

ADDIS ABABA UNIVERSITY
ADDIS ABABA INSTITUTE OF TECHNOLOGY
SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING



**Assessment Of Current Administrative Practices On Reducing The
Occurrence And Impact Of Variation Orders:
(A Case Study On Federal Housing Corporation Mixed-Use
Apartment Projects)**

By

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**A Thesis Submitted To The School Of Graduate Studies In Partial Fulfillment Of
The Requirements For The Degree Of Master Of Science In Civil Engineering
(Construction Technology And Management)**

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CERTIFICATION

The undersigned have examined the thesis title “Assessment of current administrative practices on reducing the occurrence and impact of variation orders (A case study on Federal Housing Corporation mixed-use apartment projects)” and hereby recommended for acceptance by the Addis Ababa University in partial fulfillment of the requirement for the degree of Master’s Thesis and hereby certify that it is worthy of acceptance.

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DECLARATION

I hereby declare that this research has been carried out under the supervision of Dr. Abraham Assefa, School of Civil and Environmental Engineering, Addis Ababa University as part of the Masters of Science program in Construction Technology and Management. In addition, I declare that this research is my work towards the Master of Science in Construction Technology and Management and that, to the best of my knowledge, it contains no material previously published by another person.

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ABSTRACT

This study investigates the current administration practices of variation orders within the Federal Housing Corporation (FHC), highlighting the reduction of occurrence and negative impacts and also assessing best practices essential for effective administration. Findings reveal that variation orders frequently arise due to factors such as material unavailability, design changes, and discrepancies in the Bill of Quantities (BOQ), leading to significant cost overruns and schedule delays. Current administrative practices at FHC are found to be inadequate, characterized by unclear documentation, inconsistent risk assessments, and insufficient stakeholder engagement during the planning phase. The study emphasizes the importance of adopting comprehensive strategies, including the integration of Building Information Modeling (BIM) and other technological tools to enhance communication and streamline processes. It underscores the necessity of clearly defined roles and responsibilities among stakeholders, promoting prompt decision-making and trust-based relationships as vital components for effective variation management. Recommendations include enhancing documentation practices, implementing proactive risk management, and investing in continuous professional development for staff. By addressing these recommendations, FHC can significantly improve its capacity to manage variation orders, ultimately leading to better project outcomes and heightened stakeholder satisfaction in future construction projects.

Key Words: - Administrative practices, BIM, Construction projects, FHC, Variation orders

ABBREVIATIONS

A/E	Architect/Engineer
AIA	American Institute of Architects
BIM	Building Information Modeling
BOQ	Bill of Quantities
CBD	Cost Breakdown Document
CII	Construction Industry Institute
CIOB	Chartered Institute of Building
CITB	Construction Industry Training Board
CPM	Construction Project Management
CRS	Congressional Research Service
DB	Design Build
DBB	Design Bid Build
EOT	Extension of Time
FHC	Federal Housing Corporation
FIDIC	International Federation of Consulting Engineers
FS	Feasibility Study
GPS	Global Positioning System
GRP	Glass Reinforced Plastic
IPC	Interim Payment Certificate
LC	Letter of Credit
MS	Microsoft
NIST	National Institute of Standards and Technology
P#	Participant
PDF	Portable Document Format
PPA	Public Procurement & Property Administration Agency
PPR	Polypropylene Random Copolymer Pipes
RE	Resident Engineer
RICS	Royal Institution of Chartered Surveyors
TOR	Terms of Reference

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Chapter 1 INTRODUCTION

1.1 Background of study

Building construction plays a significant role in realizing economic development and expanding investment. The role of building construction is critical for long-term development. Building development is also required to improve services in trade, education, hotels, governmental and private service centers, health sectors, etc. Making new buildings, as well as maintaining and upgrading existing ones, is critical for achieving long-term social and economic development. The building construction industry in Ethiopia has been in a fast-growing mode which plays an influential role in the country's development (Drew, 2012).

A variation order is a deviation from the base contract or work scope mutually agreed upon at the time of contracting in any project. The involvement of various stockholders in the construction industry causes undesirable changes in a project and increases the likelihood that construction tasks become time-consuming and costly. Variation is becoming common in construction tasks and an almost unavoidable condition. It is used in all kinds of construction projects and is crucial in determining project costs and timelines (Drew, 2012).

