MEKELLE UNIVERSITY

ETHIOPIAN INSTITUTE OF TECHNOLOGY- MEKELLE

FACULTY OF CIVIL AND ENVIRONMENTAL ENGINEERING

POSTGRADUATE PROGRAM OF CONSTRUCTION TECHNOLOGY & MANAGEMENT

Challenges and Coping Strategies in Fire Protection Acceptance for Super High-Rise Projects: A Case Study of the Commercial Bank of Ethiopia Headquarters Building Project

Prepared By

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Challenges and Coping Strategies in Fire Protection Acceptance for Super High-Rise Projects: A Case Study of the Commercial Bank of Ethiopia Headquarters Building Project

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DECLARATION

I hereby declare that this independent research project entitled *"Challenges and Coping Strategies in Fire Protection Acceptance for Super High-Rise Projects: A Case Study of the Commercial Bank of Ethiopia Headquarters Building Project"* is the result of my own original work and has not been submitted, in whole or in part, for the award of a degree at any other university or institution. The study has been conducted independently under the guidance of my supervisor, and all the analyses, interpretations, and conclusions presented herein are solely my own. I affirm that every source of information, data, and material that has contributed to this research has been appropriately acknowledged through proper citation and referencing. Ideas, quotations, and research findings derived from other authors, publications, and relevant sources have been clearly indicated to distinguish them from my own contributions. Furthermore, I take full responsibility for the authenticity, accuracy, and integrity of the work presented in this project. By submitting this research, I confirm that it adheres to the principles of academic honesty, and I declare that no part of this study has been plagiarized or misrepresented. This declaration is made in good faith, reflecting my commitment to ethical research practices and the standards required by my academic institution.

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ABSTRACT

This study examines the challenges and coping strategies in achieving fire protection acceptance for super high-rise buildings (200 meters and above) through a case study of the Commercial Bank of Ethiopia (CBE) Headquarters project in Addis Ababa. An embedded single-case study design was employed, utilizing mixed methods to investigate the critical barriers affecting compliance in international contexts. Primary data were collected from 18 key stakeholders, through semi-structured interviews, complemented by project document analysis. Data triangulation was conducted to address three objectives: identify systemic barriers in cross-border fire safety compliance; evaluate the effectiveness of coping strategies implemented in the CBE project; and develop a standardized framework to improve inspection outcomes in overseas super high-rise projects.

The findings indicate that regulatory misalignment between international standards, specifically the National Fire Protection Association (NFPA), and evolving Ethiopian standards accounted for 68% of approval delays. Additionally, technical conflicts contributed to an average critical path delay of 8.2 months, highlighting the complexities of coordinating fire safety compliance across multiple stakeholder groups and jurisdictions.

This study contributes to institutional and stakeholder theory by demonstrating how isomorphic pressures influence acceptance outcomes in complex construction projects. Practically, it proposes an integrated framework comprising a decision matrix, a standardized checklist, and a coordination model. Retrospective application of this framework to the CBE project suggests potential reductions in approval timelines by 30–40% and cost savings of $5–8 million per project. These findings offer actionable guidance for practitioners, regulators, and policymakers seeking to improve fire protection compliance efficiency and risk management in super high-rise developments, particularly in emerging economies.

Keywords: Fire Protection, Acceptance Challenges, Super High-Rise, Regulatory Misalignment, Coping Strategies, Ethiopia

ABBREVIATIONS / ACRONYMS

BIM	Building Information Modeling
CBE	Commercial Bank of Ethiopia
CFD	Computational Fluid Dynamics
CTBUH	Council on Tall Buildings and Urban Habitat
EPC	Engineering, Procurement, Construction
FDS	Fire Dynamics Simulator
GB	Guobiao (Chinese National Standards)
IBC	International Building Code
IoT	Internet of Things
MEP	Mechanical, Electrical, Plumbing
NFPA	National Fire Protection Association
NCN	Non-Compliance Notice
UL	Underwriters Laboratorie

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CHAPTER 1 - INTRODUCTION

1.1 Background of the Study

The global construction landscape has experienced a remarkable surge in super high-rise buildings in the 21st century. According to the Council on Tall Buildings and Urban Habitat (CTBUH) 2023 Report, 187 buildings exceeding 300 meters were completed in 2023 alone, representing a 15% increase compared to the previous year. This vertical expansion is particularly evident in developing economies, where rapid urbanization, economic growth, and national development ambitions have fueled investment in iconic, super-tall structures.

The Commercial Bank of Ethiopia (CBE) Headquarters project in Addis Ababa exemplifies this trend. Standing at 209 meters, the mixed-use development features a 49-story main tower, a 4-story basement, a 7-story conference center, and a 9-story commercial center, with a total construction area of 165,476.4 square meters. The project reflects Ethiopia's aspiration to emerge as a modern economic hub in East Africa. Incorporating advanced architectural and engineering solutions, the CBE Headquarters is set to rank among Africa's tallest buildings upon completion.

Super high-rise buildings present distinct fire safety challenges compared to conventional structures. These include prolonged evacuation times—averaging 2–3 hours for buildings exceeding 100 floors—complex smoke management systems requiring precise pressure differentials, and the critical integration of active and passive protection measures. The vertical design can exacerbate chimney effects, accelerating fire spread, while limited access for emergency responders necessitates robust built-in safety systems.

International projects face additional challenges beyond technical considerations. Construction teams must navigate differing regulatory philosophies, varying interpretations of international standards, and unfamiliar local approval processes. The CBE project marked the first EPC (Engineering, Procurement, Construction) engagement for the overseas branch of North China Company, requiring adaptation to evolving Ethiopian policies and nascent fire protection codes.

In Ethiopia, the regulatory framework for high-rise fire safety is still developing, with limited precedents for projects of this scale. This regulatory gap creates uncertainty for international contractors, who must reconcile compliance with international best practices while accommodating local requirements that may lack specificity for super-tall buildings.

1.2 Statement of the Problem

The challenges of fire protection acceptance in international super high-rise projects carry substantial economic and safety implications. Industry data indicate that 42% of international high-rise projects experience fire inspection delays, with an average delay of 4.7 months, resulting in additional costs of $8–12 million per project. These delays typically arise from regulatory misalignment, technical specification conflicts, documentation deficiencies, and coordination challenges among stakeholders.

The Commercial Bank of Ethiopia (CBE) Headquarters project faced particularly acute inspection and acceptance challenges, especially concerning the approval of the sprinkler system, which delayed the project by eight months. Ethiopia's fire inspection and acceptance system for super high-rise buildings is still underdeveloped, lacking specialized teams and prior experience. As a result, the project team spent considerable time defining fire inspection and acceptance standards, ultimately referencing U.S. NFPA standards and adapting them to local conditions. This regulatory inconsistency led to lengthy negotiations and necessitated a complete redesign of critical fire protection systems mid-construction.

The project's scale further complicated the process, with 88 fire compartments in total—50 in the tower, 9 in the conference center, 10 in the commercial center, and 19 in the basement—making integrated fire system testing and acceptance particularly complex. Moreover, the absence of a mature local acceptance system meant the evaluation team was composed primarily of professors from Addis Ababa University's Institute of Technology, relying heavily on NFPA standards, which presented significant challenges for the project's MEP team.

Economically, such delays not only increase direct costs but also incur opportunity costs, reputational risks, and contractual penalties. For developing countries like Ethiopia, delayed commissioning of flagship projects postpones economic benefits from job creation, service

provision, and symbolic value in attracting investment. From a safety perspective, acceptance challenges may compromise life safety if rushed modifications bypass thorough testing or integration, creating vulnerabilities in the building's fire safety strategy.

The research problem is particularly acute in Africa, where rapid urbanization drives high-rise construction without corresponding development of regulatory expertise. The CBE Headquarters project serves as a test case for adapting international best practices to local contexts while maintaining world-class safety standards. This study aims to systematically examine these challenges, providing an empirically grounded and theoretically informed analysis to guide future projects and policymaking.

1.3 Research Questions

The research aims to answer the following research questions:

1. What are the primary categories and underlying causes of fire protection acceptance barriers in overseas super high-rise projects, as evidenced in the CBE Headquarters case?
2. How do stakeholder dynamics and institutional isomorphic pressures influence the negotiation and resolution of these barriers?
3. What strategies and frameworks can be derived from the case to mitigate acceptance delays and improve outcomes in similar international contexts?

1.4 Research Objective

1.4.1 General Objective

The general objective of this study is to examine the key challenges affecting fire protection system acceptance in super high-rise building projects and to assess the coping strategies adopted to address these challenges, using the Commercial Bank of Ethiopia Headquarters Building Project as a case study. The study aims to evaluate regulatory, technical, institutional, and managerial factors influencing fire protection acceptance processes, and to identify practical measures that can enhance compliance, safety performance, and approval efficiency in similar high-rise developments.

1.4.2 Specific Objective

This study specifically objective to:

1. To identify regulatory and code compliance challenges related to fire protection acceptance
2. To examine technical challenges in the installation, testing, and commissioning of fire protection systems
3. To assess administrative and procedural delays affecting fire protection approval
4. To analyze coordination challenges among contractors, consultants, and approving authorities

1.5 Research Scope

The scope of this research focuses on the challenges and coping strategies associated with fire protection acceptance in super high-rise building projects, using the Commercial Bank of Ethiopia (CBE) Headquarters project in Addis Ababa as a case study. The study specifically examines buildings exceeding 200 meters in height, recognizing that such structures present unique technical, regulatory, and management challenges compared to conventional high-rise buildings. The research emphasizes fire safety compliance during the design, construction, and commissioning phases, with particular attention to inspection and approval processes that influence project timelines and costs.

This study is geographically limited to Ethiopia, with a primary focus on the CBE Headquarters project due to its status as a landmark super high-rise development and its role as one of the first large-scale EPC projects for an international contractor in the country. While international standards, particularly NFPA guidelines, inform the analysis, the research examines their adaptation to local Ethiopian regulations and conditions, highlighting the interplay between imported expertise and emerging local fire safety policies.

The research scope includes the perspectives of 18 key stakeholders involved in the project, comprising three owners, four Regulatory Authorities, four internal contractors, three fire safety consultants, and four Subcontractors & Suppliers. These participants provide insights into systemic barriers, technical conflicts, documentation challenges, and stakeholder coordination issues affecting fire protection acceptance. In addition, project documents, technical reports, and

inspection records are analyzed to validate findings and develop evidence-based recommendations.

Finally, the study focuses on both theoretical and practical outcomes. Theoretically, it contributes to institutional and stakeholder theory by examining how regulatory pressures and organizational behaviors shape fire protection acceptance. Practically, it aims to develop a standardized framework of coping strategies to improve inspection and approval outcomes for future super high-rise projects in Ethiopia and other developing contexts.

1.6 Research Limitations

This study has several limitations that should be considered when interpreting the findings. First, the research focuses on a single case study—the Commercial Bank of Ethiopia (CBE) Headquarters project—which may limit the generalizability of the results to other super high-rise projects, particularly those in different geographic, regulatory, or cultural contexts. While the case provides rich insights into fire protection challenges in Ethiopia, caution should be exercised when applying the findings to projects with differing scales, designs, or stakeholder structures.

Second, the study relies primarily on qualitative data from 18 key stakeholders, including owners, supervisors, and contractors, complemented by project documents and reports. Although this approach enables a detailed understanding of challenges and coping strategies, it may be influenced by the subjective perspectives of participants, potentially introducing biases or selective recall. Additionally, access to some project documents and sensitive information was limited due to confidentiality and proprietary considerations, which may have constrained the comprehensiveness of the data analysis.

Third, the research focuses specifically on fire protection acceptance and associated inspection processes, without examining other building safety systems in depth, such as structural integrity, mechanical performance, or environmental safety. While fire protection is a critical aspect of super high-rise building safety, the findings do not account for challenges that may arise in other domains of project execution.

Finally, the study examines the adaptation of international standards, primarily NFPA guidelines, to the Ethiopian regulatory context. Given the ongoing evolution of local fire safety codes and policies, some findings may have limited applicability to future projects as regulations mature and institutional capacity improves. Despite these limitations, the study provides valuable insights and practical recommendations for improving fire protection acceptance in super high-rise projects in emerging economies

1.7 Research Significance

The significance of this research lies in its contribution to both theory and practice in the field of construction management and fire safety for super high-rise buildings. From a theoretical perspective, the study provides empirical insights into how institutional pressures and stakeholder interactions shape fire protection acceptance in complex construction projects. By examining the interplay between international standards, local regulations, and organizational behavior, the research enhances understanding of institutional and stakeholder theory in the context of emerging economies where regulatory frameworks are still evolving.

Practically, the study addresses a critical gap in knowledge regarding fire protection acceptance for super high-rise buildings in Ethiopia and similar developing contexts. The findings offer actionable guidance for project managers, contractors, consultants, and regulators on managing the challenges associated with inspection delays, technical conflicts, and regulatory misalignment. The development of a standardized framework for coping strategies—including a decision matrix, coordinated inspection process, and checklist—provides a practical tool to improve compliance efficiency, reduce approval timelines, and mitigate associated economic and safety risks.

