sig. (2-tailed)	0.965	0.256	0.681	0.409	0.445	0.809	0.629	0.296	0.726	0.842	0.090	0.754	0.157	1.000	0.754		0.321	0.754
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
Reduced durability and lifespan of the structure	Pearson Correlation	0.179	0.134	-0.022	0.147	0.055	0.204	.250*	0.085	.231*	-0.029	0.142	.416**	0.093	0.059	-0.176	0.111	1	.416**
	Sig. (2-tailed)	0.108	0.231	0.847	0.187	0.623	0.066	0.024	0.445	0.036	0.799	0.203	0.000	0.405	0.598	0.114	0.321		0.000
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
Higher maintenance costs and frequent repairs	Pearson Correlation	0.183	0.166	0.050	0.059	0.092	0.212	0.179	0.061	0.106	-0.069	0.017	1.000**	-0.042	-0.142	-0.003	0.035	.416**	1
	Sig. (2-tailed)	0.101	0.136	0.656	0.599	0.411	0.055	0.108	0.588	0.344	0.537	0.877	0.000	0.706	0.205	0.978	0.754	0.000	
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
Poor functionality and usability of the building	Pearson Correlation	0.112	0.021	-0.017	0.090	0.053	0.151	0.117	-0.068	0.036	-0.032	0.013	.319**	0.006	0.000	-0.068	0.120	.231*	.319**
	Sig. (2-tailed)	0.314	0.854	0.879	0.421	0.634	0.176	0.294	0.541	0.748	0.777	0.905	0.004	0.959	1.000	0.545	0.281	0.037	0.004
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
Aesthetic deficiencies and compromised appearance	Pearson Correlation	-0.105	-0.051	0.147	-0.158	0.008	-.222*	-0.084	0.103	-0.066	0.005	0.021	-0.024	-0.170	-0.162	.517**	0.095	-0.206	-0.024
	Sig. (2-tailed)	0.350	0.648	0.188	0.155	0.942	0.045	0.451	0.357	0.554	0.962	0.850	0.830	0.126	0.147	0.000	0.396	0.063	0.830
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
Reduced market value of the property	Pearson Correlation	-0.012	-0.037	0.108	-0.179	-0.028	-0.064	0.021	-0.079	-0.010	-0.113	-0.042	-0.187	-0.060	-0.045	0.114	-0.116	-0.053	-0.187
	Sig. (2-tailed)	0.913	0.742	0.333	0.108	0.800	0.565	0.849	0.481	0.930	0.312	0.710	0.093	0.592	0.686	0.307	0.297	0.638	0.093
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
Negative impact on reputation of contractors/architects	Pearson Correlation	-0.079	-0.155	-0.042	-.244*	-0.139	-0.093	-0.107	-0.017	-0.102	-.230*	-0.210	-0.215	-0.139	0.074	0.174	-0.098	-0.089	-0.215
	Sig. (2-tailed)	0.481	0.165	0.710	0.027	0.213	0.408	0.337	0.878	0.362	0.038	0.058	0.053	0.213	0.511	0.119	0.379	0.425	0.053
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
Total	Pearson Correlation	.536**	.707**	.646**	.376**	.643**	.703**	.710**	0.143	.677**	.630**	.583**	.370**	.633**	0.124	0.176	0.195	.349**	.370**
	Sig. (2-tailed)	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.020	0.000	0.000	0.000	0.001	0.000	0.027	0.011	0.018	0.001	0.001
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix H: The correlation for strategies to minimize the gap

Correlations

		Strengthening and consistent enforcement of building codes and regulations	Mandating and enforcing comprehensive on-site supervision	Promoting and ensuring the use of quality and certified building materials	Implementing thorough project planning and scheduling	Providing training and capacity building for construction workers	Utilizing Building Information Modeling (BIM) and digital tools	Establishing a formal change management process for client requests	Regular quality control and quality assurance inspections	Promoting ethical practices and transparency in construction contracts	Establishing an effective mechanism to handle complaints and disputes	Involving clients in regular progress meetings and design reviews	Enhanced communication and collaboration among stakeholders	Engaging experienced contractors and subcontractors
Strengthening and consistent enforcement of building codes and regulations	Pearson Correlation	1	0.121	-0.178	0.172	-0.095	-0.152	-0.135	-0.010	-0.120	-0.132	-0.182	-0.125	-0.120
	Sig. (2-tailed)		0.279	0.109	0.122	0.395	0.172	0.226	0.930	0.283	0.236	0.101	0.262	0.282
	N	82	82	82	82	82	82	82	82	82	82	82	82	82
Mandating and enforcing comprehensive on-site supervision	Pearson Correlation	0.121	1	0.005	0.178	0.087	-0.047	0.045	0.080	-0.030	-0.118	-0.071	-0.064	0.045
	Sig. (2-tailed)	0.279		0.963	0.110	0.436	0.678	0.690	0.475	0.786	0.293	0.524	0.567	0.689
	N	82	82	82	82	82	82	82	82	82	82	82	82	82
Promoting and ensuring the use of quality and certified building materials	Pearson Correlation	-0.178	0.005	1	.486**	.305**	0.208	.307**	0.217	.361**	.338**	.245*	.363**	.309**
	Sig. (2-tailed)	0.109	0.963		0.000	0.005	0.061	0.005	0.050	0.001	0.002	0.027	0.001	0.005
	N	82	82	82	82	82	82	82	82	82	82	82	82	82
Implementing thorough project planning and scheduling	Pearson Correlation	0.172	0.178	.486**	1	.266*	.227*	.371**	.333**	.491**	.363**	.225*	.361**	.329**
	Sig. (2-tailed)	0.122	0.110	0.000		0.016	0.041	0.001	0.002	0.000	0.001	0.042	0.001	0.003
	N	82	82	82	82	82	82	82	82	82	82	82	82	82
Providing training and capacity building for construction workers	Pearson Correlation	-0.095	0.087	.305**	.266*	1	.572**	.340**	.301**	.519**	.347**	.414**	.432**	.237*
	Sig. (2-tailed)	0.395	0.436	0.005	0.016		0.000	0.002	0.006	0.000	0.001	0.000	0.000	0.032
	N	82	82	82	82	82	82	82	82	82	82	82	82	82
Utilizing Building Information Modeling (BIM) and digital tools	Pearson Correlation	-0.152	-0.047	0.208	.227*	.572**	1	.542**	.319**	.540**	.410**	.524**	.473**	0.209
	Sig. (2-tailed)	0.172	0.678	0.061	0.041	0.000		0.000	0.004	0.000	0.000	0.000	0.000	0.060
	N	82	82	82	82	82	82	82	82	82	82	82	82	82
Establishing a formal change management process for client requests	Pearson Correlation	-0.135	0.045	.307**	.371**	.340**	.542**	1	.378**	.439**	.465**	0.157	.318**	.418**
	Sig. (2-tailed)	0.226	0.690	0.005	0.001	0.002	0.000		0.000	0.000	0.000	0.160	0.004	0.000
	N	82	82	82	82	82	82	82	82	82	82	82	82	82
Regular quality control and	Pearson Correlation	-0.010	0.080	0.217	.333**	.301**	.319**	.378**	1	.550**	.434**	.365**	.465**	.452**