The possibility of misunderstanding among contracting parties increases as the number of variation orders on a project due to the added complexity and ambiguity they introduce. Variation can alter the original contract terms, leading to confusion regarding responsibilities, timelines, and costs. This often results in disputes and a communication breakdown (Wu et al., 2004). A misunderstanding may occur because one or more of the parties is unfamiliar with the variation order process, the costs associated with applying

changes, or the delays, conflicts, and interruptions to the construction sequence and schedule, all of which can negatively impact project coordination.

Construction engineering is a strong growth driver for the national economy due to its extensive linkage with other sectors; however, the industry has not adequately prepared for the associated project management problem. One of the main issues confronting the construction project during the construction stage is the issue of variation orders. Therefore, it is important to ensure these projects are being executed successfully without any major problems while diminishing the adverse effects of variation orders on the project outcome (Hwang, 2013).

As the number of variation orders increases, the potential for misunderstandings among contracting parties also rises due to the added complexity and ambiguity they introduce. Variations can alter original contract terms, leading to confusion regarding responsibilities, timelines, and costs. This often results in disputes and communication breakdowns (Wu et al., 2004). Misunderstandings may arise when one or more parties are unfamiliar with the variation order process, including the costs associated with changes and the potential delays, conflicts, and interruptions to the construction schedule, all of which can negatively impact project coordination (Hwang, 2013).

Construction engineering serves as a strong growth driver for the national economy due to its extensive linkages with other sectors; however, the industry has not adequately prepared for the project management challenges associated with variation orders (Ethiopian Economic Association, 2022). One of the main issues confronting construction projects during the execution phase is the management of variation orders. Therefore, it is crucial to implement effective administrative practices aimed at reducing the occurrence and impact of these variation orders. By ensuring that projects are executed successfully

without major problems, these practices can help mitigate the adverse effects of variation orders on project outcomes, ultimately enhancing the efficiency and effectiveness of the construction sector.

Given the critical role that construction engineering plays as a growth driver for the national economy, it is essential to address the challenges associated with project administration, particularly concerning variation orders. These issues not only affect project execution but also have broader implications for economic stability and housing accessibility. In this context, the Federal Housing Corporation (FHC) emerges as a focal point for study due to its significant mandate in the housing sector. Established in March 2009, the FHC was tasked with the vital responsibility of undertaking new housing developments aimed at providing affordable rental options for government employees, officials, and the general public (FHC, 2019).

The FHC's strategic objectives align closely with the overarching need to enhance project management practices within the construction industry. By focusing on the FHC, this research seeks to explore how effective administration of variation orders can contribute to the corporation's mission. The FHC's initiatives to develop and upgrade properties not only address immediate housing needs but also serve as a model for best practices in managing construction projects. Thus, the examination of the FHC's administrative practices provides valuable insights into mitigating the adverse effects of variation orders, ensuring that housing developments are executed successfully and contribute positively to the national economy (FHC, 2019).

From the TOR of the Federal Housing Corporation projects, with the vision to share and increase the responsibility of providing housing, was given the role of undertaking new housing developments. The major target groups of the housing development are

government employees, government officials, people representatives, and the general public. The long-term objective of the corporation is settling down the housing rental market with the vision to provide access to affordable rental housing in cities. The different development programs will be undertaken through new developments and upgrading of existing properties for the right use. To carry out the above state obligation the Federal Housing Corporation was re-established in March 2009 hereinafter called the Corporation is recognized as a public enterprise that was the name Rental House Administration agency since Tikimit 28/1968. The purpose of the corporation is (FHC, 2019):

- To construct, cause to contract, rent out, sell, or buy up on special decision houses that may be used for different services.
- To administer and rent out federal government-owned houses and possessions.
- To carry out necessary maintenance and repair works to preserve and protect government-owned houses.
- To make sure the government-owned house and possession are legally registered and protected
- To construct and rent out houses for government officials and employees by government direction and budget outlays.
- To undertake a study on the valuation relating to a government house that the government has decided to sell and collect proceedings therefrom.
- To make a study and forward a proposal to get financial, technological, and modern administrative inputs to be competitive and profitable at a domestic level based on the direction given by the supervising authority.

The mission of the Federal Housing Corporation is to produce and preserve opportunities for affordable housing, and economic development and to revitalize underserved communities in the Country (FHC, 2019).