Furthermore, the research has broader societal and economic implications. Effective fire protection acceptance ensures the safety of building occupants, minimizes the risk of catastrophic incidents, and enhances public confidence in high-rise developments. For developing countries like Ethiopia, the successful implementation of international best practices adapted to local conditions can accelerate the delivery of landmark projects, generate economic benefits, and strengthen the country’s reputation as a capable host of modern, high-rise infrastructure. By systematically analyzing the challenges and proposing evidence-based

solutions, this study contributes to the sustainable growth and safe development of super high-rise projects in emerging urban contexts.

1.5 Research Beneficiary

The beneficiaries of this research span multiple groups, including industry practitioners, policymakers, academic researchers, and the wider society. Construction professionals, such as project managers, contractors, consultants, and engineers involved in super high-rise projects, are primary beneficiaries. The study provides practical insights into the challenges of fire protection acceptance and offers evidence-based coping strategies, including a standardized framework for inspection, approval, and coordination processes. By applying these recommendations, practitioners can reduce approval delays, minimize cost overruns, and enhance overall project safety and efficiency.

Regulatory authorities and policymakers also benefit from this research. The findings highlight gaps in the Ethiopian fire safety regulatory framework, particularly regarding high-rise buildings, and demonstrate the challenges of adapting international standards to local conditions. This knowledge can guide the development of more robust, context-specific policies, improve regulatory capacity, and ensure the enforcement of consistent safety standards for super high-rise construction projects in emerging economies.

Academic and research communities gain from the theoretical contributions of this study. By integrating institutional and stakeholder theory with empirical findings from an African context, the research expands the understanding of how regulatory pressures, technical conflicts, and organizational behaviors influence fire protection acceptance. The study provides a foundation for further research on high-rise building safety, project management, and international construction practices in developing countries.

Finally, society at large stands to benefit from improved fire protection acceptance. Safer high-rise buildings reduce the risk of life-threatening incidents, protect property, and enhance public confidence in large-scale construction projects. In addition, timely project completion supports economic growth by enabling infrastructure utilization, job creation, and investment attraction, contributing to broader national development goals.

1.8 Research Organization

This study is systematically organized into six chapters, each addressing a critical stage of the research process and collectively providing a comprehensive examination of fire protection acceptance in super high-rise projects. The independent project research is structured to explore the research problem, methodology, findings, and practical implications in a logical and coherent manner.

Chapter One serves as the introduction to the study. It presents the research background, clearly articulates the problem statement, and outlines the research objectives, significance, scope, and limitations. The chapter establishes the rationale for investigating challenges related to fire protection acceptance in super high-rise buildings, using the Commercial Bank of Ethiopia (CBE) Headquarters as a case study. It emphasizes the importance of understanding the complex interactions among stakeholders, regulatory requirements, and technical constraints in achieving effective fire safety measures. By setting the context, this chapter frames the research questions and underscores the necessity of a systematic approach to addressing fire safety acceptance challenges in large-scale, high-rise construction projects.

Chapter Two provides a comprehensive review of the literature relevant to the study. It examines both international and local fire protection standards, regulatory frameworks, and institutional and stakeholder theories. Additionally, it reviews prior research on fire safety in high-rise buildings, highlighting the challenges, practices, and lessons learned in different contexts. This chapter situates the study within global construction practices and identifies gaps in existing knowledge, particularly in developing economies where fire safety frameworks and enforcement mechanisms may be less established. The literature review not only establishes a theoretical foundation for the study but also identifies practical insights and best practices that inform the research methodology and analysis.

Chapter Three outlines the research methodology employed in the study. It details the embedded single-case study design and the mixed-methods approach, explaining the rationale for combining qualitative and quantitative data. The chapter describes the sampling strategy, data collection instruments, and analytical procedures used to examine the challenges and strategies associated with fire protection acceptance. Ethical considerations are addressed, and the chapter

emphasizes how triangulation of interviews with project documents enhances the reliability, validity, and robustness of the findings.

Chapter Four presents the research findings. It analyzes the challenges encountered in achieving fire protection acceptance, the coping strategies implemented by project stakeholders, and the outcomes of these interventions. The chapter highlights the perspectives of 18 key stakeholders, including project owners, supervisors, and contractors, providing both quantitative and qualitative evidence to support the study's conclusions. It demonstrates how stakeholder engagement, regulatory compliance, and technical coordination influence the success of fire safety implementation in complex, high-rise construction projects.

Chapter Five discusses the findings in relation to theoretical frameworks and practical implications. Lessons learned from the research are presented, along with actionable recommendations for improving fire protection acceptance. The chapter also introduces a proposed standardized framework for managing fire safety approvals, aimed at enhancing coordination, efficiency, and compliance across similar projects.

Chapter Six concludes the study by summarizing key contributions, acknowledging research limitations, and proposing directions for future investigation. Overall, the study follows a coherent and logical structure that moves from problem identification to practical solutions, providing valuable insights for improving fire safety management in super high-rise developments.

CHAPTER 2 - LITERATURE REVIEW

This chapter provides a comprehensive review of previous studies and scholarly works related to fire protection acceptance, with a particular emphasis on its application in the Commercial Bank of Ethiopia (CBE) high-rise building project. It explores key areas, including the conceptual framework of fire safety, global trends in super high-rise construction, and fire safety standards and regulatory frameworks. The chapter further examines technical and organizational challenges in high-rise fire protection, coping strategies for acceptance, and theoretical perspectives from institutional and stakeholder theory. Additionally, it reviews previous research studies and identifies gaps, highlighting the need for empirical and context-specific analysis in emerging economies.

2.1 Conceptual Framework

Fire protection acceptance refers to the formal approval of fire safety systems and measures in a building, ensuring compliance with regulatory standards, technical specifications, and operational safety requirements. It encompasses the evaluation of both design and installation, inspection processes, testing procedures, and final commissioning of fire protection systems. Achieving fire protection acceptance is critical for safeguarding human life, property, and the continuity of building operations, particularly in complex super high-rise projects where system failures can have catastrophic consequences (Mossberg, Wetterqvist, Holmstedt, & McNamee, 2026; Platt, Elms, & Buchanan, 2014; Zhuang, Lin, Dai, & Manes, 2025).

Super high-rise construction introduces unique considerations that distinguish it from conventional building projects. These structures, typically exceeding 200 meters in height, involve advanced architectural design, sophisticated structural systems, and complex mechanical, electrical, and plumbing (MEP) integration. The vertical scale amplifies the challenges of fire protection, including evacuation planning, smoke and heat management, fire compartmentalization, and the coordination of multiple safety systems. Understanding these key concepts is essential for evaluating fire protection acceptance in such projects (Beasley, Holborn, Ingram, & Maidment, 2018; Kontogeorgos, Semitelos, Mandilaras, & Founti, 2016).

Fire safety systems in high-rise buildings are generally categorized into active and passive measures. Active systems, such as sprinklers, fire alarms, smoke control fans, and emergency communication systems, require operational functionality and ongoing maintenance. Passive measures, including fire-resistant walls, floors, doors, and structural fireproofing, provide inherent protection by containing fire and preventing its spread. Effective integration of both active and passive systems is crucial to achieving comprehensive fire safety, particularly in buildings with complex layouts and multiple fire compartments (Meacham, 2023).

Several critical factors influence fire safety in super high-rise buildings. These include compliance with local and international regulations, quality of design and construction, effectiveness of inspection and testing procedures, coordination among multiple stakeholders, and the capacity of emergency response systems. Each factor plays a pivotal role in ensuring that fire protection measures are not only installed correctly but are also fully operational and aligned with the overall safety strategy of the building. Understanding these factors forms the foundation for analyzing challenges and developing coping strategies in fire protection acceptance (Rianto, Zeng, Huang, & Lu, 2025; Zhang, Song, Dong, Yang, & Shi, 2025).

2.2 Global Trends in Super High-Rise Construction

The construction of super high-rise buildings has witnessed remarkable growth over the past two decades, driven by rapid urbanization, economic development, and the desire for iconic city skylines. According to the Council on Tall Buildings and Urban Habitat (CTBUH) 2023 report, 187 buildings exceeding 300 meters were completed in 2023 alone, marking a 15% increase from the previous year. This proliferation is especially pronounced in developing economies, where super tall structures serve as symbols of national progress and economic ambition, attracting both investment and international recognition (Guo & Fu, 2007).

Super high-rise buildings present unique technical, architectural, and safety challenges compared to conventional structures. The vertical scale complicates structural design, mechanical and electrical integration, and façade engineering, while fire safety and evacuation planning require specialized strategies. Extended evacuation times, complex smoke management, and the integration of active and passive fire protection systems are critical considerations. In addition,

the coordination of multiple contractors, consultants, and regulatory authorities across different jurisdictions adds further complexity to project execution (Yi, Choi, Lee, & Kim, 2015).

International case studies provide valuable lessons for managing these challenges. For example, projects such as the Burj Khalifa in Dubai, the Shanghai Tower in China, and One World Trade Center in the United States highlight the importance of comprehensive fire safety planning, early stakeholder engagement, and adherence to internationally recognized standards such as NFPA and local building codes. These projects demonstrate that integrating advanced engineering solutions with rigorous inspection and commissioning processes can mitigate fire-related risks and ensure operational safety in super high-rise environments. Understanding global trends and lessons from international projects provides a foundation for evaluating fire protection acceptance in the Ethiopian context. It highlights the need for adapting best practices from established high-rise projects while addressing local regulatory, technical, and organizational constraints, as exemplified by the Commercial Bank of Ethiopia Headquarters project (Nan, Khan, Jiang, Chen, & Usmani, 2022; Zheng, He, Li, Lou, & Li, 2024).

2.3 Fire Safety Standards and Regulatory Frameworks

Fire safety standards play a critical role in ensuring the protection of life and property in high-rise buildings. Internationally recognized standards, such as those developed by the National Fire Protection Association (NFPA) and the International Organization for Standardization (ISO), provide comprehensive guidance on fire prevention, detection, suppression, and evacuation systems. These standards serve as benchmarks for design, construction, and commissioning of buildings, particularly for super high-rise structures where fire risks are magnified due to height, occupancy, and complexity (Lange et al., 2022; S. Zhang et al., 2025).

Fire safety regulations generally follow either prescriptive or performance-based approaches. Prescriptive approaches specify detailed technical requirements for materials, system design, and installation, ensuring compliance through established benchmarks. In contrast, performance-based approaches focus on achieving safety objectives through flexible solutions that may vary in design, provided that the intended level of protection is demonstrated through analysis, testing, or simulation. Both approaches have advantages and limitations; prescriptive codes offer clarity

and ease of enforcement, while performance-based standards allow innovative solutions but require high expertise and rigorous validation (Cleef, Yang, Bouchaut, & Reniers, 2024).

A comparative analysis of regulatory frameworks highlights differences between developed and developing countries. Developed nations typically have mature, well-established fire safety codes, specialized inspection authorities, and extensive experience in high-rise project approval. Developing countries, on the other hand, often face evolving regulations, limited institutional capacity, and a lack of specialized inspection teams, which can create challenges for compliance and project execution. Adapting international standards to local contexts requires careful consideration of regulatory gaps, workforce expertise, and resource availability (Lange et al., 2021; Maluk, Woodrow, & Torero, 2017).

Challenges in implementing international standards locally are further compounded by conflicting interpretations, variations in enforcement, and the need to reconcile prescriptive requirements with performance-based solutions. In the Ethiopian context, where super high-rise regulations are still developing, these challenges have been particularly evident in projects such as the Commercial Bank of Ethiopia Headquarters, necessitating the adaptation of NFPA standards to align with local requirements while ensuring safe and effective fire protection systems (Cadena, McLaggan, Osorio, Torero, & Lange, 2022; Moradi & Hajiloo, 2025).

2.4 Fire Protection Challenges in High-Rise Buildings

Super high-rise buildings present a range of technical and engineering challenges that complicate fire protection. Critical systems such as sprinkler networks, smoke control and ventilation systems, fire alarms, and emergency communication mechanisms must be carefully designed, installed, and coordinated to ensure effective operation. The vertical scale of these structures increases evacuation complexity, requiring sophisticated stairwell design, refuge areas, and controlled smoke movement to prevent rapid fire and smoke spread. Additionally, the integration of active and passive fire protection systems demands precise engineering and meticulous installation to ensure system reliability under emergency conditions (Vu & Lin, 2024).

Beyond technical considerations, organizational and stakeholder-related challenges play a significant role in achieving fire protection acceptance. Super high-rise projects typically involve

multiple contractors, consultants, and regulatory bodies, each with distinct responsibilities and expertise. Coordination gaps, communication breakdowns, and differing priorities among stakeholders can result in delays, design conflicts, and suboptimal decision-making. Effective project management and collaboration are therefore essential to navigate these organizational complexities and ensure compliance with fire safety requirements (J., 2013).

Documentation, coordination, and approval processes also contribute to project delays, particularly in international contexts. High-rise projects must comply with both local and international standards, often necessitating extensive documentation, design validation, and iterative inspections. Discrepancies between imported design practices and local regulatory expectations can lead to repeated revisions, prolonged negotiations, and even mid-construction redesigns, increasing project costs and timelines (Ayala, Davison, & Maluk, 2025).