quality assurance inspections	Sig. (2-tailed)	0.930	0.475	0.050	0.002	0.006	0.004	0.000		0.000	0.000	0.001	0.000	0.000
	N	82	82	82	82	82	82	82	82	82	82	82	82	82
Promoting ethical practices and transparency in construction contracts	Pearson Correlation	-0.120	-0.030	.361**	.491**	.519**	.540**	.439**	.550**	1	.646**	.424**	.598**	.423**
	Sig. (2-tailed)	0.283	0.786	0.001	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000
	N	82	82	82	82	82	82	82	82	82	82	82	82	82
Establishing an effective mechanism to handle complaints & disputes	Pearson Correlation	-0.132	-0.118	.338**	.363**	.347**	.410**	.465**	.434**	.646**	1	.412**	.604**	.361**
	Sig. (2-tailed)	0.236	0.293	0.002	0.001	0.001	0.000	0.000	0.000	0.000		0.000	0.000	0.001
	N	82	82	82	82	82	82	82	82	82	82	82	82	82
Involving clients in regular progress meetings and design reviews	Pearson Correlation	-0.182	-0.071	.245*	.225*	.414**	.524**	0.157	.365**	.424**	.412**	1	.570**	.258*
	Sig. (2-tailed)	0.101	0.524	0.027	0.042	0.000	0.000	0.160	0.001	0.000	0.000		0.000	0.019
	N	82	82	82	82	82	82	82	82	82	82	82	82	82
Enhanced communication and collaboration among stakeholders	Pearson Correlation	-0.125	-0.064	.363**	.361**	.432**	.473**	.318**	.465**	.598**	.604**	.570**	1	.437**
	Sig. (2-tailed)	0.262	0.567	0.001	0.001	0.000	0.000	0.004	0.000	0.000	0.000	0.000		0.000
	N	82	82	82	82	82	82	82	82	82	82	82	82	82
Engaging experienced contractors and subcontractors	Pearson Correlation	-0.120	0.045	.309**	.329**	.237*	0.209	.418**	.452**	.423**	.361**	.258*	.437**	1
	Sig. (2-tailed)	0.282	0.689	0.005	0.003	0.032	0.060	0.000	0.000	0.000	0.001	0.019	0.000	
	N	82	82	82	82	82	82	82	82	82	82	82	82	82
Engaging qualified and experienced professionals for design and oversight	Pearson Correlation	-0.130	-0.087	.270*	.392**	.252*	0.181	.226*	.387**	.475**	.393**	.294**	.385**	.549**
	Sig. (2-tailed)	0.245	0.436	0.014	0.000	0.023	0.103	0.042	0.000	0.000	0.000	0.007	0.000	0.000
	N	82	82	82	82	82	82	82	82	82	82	82	82	82
Encouraging stakeholder involvement throughout the project	Pearson Correlation	-0.065	0.138	.364**	.580**	.350**	.264*	.405**	.481**	.492**	.586**	.285**	.543**	.466**
	Sig. (2-tailed)	0.565	0.215	0.001	0.000	0.001	0.016	0.000	0.000	0.000	0.000	0.009	0.000	0.000
	N	82	82	82	82	82	82	82	82	82	82	82	82	82
Implementing feedback mechanisms for continuous improvement	Pearson Correlation	-0.089	0.131	.263*	.466**	.230*	.243*	.235*	.412**	.469**	.330**	.341**	.284**	.434**
	Sig. (2-tailed)	0.425	0.241	0.017	0.000	0.037	0.028	0.034	0.000	0.000	0.002	0.002	0.010	0.000
	N	82	82	82	82	82	82	82	82	82	82	82	82	82
Total	Pearson Correlation	-0.086	0.094	.514**	.656**	.602**	.607**	.585**	.652**	.802**	.723**	.592**	.739**	.631**
	Sig. (2-tailed)	0.044	0.040	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	82	82	82	82	82	82	82	82	82	82	82	82	82

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).