In the research assessment, while the mission of the Federal Housing Corporation emphasizes the production of affordable housing, a review of their apartment selling tender documents and rental prices suggests a discrepancy between stated objectives and actual market practices. The prevailing prices indicate that the Corporation may not effectively fulfill its mission of providing affordable housing, particularly for the mentioned

communities. This raises concerns about the alignment between their stated goals and real-world outcomes.

Focuses on three strategic objectives:

- Producing and preserving the supply of quality affordable housing;
- Increasing home for rental opportunities; and
- Revitalizing neighborhoods, promoting community development, and providing economic opportunities (FHC, 2019).

As part of the new role, the corporation planned to construct 16,173 housing units in three years between 2010 and 2012. These new developments are going to take place on the lands under the ownership of the corporation and new land is to be granted from the city administrations of Addis Ababa and Dire Dawa. For the 2010 budget year, part of the work has been started on twenty-eight locations found in Addis Ababa on the corporation's owned properties. An agreement was made with three consulting firms to undertake a new design, design revision (designs of 40/60 and diaspora apartment designs) and geotechnical investigation works for the newly constructed buildings. Additional agreements will be made with other firms to undertake the construction and construction management works (FHC, 2019).

With the general aim of understanding the feasibility of the different factors for the planned new housing development, the corporation has prepared TOR to lay the basis to procure the service of a competent and qualified consultant with reputable experience in conducting feasibility study (FS) of housing development-based projects (FHC, 2019).

The first phase is developed on 26ha of land owned by the FHC, and extra land will be provided by the city council. The project is funded by a mix of government grants and bank loans. Planning activities were underway. It was expected that the villas would be

completed in less than 18 months, and the flats would take between 24 and 36 months to construct (FHC, 2019).

The project involves the construction of the mentioned residential units in Addis Ababa, Ethiopia. The US\$1,200 million project includes the following: Construction of villas, Construction of high-rise apartments extending from nine to 21 stories, Construction of retail space, Construction of a community center, Construction of parking spaces, Construction of related facilities, Installation of elevators, Installation of safety and security systems. These construction projects are planned to solve the urban housing shortage using modern construction technologies (FHC, 2019).

In the research assessment, the feasibility of constructing 21-story buildings in Addis Ababa, Ethiopia, involves several critical considerations. Firstly, the availability and reliability of essential infrastructure, such as electrical systems, waste management solutions, and elevator systems, must be assessed. While modern construction technologies can facilitate the implementation of these systems, the existing urban infrastructure may pose challenges, including limited power supply and inadequate waste disposal mechanisms. Therefore, while technically possible, the successful execution of such projects would require comprehensive planning and investment in supporting infrastructure to ensure sustainability and functionality.

1.2 Statement of problem

Many public building projects go over budget and take longer to complete. Almost every project that is started has some form of variation. Though variations are unavoidable in construction projects, many are the result of poor planning, poor designs, a poor client brief, a lack of need identification and requirements, and an overreliance on incomplete

designs. These factors, when combined, have frequently resulted in significant variations in many publicly funded construction Projects. Currently, construction projects face a variety of issues throughout the duration of the project's execution (Olanrewaju et al., 2020).

Olanrewaju et al. (2020) emphasize that inadequate administrative practices can intensify the frequency and severity of variation orders, leading to unsatisfactory project outcomes. The existence of variation order is one of the most common issues. Variation works, their causes, and impacts are now becoming a common concern also in FHC building projects. This situation necessitates a critical analysis of the Federal Housing Corporation's current administrative framework to determine its effectiveness in addressing these issues.

1.3 Background and Summary of Projects

1.3.1 Lot 1/ Tezenia

The project is situated in Phase 1 of the FHC initiatives, specifically identified as Project #1, known as the "Tezenia" project, Lot 1. This construction endeavor is located in proximity to SostKutir Matoria and the Torhayloch Total St. Kidane-Mihret Church, with GPS coordinates of 8.99493, and 38.71436. The project's structural design encompasses a configuration of 2 Basement levels, Ground floor, and 10 additional stories, with an initial contract duration set at 600 days.

As of now, the physical completion percentage of the Tezenia project stands at an impressive 99.90%. The total initial cost of the project is recorded at 353,723,090.66 Birr, as detailed in Table 1. The project follows a Design-Bid-Build (DBB) delivery system.