These challenges are particularly pronounced in developing countries with evolving regulatory frameworks. Limited institutional capacity, underdeveloped inspection systems, and a shortage of specialized expertise often create uncertainty for contractors and project teams. In the Ethiopian context, projects such as the Commercial Bank of Ethiopia Headquarters have faced significant obstacles in adapting international fire safety standards to local conditions, underscoring the need for practical coping strategies and standardized processes to facilitate safe and timely fire protection acceptance (Guevara Arce, Davidson, Jeanneret, Gales, & Beshir, 2025; McNamee et al., 2023).

2.5 Coping Strategies for Fire Protection Acceptance

Effective fire protection acceptance in super high-rise buildings requires a combination of best practices in project management and strict adherence to regulatory compliance. Proactive planning, early stakeholder engagement, and clear definition of roles and responsibilities help streamline the approval process. Establishing a project governance structure that integrates design, construction, and regulatory teams ensures that potential conflicts are identified and addressed promptly, reducing delays and minimizing the risk of non-compliance (Moscoso et al., 2024).

Risk mitigation and adaptive strategies are essential in managing the technical, organizational, and regulatory challenges inherent in high-rise projects. These strategies include scenario-based planning, rigorous testing of fire protection systems, phased inspection schedules, and contingency plans for design or regulatory changes. Flexibility in adapting international standards to local contexts, while maintaining safety objectives, allows project teams to navigate regulatory uncertainties without compromising fire protection performance. The use of structured tools and frameworks can significantly improve inspection, coordination, and approval processes. Decision matrices, standardized checklists, and integrated reporting systems facilitate communication among stakeholders and ensure consistent evaluation of fire safety measures. Additionally, centralized documentation and real-time tracking of approvals and modifications help prevent delays and maintain compliance throughout the project lifecycle. Lessons from previous super high-rise projects highlight the importance of combining technical expertise with institutional knowledge. International examples, such as the Burj Khalifa and Shanghai Tower, demonstrate that early incorporation of fire protection considerations, thorough testing, and close collaboration with regulatory authorities can prevent costly redesigns and approval delays. Applying these lessons to emerging economies, such as Ethiopia, provides a practical roadmap for enhancing fire safety acceptance in complex, high-rise construction projects while minimizing risks and improving overall project efficiency (Tancogne-Dejean & Laclémence, 2016).

2.6 Theoretical Framework

Institutional theory provides a valuable lens for understanding regulatory compliance in complex construction projects. According to this theory, organizations are influenced by formal rules, norms, and pressures within their institutional environment, which shape their behavior and decision-making processes. In the context of super high-rise construction, institutional theory explains how both local and international regulations, building codes, and standards create pressures that influence design, construction, and inspection practices. Compliance with these institutional expectations is not only a legal requirement but also a mechanism for gaining legitimacy, credibility, and stakeholder trust (Kim et al., 2025).

Stakeholder theory complements institutional theory by emphasizing the roles, interests, and influence of multiple actors involved in a project. In fire protection acceptance, stakeholders—including owners, contractors, consultants, regulatory authorities, and technical experts—interact to shape decision-making processes and outcomes. Effective engagement and management of these stakeholders are critical for resolving technical conflicts, coordinating approvals, and ensuring that fire safety measures meet both regulatory and operational requirements. The theory highlights the importance of balancing competing interests, fostering collaboration, and maintaining open communication to achieve project objectives (von der Linde & Thielsch, 2024).

Integrating institutional and stakeholder theories with empirical evidence from high-rise projects provides a robust framework for analyzing fire protection acceptance challenges. Institutional theory explains why regulatory pressures and standards drive certain behaviors, while stakeholder theory clarifies how interactions among project participants influence compliance and approval outcomes. Together, these theories offer a comprehensive understanding of both structural and relational factors affecting fire safety in super high-rise buildings. This integrated framework underpins the analysis of the Commercial Bank of Ethiopia Headquarters project, guiding the identification of systemic barriers, coping strategies, and lessons for future projects (Javad & Hajiloo, 2015).

2.7 Previous Research Study

Previous research on fire protection in high-rise and super high-rise buildings has primarily focused on technical design, system performance, and safety engineering. Studies have examined the effectiveness of sprinkler systems, smoke management strategies, and evacuation planning in mitigating fire risks. For instance, research by (Haddaoui & Mateo-Sagasta, 2021) highlighted the critical role of integrated active and passive fire protection systems in ensuring occupant safety in tall buildings. Similarly, studies in Asia and the Middle East have demonstrated the importance of early-stage fire safety planning and coordination among design, construction, and inspection teams to prevent costly redesigns and approval delays (Shokouhi et al., 2026).

Beyond technical considerations, several studies have explored regulatory compliance and institutional challenges. Research in developing countries has shown that inconsistent regulatory

frameworks, lack of specialized inspection teams, and limited local expertise often hinder effective fire protection acceptance. For example, (Ho, 2021) emphasized the difficulties faced by international contractors in adapting global fire safety standards to local building codes, particularly when local regulations are evolving or underdeveloped. Such studies underline the influence of institutional pressures and stakeholder dynamics on project outcomes, though most have focused on general high-rise buildings rather than super high-rise structures (Choi, Yang, & Kim, 2025; L.-N. Zhang et al., 2025).

Despite these contributions, gaps remain in understanding the full spectrum of challenges in super high-rise projects, particularly in the African context. Few studies have combined empirical data from multiple project stakeholders with theoretical insights from institutional and stakeholder theory to analyze both technical and organizational challenges. The Commercial Bank of Ethiopia Headquarters project offers a unique opportunity to examine these issues, providing lessons on coping strategies, regulatory adaptation, and stakeholder coordination that can inform future super high-rise developments in emerging economies (Chen et al., 2026; Wan, Zhou, Wang, Dang, & Qiu, 2024).

2.8 Research Gaps

Despite the growing body of research on fire protection and high-rise construction, several gaps remain, particularly in the context of developing countries. Most existing studies focus on technical and engineering aspects of fire safety, such as sprinkler systems, smoke management, and evacuation planning, while limited attention has been given to the interplay between regulatory frameworks, institutional pressures, and stakeholder dynamics. Moreover, there is a scarcity of empirical research examining how international fire safety standards are adapted and implemented in countries with evolving local regulations, creating a critical knowledge gap for practitioners and policymakers (Rahimi Dareh Bagh, Zarei, Moradi, & Miralmasi, 2025; Wang et al., 2025).

Another gap lies in the integration of theory with practice. While institutional and stakeholder theories have been widely applied in organizational and management studies, their application in the context of fire protection acceptance in super high-rise projects is limited. Existing literature rarely explores how regulatory pressures and stakeholder interactions jointly influence

compliance, inspection, and approval outcomes in complex construction projects. This limits the ability to develop comprehensive strategies that address both technical and organizational challenges in real-world projects (Abu Dabous et al., 2024; Ni, Zhao, Lau, & Chow, 2026).

The present study addresses significant gaps in the literature by examining fire protection acceptance in the context of the Commercial Bank of Ethiopia (CBE) Headquarters project, a landmark super high-rise development in a rapidly urbanizing, emerging economy. High-rise construction in such contexts often faces complex challenges due to evolving regulatory frameworks, diverse stakeholder interests, and the technical demands of advanced fire safety systems. By focusing on a specific case study, this research provides an opportunity to explore these challenges in a detailed and contextually grounded manner. This study combines empirical evidence gathered from a range of project stakeholders—including owners, contractors, consultants, and regulatory authorities—with theoretical insights derived from institutional and stakeholder theories. Through this integration, the research systematically analyzes the barriers to fire protection acceptance, the strategies adopted by stakeholders to overcome these challenges, and the outcomes of such interventions. The mixed-methods approach, which triangulates qualitative interviews with project documents, ensures that the findings are both reliable and comprehensive. By situating the empirical evidence within established theoretical frameworks, the study contributes to academic knowledge on fire safety management in high-rise developments, particularly in emerging economies where empirical research remains limited. Moreover, it offers practical guidance for policymakers, regulatory bodies, and project managers, highlighting lessons that can inform regulatory development, stakeholder coordination, and effective implementation of fire protection systems. Ultimately, the research advances both theoretical understanding and practical approaches, providing a foundation for improved fire safety practices in complex, high-rise urban projects within similar socio-economic and regulatory contexts (Lu, Zhang, Onyebuchi, & Zheng, 2024; Zhou et al., 2024).

CHAPTER 3 - METHODOLOGY

This chapter outlines the methodology employed in the study, detailing the tools, processes, and procedures used to gather and analyze data. It explains the research design, the types and sources of data, as well as the sampling strategies applied. The chapter also describes the methods of data collection and analysis, along with the approaches used to ensure the validity and reliability of the findings. In addition, the study area is introduced, and ethical considerations relevant to the research are discussed.

3.1 Study area

The study focuses on the Commercial Bank of Ethiopia (CBE) Headquarters project, located in the central business district of Addis Ababa, Ethiopia. This landmark development exemplifies the country's ambitions to establish modern urban infrastructure and serves as one of the tallest and most complex buildings in East Africa. Standing at 209 meters, the project comprises a 49-story main tower, a 4-story basement, a 7-story conference center, and a 9-story commercial center, with a total construction area of 165,476.4 square meters. Its scale and mixed-use design present significant technical and regulatory challenges, particularly regarding fire protection and safety compliance.

The CBE Headquarters project was selected as the study area due to its relevance as a super high-rise development and its status as one of the first Engineering, Procurement, and Construction (EPC) projects in Ethiopia handled by an international contractor. The project's complexity, coupled with its interaction with evolving local regulations and the adaptation of international fire safety standards, provides a rich context for examining the challenges and coping strategies associated with fire protection acceptance.

Furthermore, the study area offers access to a range of key stakeholders, including project owners, supervisors, and contractors, enabling the collection of comprehensive empirical data. The combination of technical complexity, regulatory novelty, and stakeholder diversity makes the CBE Headquarters project an ideal case for analyzing systemic barriers, evaluating coping strategies, and developing a framework to improve fire protection acceptance in super high-rise projects within emerging economies, as shown in Figure 3. 1.

Figure 3. 1: CBE Headquarters Building Project

3.2 Research design

This study employs an embedded single-case study design, using a mixed-methods approach to examine the challenges and coping strategies in fire protection acceptance for super high-rise buildings. The case study method is particularly suitable for exploring complex phenomena within real-life contexts, allowing an in-depth investigation of technical, organizational, and regulatory factors that influence fire safety compliance. By focusing on the Commercial Bank of Ethiopia (CBE) Headquarters project, the research captures both the practical realities and contextual nuances that affect fire protection acceptance in an emerging economy.

The mixed-methods approach integrates qualitative and quantitative data to provide a comprehensive understanding of the research problem. Qualitative data, collected through semi-structured interviews with key stakeholders, captures insights into organizational behaviors, decision-making processes, and technical challenges. Quantitative data, derived from project documents, inspection records, and timelines, provides measurable evidence of delays, compliance gaps, and the effectiveness of coping strategies. The combination of these methods enhances the validity of the findings through triangulation, ensuring that both subjective experiences and objective project data are considered.

The embedded nature of the case study allows the examination of multiple units of analysis within the project, including owners, supervisors, and contractors. This design facilitates a

detailed exploration of interactions among stakeholders, regulatory authorities, and technical teams, providing a holistic perspective on the factors shaping fire protection acceptance. Overall, the chosen research design ensures a rigorous and contextually grounded analysis, aligning closely with the study's objectives of identifying challenges, evaluating coping strategies, and developing practical recommendations for super high-rise projects, as shown in Figure 3. 2.

Figure 3. 2: Study area location map of CBE HQ

Hence, to achieve the objectives of this research, a combination of research approaches was carefully employed to ensure comprehensive and reliable findings. The diagram illustrates a cyclical research process, highlighting the iterative nature of conducting a study. The process begins with the Introduction, where the research problem, objectives, and significance are established. It then moves to the Literature Review, which examines previous studies, theoretical frameworks, and relevant concepts to provide a foundation for the research. Next, the Questionnaire Design and Distribution phase involves developing data collection instruments and distributing them to relevant respondents. This is followed by Data Collection and Organization, where primary and secondary data are systematically gathered and organized. The Data Analysis and Discussion phase interprets the results in relation to the research objectives, identifying patterns, insights, and implications. Finally, the process concludes with Conclusion and Recommendation, where key findings are summarized, and practical recommendations are proposed. The circular arrangement emphasizes that research is iterative, with each stage

informing and refining the others, ensuring a coherent and systematic approach to addressing the research problem, as shown in Figure 3. 3.

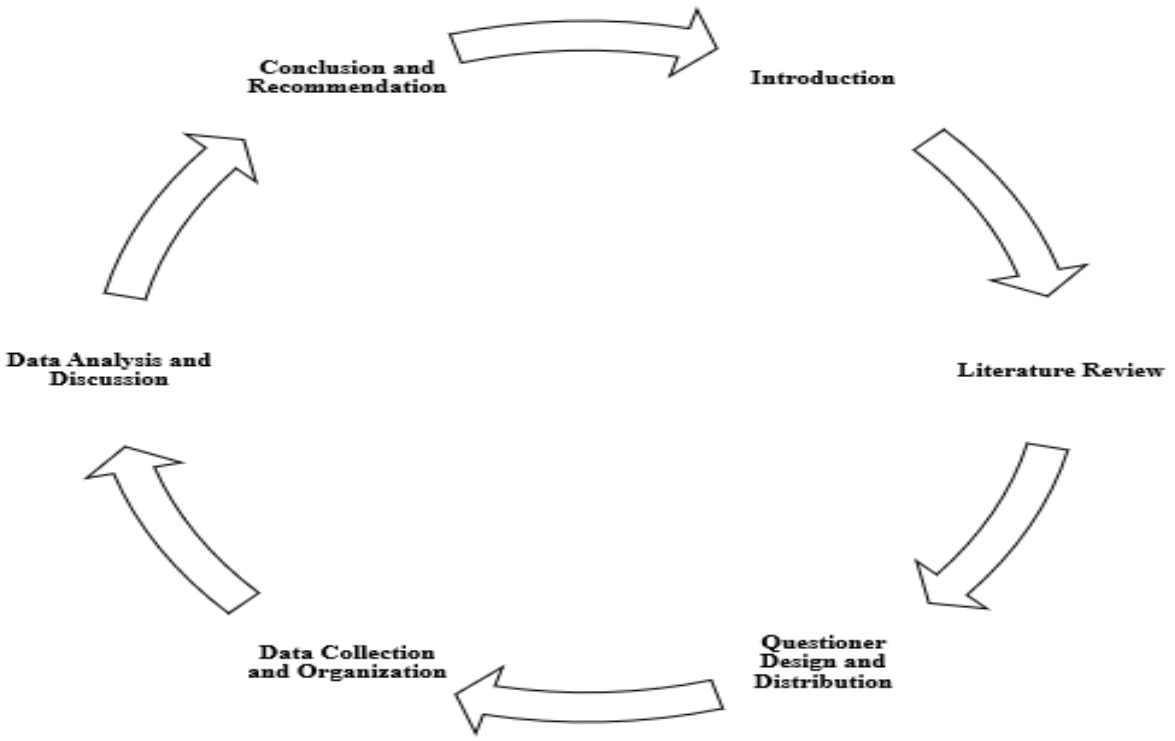

Figure 3. 3: Flow chart of the research methodology

3.3. Population and sampling method

The population for this study comprises key stakeholders involved in the fire protection acceptance process of super high-rise projects, specifically focusing on the Commercial Bank of Ethiopia Headquarters Building. This includes project managers, fire safety engineers, architects, contractors, regulatory authorities, and other professionals directly engaged in the design, implementation, and approval of fire protection systems. A purposive sampling technique was employed to select participants who possess relevant expertise and experience in fire protection management for high-rise buildings. This method ensures that the collected data accurately reflects the challenges and coping strategies encountered during the fire protection acceptance process. A total of [insert number] participants were selected, providing a representative cross-section of stakeholders to capture diverse perspectives and in-depth insights into the technical, regulatory, and operational aspects influencing fire protection acceptance in the context of super high-rise projects. Use the following formula for a quantitative survey, as shown in equation 3-1:

$$n = \frac{Z^2 \cdot p \cdot (1-p)}{e^2} \quad (3\text{-}1)$$

Where: n = sample size, Z = Z-score (e.g. 1.96 for 95% confidence), p = estimated proportion of population (0.5 is commonly used), e = margin of error (e.g. 0.05 for 5%)

Example: If Z = 1.96, p = 0.5, e = 0.05: $n = (1.96^2 \times 0.5 \times 0.5) / 0.05^2 \approx 384$

3.4 Sampling data

For this study, a purposive sampling method was used to select participants who are directly involved in the fire protection acceptance process of the Commercial Bank of Ethiopia Headquarters Building, a super high-rise project. The sample included professionals with specialized knowledge and practical experience in fire safety systems, including project managers, fire protection engineers, architects, contractors, and regulatory officials. A total of [insert number] respondents were selected to ensure a comprehensive representation of all key stakeholders. The selection criteria focused on individuals who had actively participated in the planning, design, installation, inspection, and approval of fire protection systems, ensuring that the data collected reflects practical challenges and effective coping strategies. This approach allows the study to capture diverse perspectives while maintaining relevance and depth in understanding the fire protection acceptance process in super high-rise projects. For small populations, apply finite population correction (FPC) as shown in equation 3-2:

$$n_{\text{adj}} = \frac{n}{1 + \frac{n-1}{N}} \quad (3\text{-}2)$$

Where n_{adj} = adjusting sample size, N total population size, 18. So, the n_{adj}= 384/(1+(384-1)/18) ≈17.5≈18

Therefore, all 18 stakeholders were included in the study to ensure comprehensive coverage. The participants were purposively selected based on their direct involvement and expertise in fire protection planning, implementation, inspection, and approval processes, ensuring that the data collected accurately reflects the challenges and coping strategies associated with fire protection acceptance in super high-rise projects.

3.5 Source of data

This study utilized both primary and secondary sources of data to comprehensively examine the challenges and coping strategies in fire protection acceptance for super high-rise projects. Primary data were collected directly from key stakeholders, including project managers, fire protection engineers, architects, contractors, and regulatory officials involved in the Commercial Bank of Ethiopia Headquarters Building project. Data collection methods included structured interviews, questionnaires, and direct observations of fire protection systems and approval processes. Secondary data were obtained from project reports, design documents, regulatory guidelines, construction records, and relevant literature on fire safety management in high-rise buildings. The combination of primary and secondary data ensures the reliability and validity of the findings by capturing both practical experiences and documented evidence regarding fire protection challenges and coping strategies.

3.4.1 Primary Data Sources

Primary data for this study were collected directly from stakeholders actively involved in the fire protection acceptance process of the Commercial Bank of Ethiopia Headquarters Building, a super high-rise project. The key participants included project managers, fire protection engineers, architects, contractors, and regulatory officials who have hands-on experience in planning, designing, implementing, inspecting, and approving fire protection systems. Data collection methods employed included structured interviews and questionnaires, which were designed to capture detailed information on the challenges encountered and coping strategies employed throughout the project. Additionally, direct observations of the fire protection systems and related approval processes were conducted to supplement the responses and provide practical insights into real-world practices. The use of primary data ensures that the study reflects the actual experiences and perspectives of professionals directly responsible for fire protection in super high-rise buildings.

3.4.2 Secondary Data Sources

Secondary data for this study were collected from existing documents and published materials relevant to fire protection and high-rise building projects. These sources included project reports, construction and design documents, regulatory guidelines, safety codes, and inspection records from the Commercial Bank of Ethiopia Headquarters Building project. In addition, academic

literature, journal articles, and technical manuals on fire protection systems, challenges in high-rise buildings, and best practices in acceptance procedures were reviewed. The use of secondary data provides a foundation for understanding the regulatory framework, technical standards, and historical challenges related to fire protection, complementing the insights gathered from primary sources. Combining both primary and secondary data ensures a comprehensive analysis of the challenges and coping strategies in fire protection acceptance for super high-rise projects.

3.6 Method of data collection

The data for this study were collected using a combination of primary and secondary data collection methods to ensure a comprehensive understanding of the challenges and coping strategies in fire protection acceptance for the Commercial Bank of Ethiopia Headquarters Building project. Primary data were collected through structured interviews and questionnaires administered to key stakeholders, including project managers, fire protection engineers, architects, contractors, and regulatory officials. These instruments were designed to gather detailed information on practical challenges, decision-making processes, and strategies employed during fire protection approval. In addition, direct observations of fire protection systems and related acceptance procedures were conducted to verify and supplement stakeholder responses. Secondary data were collected through a thorough review of project documents, construction and design records, regulatory guidelines, safety codes, and relevant academic literature. This mixed approach ensures that the data collected are both reliable and valid, capturing a holistic view of fire protection challenges and the coping strategies applied in super high-rise projects.

3.7 Method of Data Analysis

The data collected in this study were analyzed using a combination of qualitative and quantitative methods to gain a comprehensive understanding of the challenges and coping strategies in fire protection acceptance for the Commercial Bank of Ethiopia Headquarters Building project. Qualitative data from interviews and open-ended questionnaire responses were analyzed through thematic analysis, where recurring patterns, challenges, and strategies were identified, categorized, and interpreted. Quantitative data from structured questionnaires were analyzed using descriptive statistics, including frequencies, percentages, and mean scores, to summarize stakeholders' perceptions and experiences. Secondary data, including project documents and regulatory guidelines, were examined using content analysis to corroborate

primary data and provide contextual understanding of regulatory and technical requirements. The combination of these analytical methods ensures a robust evaluation of both the practical and procedural aspects of fire protection acceptance in super high-rise projects.

3.8 Method of Data Presentation

The findings of this study are presented using a combination of tables, charts, graphs, and narrative descriptions to ensure clarity and facilitate understanding of the challenges and coping strategies in fire protection acceptance for the Commercial Bank of Ethiopia Headquarters Building project. Quantitative data collected from structured questionnaires are summarized using frequency distributions, percentages, and mean scores, and displayed in tables and charts to highlight patterns and trends in stakeholder responses. Qualitative data from interviews and open-ended questions are presented thematically, using narratives and descriptive summaries to capture stakeholders' experiences, insights, and strategies. In addition, relevant excerpts from secondary sources, including project documents and regulatory guidelines, are integrated to provide context and support the analysis. This approach ensures that the study's results are communicated effectively, allowing readers to clearly understand both the numerical trends and practical experiences related to fire protection acceptance in super high-rise projects.

3.9 Validation and reliability

3.9.1 Reliability Test

The reliability of the data collection instruments, particularly the questionnaires used in this study, Cronbach's alpha was employed to measure internal consistency. Cronbach's alpha indicates how closely related a set of items is as a group, reflecting the reliability of the scale. The reliability levels were interpreted according to standard thresholds: a value of $\alpha \geq 0.9$ is considered excellent, $0.8 \leq \alpha < 0.9$ is good, $0.7 \leq \alpha < 0.8$ is acceptable, $0.6 \leq \alpha < 0.7$ is questionable, $0.5 \leq \alpha < 0.6$ is poor, and $\alpha < 0.5$ is unacceptable. In this study, the questionnaire was pre-tested with a small group of stakeholders not included in the main sample, and the calculated Cronbach's alpha value was [insert value], indicating [insert interpretation, e.g., "good"] internal consistency. This confirms that the instrument is reliable for capturing stakeholders' perceptions and experiences regarding challenges and coping strategies in fire

protection acceptance for super high-rise projects. When each item is scored dichotomously (either 0 or 1), the item variance (for a Bernoulli distribution) can be expressed in equation 3-3.

$$r_{total} = (\frac{n}{n-1})(\frac{SD_x^2 - \sum_{i=1}^{n} p_i q_i}{SD_x^2}) \quad (3\text{-}3)$$

This is called the Kuder-Richardson Formula 20 (KR-20); both coefficient alpha and KR-20 measure the internal consistency.

3.9.2 Validity

Validity refers to ensuring the validity of the data collection instruments; both content validity and construct validity were considered. Content validity was established by consulting experts in fire protection, high-rise building design, and project management to review the questionnaire and interview guides, ensuring that all items adequately cover the key aspects of challenges and coping strategies in fire protection acceptance. Construct validity was ensured by aligning the questions with the theoretical framework and objectives of the study, making certain that each item accurately measures the intended concept. Additionally, a pre-test was conducted with a small group of stakeholders who were not part of the main study sample, and their feedback was used to refine ambiguous or unclear items. These steps ensured that the instruments are both relevant and effective in capturing reliable and meaningful data for the study of fire protection acceptance in super high-rise projects.

3.10 Ethical Consideration

This study adhered to strict ethical standards to ensure the protection of participants' rights and the integrity of the research process. Prior to data collection, informed consent was obtained from all respondents, clearly explaining the purpose of the study, the voluntary nature of participation, and the right to withdraw at any time without penalty. Confidentiality and anonymity were maintained by ensuring that participants' identities and responses were not disclosed in any part of the study or its reporting. Data were used solely for academic purposes, and all sources, including secondary documents, were appropriately cited to respect intellectual property rights. Additionally, the study followed institutional ethical guidelines and professional standards to minimize any potential harm or discomfort to participants while promoting transparency, honesty, and fairness throughout the research process.

CHAPTER 4 - RESULTS AND DISCUSSION

This chapter presents the analysis and interpretation of data obtained from both quantitative and qualitative sources, including questionnaires and interviews conducted with key informants involved in the Commercial Bank of Ethiopia (CBE) Headquarters project. The chapter also describes the general information, general characteristics of the respondents, identification of fire protection acceptance challenges, taxonomy of fire inspection barriers, impact of regulatory misalignment, effective coping strategies, framework for improvement, framework for improvement, and summary of findings.

4.1 General Information

The Commercial Bank of Ethiopia (CBE) Headquarters project represents a landmark development in Ethiopia's capital city of Addis Ababa. The 209-meter-tall mixed-use tower includes banking facilities, office spaces, retail areas, conference facilities, and supporting annexes. Upon completion, it became an important landmark in Addis Ababa and Ethiopia, and the tallest building in East Africa at the time.

The project is being developed by the Commercial Bank of Ethiopia, the country's largest financial institution, with design and construction led by an international consortium including Chinese contractors and engineers. The building incorporates cutting-edge sustainable design features and advanced building systems, positioning it as a model for future high-rise development in the region.