In the execution of this project, two distinct types of consultants are engaged: Design Consultants and Construction Project Management (CPM) Consultants. The Design

Consultants are tasked with the development of the project's architectural and multidisciplinary designs, ensuring that they align with client requirements and adhere to regulatory standards. Their responsibilities include the creation of comprehensive and detailed drawings.

Conversely, the CPM Consultants concentrate on the oversight of the project's implementation, managing schedules, budgets, and quality control measures to guarantee timely and cost-effective completion. They serve as a vital link between the client and contractors, facilitating effective communication and addressing any challenges that may arise during the construction process.

This collaborative approach, employing a dual-consultant team, is consistently implemented across all DBB-type mixed-use apartment projects (all projects except the Gerji project) within the FHC framework.

1.3.2 Lot 2/ Mekanisa

This project is situated within Phase 1 of the FHC projects. Project #2, referred to as the "Mekanisa" project, Lot 2, is located adjacent to the Mekanisa Batu Condominium and in proximity to the Mekaneyesus Seminarian Church, with precise GPS coordinates of 8.96840, 38.7310337. The project encompasses a structural design comprising a Basement plus Ground and ten additional floors (B+G+10), with an initial contractual duration set at 720 days. The adopted project delivery methodology is Design-Bid-Build (DBB). Currently, the physical completion percentage is an impressive 99.30%, and the total initial project cost amounts to 351,082,658.58 Birr, as detailed in Table 1.

1.3.3 Lot 3/ Bole

This project is situated in phase 1 of the FHC projects. Project #3, also known as the "Bole" project, Lot 3, is a construction project located on the backside of Friendship supermarket or near Desalech Kitfo, with a GPS location of 8.987280, 38.786178. The project size is 2B+G+9, and its initial contract time is 600 days. The project delivery system is DBB/Design Bid Build. The physical percentage completed stands at 99.50%, with a total project initial cost of 217,733,344.46 Birr as indicated in Table 1.

1.3.4 Lot 4/ Aware

This project is presently situated within Phase 1 of the FHC projects. Project #4, designated as the "Aware" project, Lot 4, is located near the Aware roundabout, adjacent to the Ethiopian Construction Authority headquarters, with precise GPS coordinates of 9.02820, 38.77673. The project encompasses a structural design comprising two basements plus ground and ten additional floors (2B+G+10), with an initial contractual duration established at 540 days. The selected project delivery system is Design-Bid-Build (DBB). Currently, the physical completion percentage is an impressive 99.90%, and the total initial cost of the project amounts to 169,914,387.78 Birr, as delineated in Table 1.

1.3.5 Lot 5/ British Embassy

This project is currently situated in phase 2 of the FHC project. Project #5, also known as the "British Embassy" project, Lot 5, is a construction project located beside the British Embassy, with a GPS location of 9.02955, 38.79008. The project size is 3B+G+8, and its initial contract time is 600 days. The project delivery system is DBB/Design Bid Build. The physical percentage completed stands at 27.00%, with a total project initial cost of 473,889,277.99 Birr as shown in Table 1.

1.3.6 Lot 6/ Kebena

From Table 1 it can be seen that this project is currently situated in phase 2 of the FHC project. Project #6, also known as the "Kebena" project, Lot 6, is a construction project located near the Kebena roundabout, with a GPS location of 8.03624, 38.77784. The project size is 2B+G+10, and its initial contract time is 540 days. The project delivery system is DBB/Design Bid Build. The physical percentage completed stands at 97.50%, with a total project initial cost of 251,214,192.22 Birr.

1.3.7 Lot 7/ Misrak Atekalay

This project is currently situated in phase 2 of the FHC project. Project #7, also known as the "Misrak Atekalay" project, Lot 7, is a construction project located near Misrak Polytechnic College, with a GPS location of 9.02262, 38.78644. The project size is 2B+G+9, and its initial contract duration is 720 days. The project delivery system is DBB/Design Bid Build. The physical percentage completed stands at 82.00%, with a total project initial cost of 359,464,744.33 Birr shown in Table 1.