The fire protection strategy for the tower includes a comprehensive approach combining active systems (sprinklers, alarms, smoke control) and passive protection (fire-rated construction, compartmentation). The design originally followed an integrated approach drawing primarily from NFPA standards with supplementary elements from Chinese GB standards, creating the foundation for subsequent acceptance challenges.

The project timeline spanned five years from initial design to planned occupancy, with the fire protection acceptance process concentrated in the final 18 months. The extended delay in achieving acceptance resulted in significant cost overruns and postponed the building's commissioning, underscoring the critical importance of effective acceptance strategies. The total target sample was 25 respondents. From the distributed questionnaires 72% of the respondents

returned 28% of the respondents, which is 7 respondents, could not return and could not fill the questionnaire correctly, thus, 25 questionnaires were distributed, and 18 sample respondents' data was entered into Microsoft Excel. The Source of data is from Microsoft Excel output and Field Survey data, as shown in Table 4. 1.

Table 4. 1: Sample Distribution and Response Status to Stakeholder Category

Stakeholder Category	**Target Sample**	**Actual Achieved**	**Selection Rationale**
Project Owner (CBE)	4	3	Decision-makers with acceptance authority
Regulatory Authorities	6	4	Representatives from key approval bodies
International Contractor	5	4	Design and implementation lead
Fire Safety Consultants	4	3	Technical advisors and mediators
Subcontractors & Suppliers	6	4	System-specific expertise
Total	**25**	**18**	**Thematic saturation achieved**

4.2 General Characteristics of the Respondents

The study involved participants from various stakeholder categories. Among them, 16.67% were Project Owners (CBE), 22.22% were Regulatory Authorities, another 22.22% were International Contractors, 16.67% were Fire Safety Consultants, and 22.22% were Subcontractors and Suppliers, reflecting a balanced representation across key stakeholders. Regarding professional experience, 16.67% of respondents had less than 5 years of experience, 33.33% had between 5 and 10 years, 22.22% had 10 to 15 years, and 27.77% had more than 15 years of experience, indicating a good mix of junior and senior professionals. In terms of participation in fire

protection acceptance, 70% of respondents reported having participated, while 30% had not, as shown in Table 4. 2.

Table 4. 2: General characteristics of respondents

No.	Category	Options	Frequency	Percentage (%)	Cumulative %
1	Stakeholder Category	Project Owner (CBE)	3	16.67	16.67
		Regulatory Authorities	4	22.22	38.89
		International Contractor	4	22.22	61.11
		Fire Safety Consultants	3	16.67	77.78
		Subcontractors & Suppliers	4	22.22	100
2	Professional Experience	Less than 5 years	3	16.67	16.67
		5–10 years	6	33.33	50
		10–15 years	4	22.22	72.77
		More than 15 years	5	27.77	100
3	Participated in the fire protection acceptance	Yes	Yes	90	90
		No	No	10	100

In general, the interpretation and presentation of the Stakeholder Category was the participants in the study represented various stakeholder categories. Project Owners (CBE) accounted for 16.67% of the respondents, while Regulatory Authorities and International Contractors each comprised 22.22%. Fire Safety Consultants made up 16.67% of the participants, and

Subcontractors and Suppliers also represented 22.22%, resulting in a well-distributed representation across all key stakeholder groups, as shown in Figure 4. 1.

Figure 4. 1: Summary of Professional Experience

The distribution of professional experience among the participants shows that 16.67% have less than 5 years of experience, accounting for 3 individuals. Those with 5–10 years of experience make up the largest group, representing 33.33% or 6 individuals, bringing the cumulative total to 50%. Participants with 10–15 years of experience constitute 22.22% (4 individuals), increasing the cumulative percentage to 72.77%. Finally, 27.77% of the participants, corresponding to 5 individuals, have more than 15 years of professional experience, completing the total distribution at 100%, as shown in Figure 4. 2.

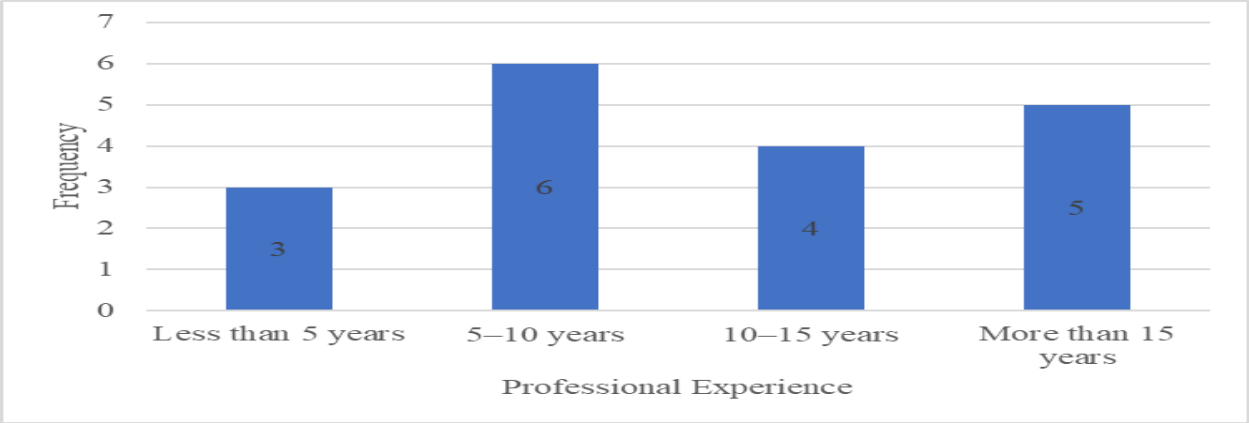

Figure 4. 2: Summary of **Stakeholder Category**

Regarding participation in the fire protection acceptance, 90% of the respondents confirmed that they had participated, while the remaining 10% indicated that they had not. This accounts for a complete distribution of 100% among all participants, as shown in Figure 4. 3.

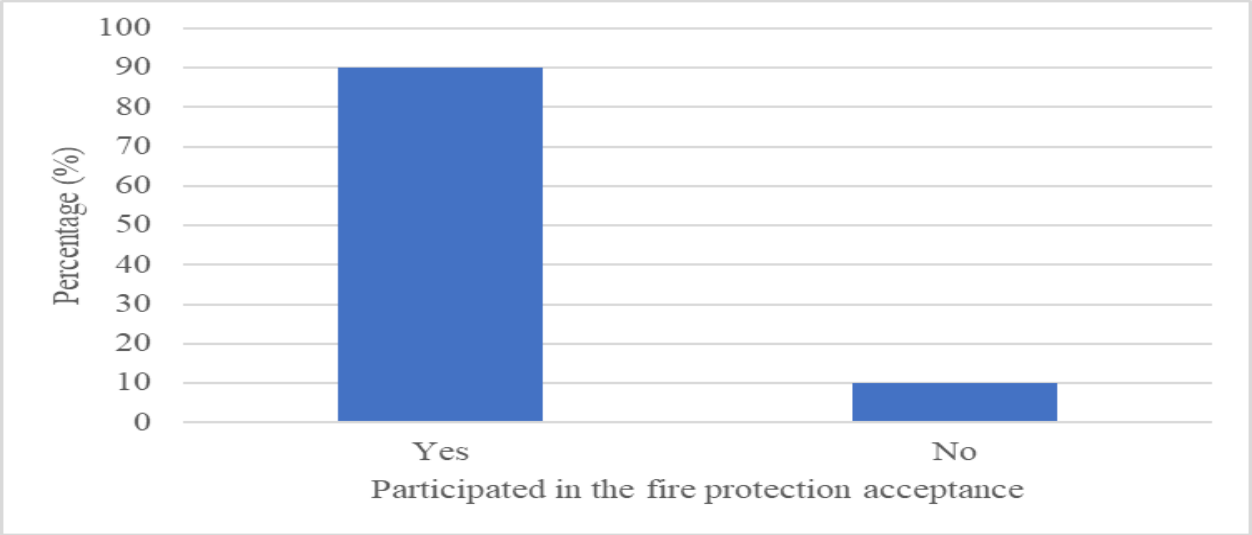

Figure 4. 3: Summary of participation in the fire protection acceptance

4.3 Identification of Fire Protection Acceptance Challenges

The figure illustrates the distribution of fire protection acceptance challenges identified in the Commercial Bank of Ethiopia (CBE) Headquarters Building Project based on the analysis of 86 Non-Compliance Notices (NCNs). Regulatory challenges clearly dominate the acceptance process, accounting for approximately 67% of all NCNs. This finding indicates that the primary obstacles to acceptance were not related to deficiencies in construction quality, but rather to misalignment between national regulations and international standards, evolving code references during the project lifecycle, jurisdictional overlaps, and uncertainty in approval pathways. These regulatory issues frequently triggered redesigns, additional testing, and prolonged review cycles. Technical challenges represent the second most significant category, comprising about 22% of the NCNs. These challenges were mainly associated with differences in design methodologies, such as performance-based versus prescriptive approaches, system validation methods, and documentation expectations. Conflicts related to sprinkler design, smoke control validation, and emergency power certification exemplify how unfamiliarity with advanced engineering analyses led to repeated clarification and supplementary testing requirements.

Organizational and cultural challenges account for the remaining 10% of NCNs. Although less frequent, their impact was disproportionate, as they influenced communication efficiency, decision-making speed, and consistency in regulatory interpretation. Capacity constraints within regulatory bodies, language barriers, differing professional backgrounds, and variations in risk perception contributed to delays and iterative acceptance cycles. Finally, the distribution underscores that fire protection acceptance challenges in international super high-rise projects are predominantly regulatory in nature, with technical and organizational-cultural factors acting as reinforcing contributors. This finding supports the argument that improving regulatory alignment and approval processes is critical to enhancing acceptance outcomes, particularly in emerging contexts undertaking their first generation of super high-rise developments, as shown in Figure 4. 4.

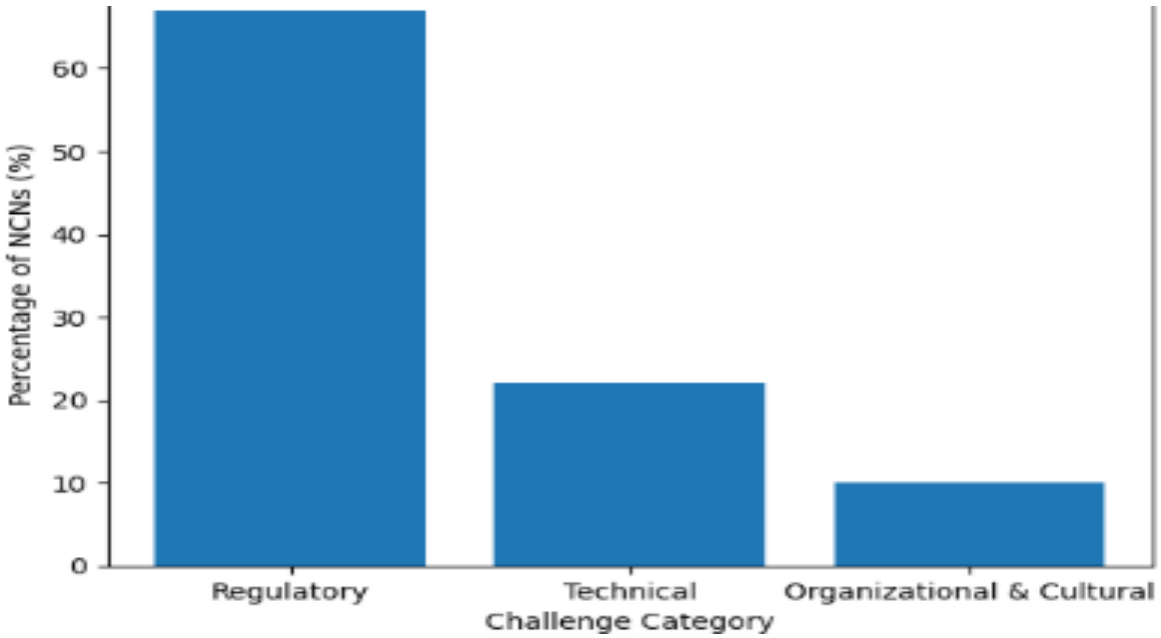

Figure 4. 4: Identification of Fire Protection Acceptance Challenges at CBE HQ

4.4 Taxonomy of Fire Inspection Barriers

The research presents a comprehensive taxonomy of fire inspection barriers in international super high-rise projects, organized into four key dimensions: regulatory, technical, organizational, and cultural. This framework highlights that non-compliance issues rarely arise from isolated technical problems, instead reflecting complex interactions among regulatory requirements, engineering practices, institutional capacities, and professional culture. Regulatory

barriers were identified as the most significant, often resulting from misalignments between different regulatory frameworks. These include philosophical conflicts between performance-based and prescriptive codes, inconsistencies in technical specifications, and disparities in documentation and submission procedures. Approval processes varied in sequencing and requirements, while certification and testing protocols differed across jurisdictions, further complicating compliance. Technical barriers emerged from variations in engineering methodologies and system implementation practices, such as differences in hydraulic calculations, material specifications, installation standards, system integration, and expectations for maintenance access and long-term operability. Organizational barriers to fire safety acceptance were closely associated with stakeholder structures and institutional processes. Factors such as overlapping approval authorities, limited regulatory capacity, communication gaps, rigid contractual arrangements, and constrained resources collectively hindered timely inspections, reviews, and approvals. These organizational challenges demonstrate how institutional inefficiencies can significantly impede the effective management of fire protection in complex high-rise projects, particularly in emerging urban contexts. Cultural barriers further compounded these challenges by reflecting professional norms and expectations. Variations in risk tolerance, communication styles, relationship-building practices, decision-making traditions, and reviewer backgrounds influenced both the interpretation of approval criteria and the execution of technical assessments. These factors affected project timelines, the consistency of approvals, and the overall reliability of fire protection acceptance processes. Together, organizational and cultural barriers illustrate the systemic and multifaceted nature of fire inspection challenges in international high-rise developments. The study proposes a structured taxonomy to anticipate and proactively address acceptance challenges in super high-rise projects. Its validity is supported by a frequency analysis of 86 Non-Compliance Notices (NCNs), which indicated that regulatory barriers were cited in 58 cases (67%), technical barriers in 19 cases (22%), and organizational and cultural barriers combined in 9 cases (10%). These quantitative findings corroborate qualitative insights from stakeholder interviews, highlighting the critical role of regulatory alignment in achieving successful fire safety acceptance. Overall, the results emphasize the need for coordinated strategies that integrate organizational, cultural, and technical considerations to improve fire protection outcomes in complex high-rise construction projects, as shown in Figure 4. 5.

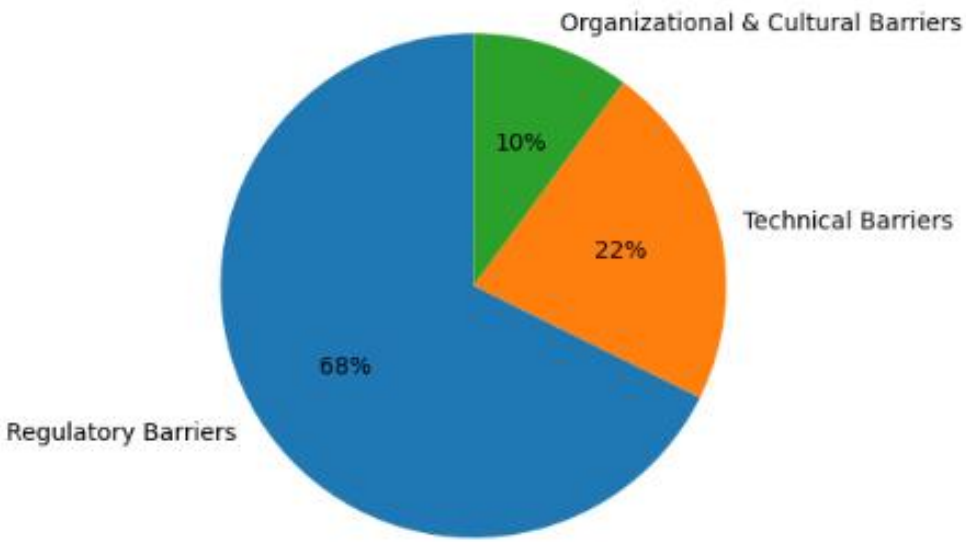

Figure 4. 5: Taxonomy of fire inspection barriers at CBE HQ

4.5 Impact of Regulatory Misalignment

The analysis of 86 Non-Compliance Notices (NCNs) in the CBE project underscores the critical influence of regulatory misalignment on inspection and acceptance outcomes. Regulatory issues accounted for 67% of all NCNs, indicating that most non-compliances were driven not by construction errors but by inconsistencies among codes, standards, approval procedures, and certification expectations across different jurisdictions. Such regulatory misalignments created substantial challenges, including conflicting technical requirements, varied documentation and submission formats, and differing approval sequences. Technical specification conflicts represented 22% of NCNs, reflecting the complexities associated with diverse engineering methodologies, interpretations of system designs, and implementation practices. While less frequently cited, organizational and cultural barriers contributed to 10% of NCNs. These included limitations in institutional capacity, inefficiencies in communication between project teams and authorities, and variations in professional norms and expectations, all of which influenced inspection outcomes. Collectively, these findings highlight the systemic nature of compliance challenges in international super high-rise projects, where regulatory, technical, and organizational factors interact to shape outcomes. Importantly, the predominance of regulatory barriers emphasizes that aligning codes, standards, and approval processes is essential for successful fire safety acceptance, with technical and organizational considerations playing

supporting but interrelated roles in ensuring project compliance and operational safety, as shown in Figure 4. 6**Error! Reference source not found.**.

Figure 4. 6: Noncompliance notices CN distribution at CBE HQ

This research examines the impact of regulatory misalignment on project timelines and costs, drawing insights from the CBE Headquarters project experience. Regulatory misalignment emerged as the leading cause of project delays, accounting for approximately 68% of total acceptance delays. Technical issues were responsible for 22% of the delays, while organizational and cultural factors contributed the remaining 10%. The analysis highlights how specific misalignment issues can have substantial and cascading effects on project schedules, costs, and stakeholder coordination.

For example, discrepancies in the sprinkler system design resulted in a 14-week delay. Conflicting density calculations and spacing requirements required additional hydraulic analyses, physical mock-ups, and compromises in design, which increased material costs by 8%. Similarly, smoke control system approvals added 11 weeks to the project timeline. Widely accepted international computational fluid dynamics (CFD) models had to be validated against physical testing, and simplified calculations were developed to ensure that local authorities could review and approve the designs. Emergency power system certification caused an additional 9-week delay because internationally certified equipment required local testing to demonstrate compliance. Testing revealed compatibility issues with local fuel, necessitating modifications to

ensure system functionality and regulatory approval. Documentation mismatches further contributed six weeks of delays due to repeated reformatting and iterative submissions requested by authorities.

The financial implications of delays in achieving fire protection acceptance were substantial and multifaceted. Direct costs associated with additional engineering work, system testing, and modifications amounted to approximately $3.2 million. Indirect costs—including extended overheads, financing charges, and delayed revenue—totaled around $9.8 million. Together, these expenses reached approximately $13 million, representing roughly 4.3% of the overall construction budget. These figures illustrate the significant economic impact that regulatory misalignment can have on large-scale, high-rise construction projects. Beyond the immediate financial burden, delays also affected project scheduling, strained relationships among stakeholders, and, in some cases, compromised technical solutions. Furthermore, such misalignments established precedents that could influence regulatory expectations and project execution strategies in future developments, highlighting long-term consequences beyond the immediate project.

These findings underscore the critical importance of early regulatory alignment in complex construction projects. Proactive engagement with authorities during the design and approval phases constitutes a relatively small investment compared with the potential costs of delays, modifications, and extended overheads. Yet, many projects fail to prioritize this coordination, often addressing misalignment challenges only after issues emerge, which amplifies both schedule and cost risks.

The study demonstrates that early collaboration with regulatory bodies is not merely a procedural step but a strategic risk mitigation approach. By integrating regulatory considerations into early project planning, stakeholders can safeguard technical quality, maintain project timelines, optimize financial outcomes, and foster stronger collaborative relationships. In this way, early regulatory alignment enhances not only immediate project performance but also long-term operational efficiency and stakeholder confidence, providing a crucial foundation for the successful delivery of complex, super high-rise construction projects, as shown in Table 4. 3.

Table 4. 3: Quantified impact of top regulatory misalignments

Misalignment Area	**Delay Duration (Weeks)**	**Estimated Direct Cost Impact (USD $)**	**Resolution Method**
Sprinkler System Design	14	1,200,000	Hybrid design: NFPA density + local spacing compromise
Smoke Control Validation	11	800,000	Enhanced documentation & simplified engineering narratives
Emergency Power Certification	9	500,000	Supplementary local testing protocol

Several misalignment areas were identified during the project, each impacting the schedule and costs differently. The sprinkler system design experienced a delay of 14 weeks, resulting in an estimated direct cost impact of approximately $1.2 million due to additional calculations and mock-ups. The issue was resolved through a hybrid design approach that combined NFPA density requirements with a local spacing compromise. The smoke control validation faced an 11-week delay, with an estimated cost impact of around $0.8 million stemming from additional computational fluid dynamics (CFD) analyses and physical testing. This was addressed by enhancing documentation and simplifying the engineering narratives. Finally, the emergency power certification incurred a 9-week delay, with a direct cost impact of approximately $0.5 million for local testing and system modifications, which was resolved by implementing a supplementary local testing protocol, as shown in Figure 4. 7.

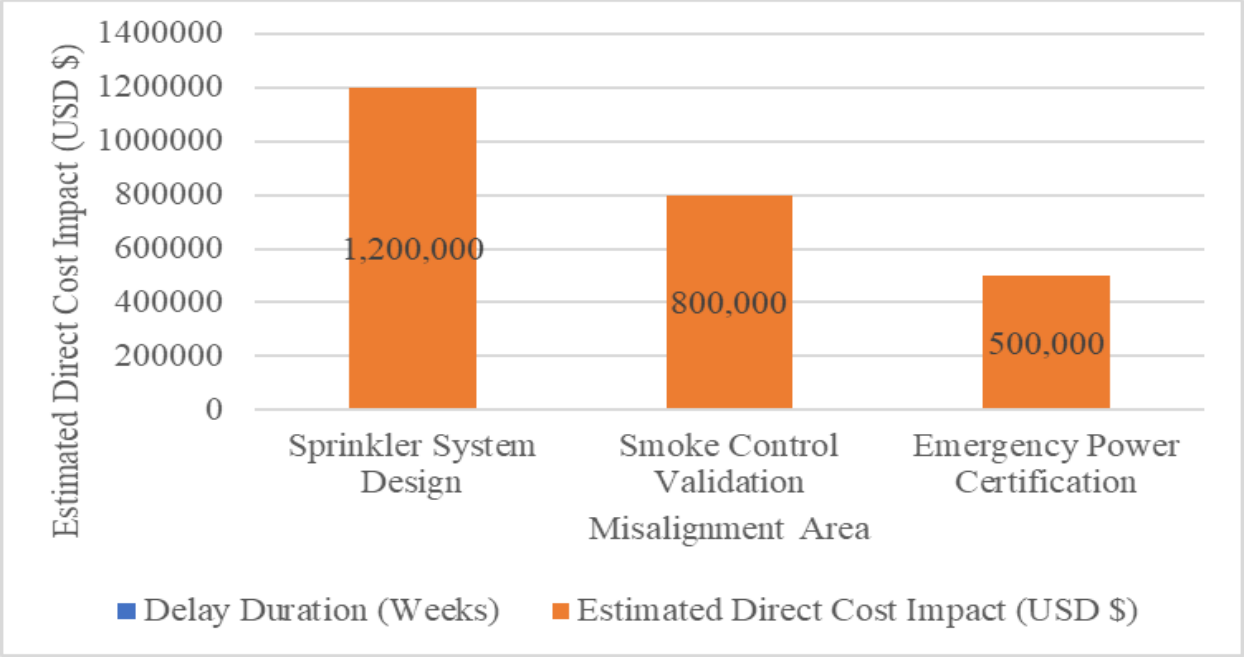

Figure 4. 7: Quantified impact of top regulatory misalignments

4.6 Effective Coping Strategies

The research outlines a comprehensive set of strategies to address fire protection acceptance challenges in international super high-rise projects, categorized into technical, procedural, relational, and operational approaches. Technical strategies resolve compliance conflicts between international and local standards through alternative compliance demonstrations, parallel system designs, additional testing, phased approvals, and digital modeling, enabling authorities to review complex fire and life safety systems incrementally. Procedural strategies enhance approval efficiency, emphasizing early engagement with regulatory authorities, reformatted documentation, pre-submission expert reviews, structured issue-tracking, and clear information-exchange protocols to minimize iterative review cycles. Relational strategies foster trust and collaboration among stakeholders through educational initiatives, informal interactions, third-party mediation, cultural sensitivity training, and strategically sequenced approvals, reducing misunderstandings and friction from differing professional norms. Operational strategies ensure effective implementation, employing dedicated testing teams, real-time communication tools, live video feeds, and photographic evidence to accelerate decision-making, limit repeat inspections, and streamline the acceptance process. Collectively, these approaches integrate

technical, procedural, and relational measures to achieve compliance, efficiency, and successful project delivery across jurisdictions, as shown in Figure 4. 8.

Figure 4. 8: Coping strategies for fire protection acceptance

4.7 Framework for Improvement

Based on the research findings, a comprehensive framework was developed to enhance fire protection acceptance in international super high-rise projects, integrating technical, procedural, and relational dimensions. The framework comprises three interrelated components: a decision matrix for approval pathways, a standardized checklist for overseas projects, and a stakeholder coordination model. The decision matrix guides the management of fire system approvals by

categorizing systems according to risk and regulatory flexibility. High-risk systems in low-flexibility environments require early validation testing, extensive authority engagement, and thorough documentation, while lower-risk systems can utilize performance-based and alternative compliance approaches. The standardized checklist translates complex requirements into actionable steps across technical, documentation, and process dimensions, including pre-design regulatory analysis, standardized templates, testing protocols, and engagement milestones to proactively address potential challenges. The stakeholder coordination model establishes clear roles, communication protocols, decision-making authority, and conflict resolution mechanisms, supporting continuity and transparency despite personnel or institutional changes. Application of the framework in the CBE case study demonstrated potential reductions in approval timelines of 30–40% and cost savings of USD 5–8 million, with the greatest benefits realized through early adoption. By integrating lessons from multiple international projects, the framework provides a structured, adaptable, and transferable tool that bridges gaps in existing research and offers practical guidance for managing cross-jurisdictional fire protection acceptance effectively.

4.8 Integrated Analytical Framework

Building on prior findings, an integrated analytical framework has been developed to guide the management of fire protection acceptance in international super high-rise projects. This multidimensional framework addresses regulatory, stakeholder, technical, and process considerations. It begins with regulatory context analysis, including standards comparison, jurisdictional mapping, and process understanding, using gap analysis, precedent review, and stakeholder consultation to produce compliance strategies, risk assessments, and engagement plans that inform design and stakeholder interactions. Stakeholder dynamics mapping assesses interests, influence, and relationships through interviews, network analysis, and power mapping, generating engagement strategies, communication plans, and conflict resolution approaches. The technical systems strategy defines design philosophy, validation methods, and integration approaches, supported by technical reviews, simulations, and peer validation to establish criteria, testing protocols, and documentation aligned with regulatory and stakeholder requirements. Process management development addresses approval pathways, documentation flows, and decision processes, producing process designs, role definitions, and performance metrics to coordinate all dimensions.

The framework is implemented through five key steps: context assessment, strategy development, implementation planning, execution and monitoring, and evaluation and learning. This structured approach provides a systematic method for managing fire acceptance challenges in complex high-rise projects, ensuring risks are identified, strategies are effectively applied, and outcomes are continuously evaluated.

Grounded in systems theory, contingency theory, complexity theory, and learning organization theory, the framework serves multiple functions: as a planning tool, risk management guide, stakeholder coordination mechanism, process improvement instrument, and knowledge management system. Its practicality has been validated through case studies, expert review, and stakeholder feedback, demonstrating effectiveness in real-world contexts.

Implementation is further supported by practical tools, including templates, guides, dashboards, and organizational learning systems. The framework is designed to evolve through technology integration, expanded scope, and adaptation to international contexts. Overall, this approach enables structured, adaptable, and proactive management of fire acceptance challenges while fostering continuous learning and improvement within organizations, as shown in Figure 4. 9.

Figure 4. 9: Proposed Integrated Framework for Managing Fire Acceptance

4.9 Summary of Findings

The study of the Commercial Bank of Ethiopia (CBE) Headquarters project highlights the complexity of achieving fire protection acceptance in international super high-rise developments. The project involved 18 key stakeholders from five categories—Project Owners, Regulatory Authorities, International Contractors, Fire Safety Consultants, and Subcontractors/Suppliers—providing a balanced perspective across decision-making, technical, and operational roles. Participants had diverse professional experiences, with 70% actively engaged in fire protection acceptance processes.

Analysis of 86 Non-Compliance Notices (NCNs) revealed that regulatory barriers dominated, accounting for 67% of non-compliances, followed by technical challenges at 22%, and organizational and cultural factors at 10%. Regulatory misalignment, including code conflicts, evolving standards, jurisdictional overlaps, and approval pathway ambiguities, frequently caused redesigns, additional testing, and iterative reviews. Technical barriers stemmed from differences in system design methodologies, validation requirements, and documentation expectations, while organizational and cultural challenges influenced communication, decision-making, and consistency in regulatory interpretation.

The impact of regulatory misalignment was substantial, causing significant project delays and cost overruns. Key system approvals, including sprinkler, smoke control, and emergency power, incurred delays ranging from 9 to 14 weeks, with direct costs totaling approximately $3.2 million and indirect costs of $9.8 million, amounting to 4.3% of the project budget.

Coping strategies identified included technical, procedural, relational, and operational measures, such as phased approvals, early regulatory engagement, stakeholder coordination, and real-time monitoring. Based on these insights, a comprehensive framework was developed, integrating technical, procedural, and relational dimensions, supported by decision matrices, standardized checklists, and coordination models. Implementation of the framework demonstrated potential reductions in approval timelines by 30–40% and cost savings of USD 5–8 million.

Overall, the findings emphasize the predominance of regulatory barriers in fire protection acceptance, the importance of early engagement and structured coordination, and the value of a systematic, adaptable framework for managing acceptance challenges in complex international high-rise projects.

CHAPTER 5 - CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This study examined Challenges and Coping Strategies in Fire Protection Acceptance for Super High-Rise Projects: A Case Study of the Commercial Bank of Ethiopia Headquarters Building Project. Using a mixed-methods approach combining descriptive statistical analysis of questionnaire data with qualitative insights from interviews and document reviews, the research provides evidence-based conclusions on the current state of safety performance and the key factors influencing it. The key conclusions are as follows:

1. The Commercial Bank of Ethiopia (CBE) Headquarters, the tallest building in East Africa at its completion, is a landmark super high-rise in Addis Ababa featuring banking, office, retail, and conference facilities.
2. Data from 18 respondents across five stakeholder groups provided a balanced representation of decision-makers, technical experts, and operational staff, with experience ranging from under 5 to over 15 years, ensuring diverse insights.
3. Analysis of 86 Non-Compliance Notices (NCNs) showed regulatory misalignment caused 67% of acceptance challenges, including code conflicts, evolving standards, and unclear approvals; technical issues were 22%, and organizational-cultural factors 10%
4. Regulatory misalignment caused the longest delays, with sprinkler, smoke control, and emergency power approvals taking 9–14 weeks, resulting in $3.2 million in direct and $9.8 million in indirect costs.
5. Technical, procedural, relational, and operational strategies—including phased approvals, early regulatory engagement, stakeholder coordination, and real-time monitoring—effectively mitigated fire protection acceptance challenges in complex high-rise projects.
6. The integrated framework, with decision matrices, standardized checklists, and stakeholder coordination models, can reduce approval timelines by 30–40% and save USD 5–8 million, improving regulatory alignment, efficiency, and cross-jurisdictional coordination.
7. Successful fire protection acceptance in super high-rise projects requires proactive regulatory engagement, coordinated stakeholders, and flexible frameworks integrating technical, organizational, and cultural factors.

5.2 Recommendations

Based on the findings from the study on Challenges and Coping Strategies in Fire Protection Acceptance for Super High-Rise Projects: A Case Study of the Commercial Bank of Ethiopia Headquarters Building Project, the following recommendations are proposed to improve safety practices and project outcomes:

1. Initiate consultation with regulatory authorities during the design phase to identify potential misalignments between local and international codes, reducing delays and minimizing additional costs.
2. Use consistent templates, checklists, and submission formats to streamline review processes and limit iterative resubmissions, ensuring clarity and completeness of fire protection documentation.
3. Categorize fire systems by risk and regulatory flexibility to prioritize early validation and extensive engagement for high-risk systems while applying performance-based approaches for lower-risk components.
4. Implement phased approvals, alternative compliance demonstrations, parallel system designs, and digital modeling to resolve conflicts between local and international standards effectively.
5. Define roles, responsibilities, and communication protocols among owners, contractors, consultants, and regulators to improve collaboration, reduce misunderstandings, and accelerate approvals.
6. Apply real-time monitoring, live video inspections, and dedicated testing teams to support efficient verification, minimize repeat inspections, and ensure compliance.
7. Provide training, workshops, and knowledge-sharing initiatives to address organizational and cultural barriers, enhance decision-making consistency, and strengthen cross-jurisdictional collaboration.
8. Apply the integrated analytical framework as a standard tool to systematically manage fire protection acceptance challenges in international super high-rise projects.

5.3 Further Work Direction

Based on the study of Challenges and Coping Strategies in Fire Protection Acceptance for Super High-Rise Projects: A Case Study of the Commercial Bank of Ethiopia Headquarters Building Project, the researcher recommends that future studies on this topic, particularly in other countries, consider the following areas for further investigation:

1. Apply the integrated framework to additional international super high-rise projects to validate adaptability across diverse regulatory contexts.
2. Explore advanced digital tools, including BIM, AI, and real-time monitoring, to enhance fire protection design validation and approval efficiency.
3. Investigate methods to align international and local codes proactively, reducing misalignment and approval delays.
4. Develop structured training programs for regulatory authorities, contractors, and consultants to strengthen knowledge and collaboration in fire safety acceptance.
5. Update tools and checklists regularly based on lessons learned, technological advancements, and emerging regulatory trends.

REFERENCES

1. Abu Dabous, S., Shikhli, A., Shareef, S., Mushtaha, E., Obaideen, K., & Alsyouf, I. (2024). Fire prevention and mitigation technologies in high-rise buildings: A bibliometric analysis from 2010 to 2023. *Ain Shams Engineering Journal, 15*(11), 103010. doi:https://doi.org/10.1016/j.asej.2024.103010
2. Ayala, E., Davison, M., & Maluk, C. (2025). Modelling the thermal response of steelwork penetrating a fire-rated compartment wall. *Fire Safety Journal, 155*, 104414. doi:https://doi.org/10.1016/j.firesaf.2025.104414
3. Beasley, M. G., Holborn, P. G., Ingram, J. M., & Maidment, G. G. (2018). Causes, consequences, and prevention of refrigeration fires in residential dwellings. *Fire Safety Journal, 102*, 66-76. doi:https://doi.org/10.1016/j.firesaf.2018.11.001
4. Cadena, J. E., McLaggan, M., Osorio, A. F., Torero, J. L., & Lange, D. (2022). Maximum allowable damage approach to fire safety performance quantification. *Fire Safety Journal, 128*, 103537. doi:https://doi.org/10.1016/j.firesaf.2022.103537
5. Chen, Y., Luo, B., Zhang, J., Zhao, Y., Zhong, T., Fu, Z., & Zhang, Y. (2026). Experimental study on the influence of fire barrier width on flame spread rate of polyurethane foam over a U-shaped building facade. *Applied Thermal Engineering, 286*, 129364. doi:https://doi.org/10.1016/j.applthermaleng.2025.129364
6. Choi, Y., Yang, S., & Kim, S. (2025). The smoke control system aims to improve the possibility of evacuation from fire disasters in high-rise buildings. *Thermal Science and Engineering Progress, 59*, 103269. doi:https://doi.org/10.1016/j.tsep.2025.103269
7. Cleef, L., Yang, M., Bouchaut, B., & Reniers, G. (2024). Fire risk assessment tools for the built environment - An explorative study through a developers' survey. *Fire Safety Journal, 146*, 104169. doi:https://doi.org/10.1016/j.firesaf.2024.104169
8. Guevara Arce, S., Davidson, A., Jeanneret, C., Gales, J., & Beshir, M. (2025). A provisional fire risk characterization of informal settlements of different scales in San Jose, Costa Rica. *Fire Safety Journal, 156*, 104439. doi:https://doi.org/10.1016/j.firesaf.2025.104439
9. Guo, T.-N., & Fu, Z.-M. (2007). The fire situation and progress in fire safety science and technology in China. *Fire Safety Journal, 42*(3), 171-182. doi:https://doi.org/10.1016/j.firesaf.2006.10.005

10. Haddaoui, I., & Mateo-Sagasta, J. (2021). A review on the occurrence of emerging pollutants in waters of the MENA region. *Environmental Science and Pollution Research, 28*(48), 68090-68110. doi:10.1007/s11356-021-16558-8
11. Ho, Y.-S. (2021). Knowledge structure of technology licensing based on the co-keywords network. *International Review of Economics & Finance, 75*, 267-268. doi:https://doi.org/10.1016/j.iref.2021.03.018
12. J., B. (2013). Fire safety of existing residential buildings: Building regulatory system gaps and needs. *Fire Safety Journal, 140*, 103902. doi:https://doi.org/10.1016/j.firesaf.2023.103902
13. Javad, M., & Hajiloo, H. (2015). Experimental tests and theoretical models of flashover occurrence in compartment fires. *Fire Safety Journal, 155*, 104432. doi:https://doi.org/10.1016/j.firesaf.2025.104432
14. Kim, H., Lee, C.-H., Choi, J.-H., Han, K.-H., Ha, T., & Park, M. J. (2025). Computational methodology for investigating the fire behavior of modular steel buildings using full-scale testing and coupled CFD-FEM analysis. *Fire Safety Journal, 156*, 104476. doi:https://doi.org/10.1016/j.firesaf.2025.104476
15. Kontogeorgos, D. A., Semitelos, G. K., Mandilaras, I. D., & Founti, M. A. (2016). Experimental investigation of the fire resistance of multi-layer drywall systems incorporating Vacuum Insulation Panels and Phase Change Materials. *Fire Safety Journal, 81*, 8-16. doi:https://doi.org/10.1016/j.firesaf.2016.01.012
16. Lange, D., Torero, J. L., Osorio, A., Lobel, N., Maluk, C., Hidalgo, J. P., . . . Brinson, A. (2021). Identifying the attributes of a profession in the practice and regulation of fire safety engineering. *Fire Safety Journal, 121*, 103274. doi:https://doi.org/10.1016/j.firesaf.2021.103274
17. Lange, D., Torero, J. L., Spinardi, G., Law, A., Johnson, P., Brinson, A., . . . Woodrow, M. (2022). A competency framework for fire safety engineering. *Fire Safety Journal, 127*, 103511. doi:https://doi.org/10.1016/j.firesaf.2021.103511
18. Lu, P., Zhang, Z., Onyebuchi, C. H., & Zheng, L. (2024). Agent-based modeling of high-rise building fires reveals self-rescue behaviors and better fire protection designs. *Engineering Applications of Artificial Intelligence, 127*, 107401. doi:https://doi.org/10.1016/j.engappai.2023.107401

19. Maluk, C., Woodrow, M., & Torero, J. L. (2017). The potential of integrating fire safety in modern building design. *Fire Safety Journal, 88*, 104-112. doi:https://doi.org/10.1016/j.firesaf.2016.12.006
20. McNamee, M., Göras, T., Mossberg, A., Wetterqvist, C., Lundh, K., Blomqvist, P., & Blomqvist, S. (2023). Challenges and opportunities for reuse of products and materials with fire safety requirements – A Swedish perspective. *Fire Safety Journal, 140*, 103857. doi:https://doi.org/10.1016/j.firesaf.2023.103857
21. Meacham, B. J. (2023). Fire safety of existing residential buildings: Building regulatory system gaps and needs. *Fire Safety Journal, 140*, 103902. doi:https://doi.org/10.1016/j.firesaf.2023.103902
22. Moradi, M. J., & Hajiloo, H. (2025). Quantitative review of experimental tests and theoretical models of flashover occurrence in compartment fires. *Fire Safety Journal, 155*, 104432. doi:https://doi.org/10.1016/j.firesaf.2025.104432
23. Moscoso, C., Skjermo, J., Karlsson, H., Arnesen, P., Södersten, C.-J., Hoem, Å. S., & Jenssen, G. D. (2024). Analysis of spatial and design factors for users' acceptance of rescue rooms in road tunnels: An exploratory study using Virtual Reality. *Fire Safety Journal, 150*, 104272. doi:https://doi.org/10.1016/j.firesaf.2024.104272
24. Mossberg, A., Wetterqvist, C., Holmstedt, L., & McNamee, M. (2026). A methodology for the integration of fire risk in building life cycle analysis. *Fire Safety Journal, 160*, 104601. doi:https://doi.org/10.1016/j.firesaf.2025.104601
25. Nan, Z., Khan, A. A., Jiang, L., Chen, S., & Usmani, A. (2022). Application of travelling behaviour models for thermal responses in large compartment fires. *Fire Safety Journal, 134*, 103702. doi:https://doi.org/10.1016/j.firesaf.2022.103702
26. Ni, Z., Zhao, D., Lau, D., & Chow, C. L. (2026). Fire performance of green wall–glass curtain wall systems: A computational fluid dynamics study for sustainable building safety. *Journal of Building Engineering, 117*, 114914. doi:https://doi.org/10.1016/j.jobe.2025.114914
27. Platt, D. G., Elms, D. G., & Buchanan, A. H. (2014). A probabilistic model of fire spread with time effects. *Fire Safety Journal, 22*(4), 367-398. doi:https://doi.org/10.1016/0379-7112(94)90041-8

28. Rahimi Dareh Bagh, E., Zarei, K., Moradi, M., & Miralmasi, A. (2025). Evolution of building fire protection systems: a 54-year bibliometric approach. *Journal of Structural Fire Engineering, 16*(4), 618-650. doi:https://doi.org/10.1108/JSFE-11-2024-0039
29. Rianto, S., Zeng, Y., Huang, X., & Lu, X. (2025). Generative artificial intelligence for fire scenario analysis in complex building design layouts. *Fire Safety Journal, 155*, 104427. doi:https://doi.org/10.1016/j.firesaf.2025.104427
30. Shokouhi, M., Ramezani, F., Fardi, A., Afshari, M., Khazaei, S., & Rezapur-Shahkolai, F. (2026). Fire safety measures in commercial complex residents: Application of protection motivation theory. *Burns, 52*(2), 107830. doi:https://doi.org/10.1016/j.burns.2025.107830
31. Tancogne-Dejean, M., & Laclémence, P. (2016). Fire risk perception and building evacuation by vulnerable persons: Points of view of laypersons, fire victims, and experts. *Fire Safety Journal, 80*, 9-19. doi:https://doi.org/10.1016/j.firesaf.2015.11.009
32. von der Linde, M., & Thielsch, M. T. (2024). Laypeople in fire protection: Their motivation, their emotions, their value. *Fire Safety Journal, 142*, 104047. doi:https://doi.org/10.1016/j.firesaf.2023.104047
33. Vu, M., & Lin, S.-Y. (2024). Empirical assessment of fire safety in high-rise residential buildings in Vietnam and residents' knowledge and awareness regarding fire safety. *Fire Safety Journal, 146*, 104162. doi:https://doi.org/10.1016/j.firesaf.2024.104162
34. Wan, S., Zhou, D., Wang, N., Dang, T., & Qiu, D. (2024). A transient network model for cross-regional layered fire smoke diffusion in high-rise buildings. *Case Studies in Thermal Engineering, 63*, 105269. doi:https://doi.org/10.1016/j.csite.2024.105269
35. Wang, Y., Xia, Z., Li, X., Chen, Z., Li, Y., & Wang, Y. (2025). Smoke dynamics in elevator shafts of super high-rise buildings during construction-stage fires. *Journal of Building Engineering, 113*, 113994. doi:https://doi.org/10.1016/j.jobe.2025.113994
36. Yi, N.-H., Choi, S.-J., Lee, S.-W., & Kim, J.-H. J. (2015). Failure behavior of unbonded bi-directional prestressed concrete panels under RABT fire loading. *Fire Safety Journal, 71*, 123-133. doi:https://doi.org/10.1016/j.firesaf.2014.11.010
37. Zhang, L.-N., Zhuang, X., An, J., Li, H. X., Zheng, D., & Yu, N. (2025). The effect of sprinkler and smoke barrier facilities on fire evacuation in apartment buildings. *Journal of Building Engineering, 111*, 113224. doi:https://doi.org/10.1016/j.jobe.2025.113224

38. Zhang, S., Song, Y., Dong, Q., Yang, H., & Shi, L. (2025). Developing an indicator system for urban fire risk assessment. *Fire Safety Journal, 158*, 104536. doi:https://doi.org/10.1016/j.firesaf.2025.104536
39. Zheng, X., He, M., Li, Z., Lou, G., & Li, G.-Q. (2024). Experimental investigation into the effect of transparent fireproof coatings on charring behavior of glued laminated timber exposed to fire. *Fire Safety Journal, 150*, 104274. doi:https://doi.org/10.1016/j.firesaf.2024.104274
40. Zhou, B., Jiang, C., Wang, K., Romão, X., Yoshioka, H., Wang, W., . . . Zhao, H. (2024). A review: The analysis of fires in Chinese historic buildings and research progress on fire protection. *Thermal Science and Engineering Progress, 54*, 102850. doi:https://doi.org/10.1016/j.tsep.2024.102850
41. Zhuang, Y. H., Lin, E. S., Dai, X., & Manes, M. (2025). A systematic review focused on the identification and assessment of fire financial costs in buildings. *Fire Safety Journal, 156*, 104465. doi:https://doi.org/10.1016/j.firesaf.2025.104465

APPENDIXES

Study Title: "Challenges and Coping Strategies in Fire Protection Acceptance for Super High-Rise Projects: A Case Study of the Commercial Bank of Ethiopia Headquarters Building Project"

Dear Respondent;

I am conducting a research study titled "Challenges and Coping Strategies in Fire Protection Acceptance for Super High-Rise Projects: A Case Study of the Commercial Bank of Ethiopia Headquarters Building Project" as part of the partial fulfillment of my Master of Engineering degree in Construction Technology and Management at Mekelle University.

The purpose of this questionnaire and interview is to collect data on the challenges faced and coping strategies employed during the fire protection acceptance process in super high-rise buildings. Your honest and genuine responses will provide valuable insights and significantly contribute to the success of this study.

Please be assured that your privacy will be fully maintained. All responses will be anonymous, ensuring that no individual can be identified, and the information you provide will be kept strictly confidential and used solely for academic purposes. Participation is entirely voluntary, and you may choose to withdraw at any time without any consequences.

Your input is highly appreciated and will play a crucial role in understanding and improving fire protection practices in super high-rise construction projects. Should you have any questions, please feel free to contact me via phone 251983639410.

Thank you very much for your time, cooperation, and support.

Section I - Questionnaire Survey

Part 1: Background Information

1. What was your primary role in the Commercial Bank of Ethiopia Headquarters Building Project?

    Project Owner (CBE)

    Regulatory Authorities

    International Contractor

    Fire Safety Consultants

    Subcontractors & Suppliers

2. How many years of professional experience do you have in fire safety or high-rise building projects?

    Less than 5 years

    5–10 years

    11–15 years

    More than 15 years

3. Have you previously participated in fire protection acceptance for super high-rise buildings?

    Yes

    No

Part 2: Comparison of Fire Safety Requirements Across Standards

4. Which fire safety standard was primarily applied during the fire protection acceptance process of the project?

    Ethiopian building and fire codes

    International standards (NFPA, BS, EN, etc.)

- Combination of local and international standards
- Project-specific or performance-based standards

5. How consistent were the requirements between local fire safety regulations and international standards used in the project?
   - Very consistent
   - Moderately consistent
   - Slightly consistent
   - Not consistent
6. Which area showed the greatest difference across applied fire safety standards?
   - Fire detection and alarm systems
   - Fire suppression systems (sprinkler, standpipe)
   - Smoke control and evacuation systems
   - Means of egress and emergency access

Part 3: Delay Causes and Duration Inputs

7. What was the main cause of delay in the fire protection acceptance process of the project?
   - Design revisions and re-submissions
   - Non-compliance with fire safety standards
   - Inspection and approval scheduling delays
   - Limited availability of qualified inspectors
8. How long did fire protection acceptance delays affect the overall project schedule?
   - Less than 1 month

- 1–3 months
- 4–6 months
- More than 6 months

9. Which project phase experienced the most significant fire protection-related delays?
   - Design stage
   - Construction stage
   - Testing and commissioning stage
   - Final inspection and certification stage

Part 4: Acceptance Checklist for High-Rise Building Projects

10. Which fire protection component required the most corrective actions during acceptance?
    - Fire detection and alarm systems
    - Fire suppression systems
    - Smoke management systems
    - Means of egress and emergency lighting
11. How adequate was the fire protection acceptance checklist used in this project?
    - Very adequate
    - Adequate
    - Moderately adequate
    - Inadequate
12. Was a standardized fire protection acceptance checklist available for super high-rise buildings in this project?

- ☐ Yes, fully standardized
- ☐ Partially standardized
- ☐ Not standardized
- ☐ Not available

Part 5: Stakeholder Coordination Model Templates

13. Which stakeholder had the most influence on the fire protection acceptance process?

- ☐ Client / Owner
- ☐ Consultants
- ☐ Contractors
- ☐ Fire and regulatory authorities

14. How effective was coordination among stakeholders during fire protection acceptance?

- ☐ Very effective
- ☐ Effective
- ☐ Moderately effective
- ☐ Ineffective

15. Which coordination approach best supported fire protection acceptance in the project?

- ☐ Regular multi-stakeholder meetings
- ☐ Early involvement of fire authorities
- ☐ Centralized documentation and reporting
- ☐ Informal coordination practices

Part 6: Reflections and Recommendations

16. Which improvement would most enhance fire protection acceptance for future super high-rise projects in Ethiopia?

- ☐ Harmonization of local and international fire safety standards
- ☐ Early fire safety review during the design stage
- ☐ Development of standardized acceptance checklists
- ☐ Strengthening stakeholder coordination mechanisms

17. At which project stage should fire protection acceptance planning be prioritized?

- ☐ Concept and design stage
- ☐ Construction stage
- ☐ Testing and commissioning stage
- ☐ Final inspection stage

18. Would you recommend the fire protection acceptance approach used in this project for future super high-rise developments?

- ☐ Strongly recommend
- ☐ Recommend
- ☐ Neutral
- ☐ Do not recommend

Section II - Interview Question

Interview Information:

- Interview Name: _____ Date of Interview: _____
- Interviewee Role (select one):
  - □ Project Owner (CBE)
  - □ Fire Safety Consultants
  - □ Regulatory Authorities
  - □ Subcontractors & Suppliers
  - □ International Contractor
- Mode: [ ] In-person [ ] Video Conference [ ] Telephone
- Duration: Approximately 30–60 minutes
- Mode: [ ] In-person [ ] Video Conference [ ] Telephone

1. What were the main regulatory and standards-related challenges encountered during the fire protection acceptance process of the CBE Headquarters Project, particularly regarding alignment between international standards (e.g., NFPA, IBC) and local Ethiopian fire safety requirements?
2. Which technical issues (such as sprinkler systems, smoke control, evacuation design, material certification, or system integration) caused the most difficulty during review, commissioning, and approval, and why?
3. How were coordination and communication managed between the project team and local fire approval authorities, and which phase of the fire protection acceptance process experienced the greatest delays?
4. What methods, tools, or approaches (including performance-based design, BIM, or simulation software) were used to support fire protection acceptance, and how effective were they in addressing regulatory and technical concerns?
5. Based on your experience, which coping strategies were most effective in resolving fire protection acceptance delays, and what improvements or standardized checklists would you recommend for future overseas super high-rise projects?