1.3.8 Lot 8/ Kokebe Tsibah

This project is currently situated in phase 2 of the FHC project. Project #8, also known as the "Kokebe Tsibah" project, Lot 8, is a construction project located beside Kokebe Tsibah School, with a GPS location of 9.03681, 38.78230. The project size is 2B+G+9, and its initial contract length is 540 days. The project delivery system is DBB/Design Bid Build. The physical percentage completed stands at 92.00%, with a total project initial cost of 229,733,266.23 Birr as indicated in Table 1.

1.3.9 Lot 9/ Sumale Tera

From Table 1 it is shown that currently situated in phase 2 of the FHC project is project 9. Project #9, also known as the "Sumale Tera" project, Lot 9, is a construction project located on Piassa Russia roundabout or beside Nur Benin Mosque, with a GPS location of 9.03158, 38.74727. The project size is 3B+G+21, and its initial contract time is 900 days. The project delivery system is DBB/Design Bid Build. The physical percentage completed stands at 41.70%, with a total project initial cost of 2,142,613,137.26 Birr.

1.3.10 Lot 10/ Gerji

This project is currently situated in phase 2 of the FHC project, this project is an apartment village having ten blocks. Project #10, also known as the "Gerji" project, Lot 10, is a construction project located beside Gerji Elementary School or near Bole International Airport, with a GPS location of 8.98912, 38.81709 as shown in Table 1. The project village has two different types of sizes, B+G+10 and B+G+9, and its initial contract duration is 540 days. The project delivery system is DB/ Design Build, with an internal consultant team from the client side. By combining the design and construction phases, potential conflicts and discrepancies between the design and implementation can be minimized. This integrated process allows for early collaboration and input from both designers and builders, leading to a more cohesive and coordinated project. Additionally, the single point of responsibility inherent in DB delivery can reduce the likelihood of change orders, resulting in improved cost and schedule certainty for construction projects. The physical percentage completed stands at 98.25%, with a total project initial cost of 3,066,405,712.50 Birr as indicated in Table 1.

The above paragraphs are used to provide the general information of the projects and descriptions are tabulated below.

Table 1 General Information about projects

Lot		Project	Size	Contract Amount (ETB)	GPS Coordinate		Status (%)	Remark
1	Phase I	Tezenia	2B+G+10	353,723,090.66	8.99493, 38.71436	DBB Delivery	99.90	
2		Mekanisa	B+G+10	351,082,658.58	8.96840, 38.7310337		99.30	
3		Bole	2B+G+9	217,733,344.46	8.987280, 38.786178		99.50	
4		Aware	2B+G+10	169,914,387.78	9.02820, 38.77673		99.90	
5	Phase II	British Embassy	3B+G+8	473,889,277.99	9.02955, 38.79008	DBB Delivery	27.00	The project remains stalled with no variation orders or progress.
6		Kebena	2B+G+10	251,214,192.22	8.03624, 38.77784		97.50	
7		Misrak Atekalay	2B+G+9	359,464,744.33	9.02262, 38.78644		82.00	
8		Kokebe Tsibah	2B+G+9	229,733,266.23	9.03681, 38.78230		92.00	
9		Sumale Tera	3B+G+21	2,142,613,137.26	9.03158, 38.74727		41.70	As of the data gathering time, this project has no variation orders.
10		Gerji Village	B+G+10 B+G+9	3,066,405,712.50	8.98912, 38.81709	DB	98.25	Since this project is DB, the contract does not entertain Variation orders.

Variation orders are implemented to correct or adjust the original scope of work because changes during the construction of projects are unavoidable (Olanrewaju et al., 2020).

A variation order is critical for improving the intended project's output. However, from the standpoint of the Employer, frequent variation orders result in a significant increase in project cost and a change in completion time (Wu et al., 2004).

Additionally, corporate, municipal, and governmental projects are afflicted with time and cost overrun concerns. Similarly, FHC building construction projects suffer from schedule and expense overruns due to the prevalence of revisions in the initial scope of the projects. Consequently, the projects were unable to be completed within the time and financial limits. Thus, the employer, contractor, and consultant all suffer in various ways (Sarhan et al., 2017).

This scenario benefits neither the employer nor the contractors, nor the public users of the project as a whole. Variation orders are commonly issued, and projects are disposed to delays, increased costs, and disagreements. Although those adjustments may have been handled or limited throughout the design and construction stages, the employer is obliged to accept them with their associated additional expenses during construction. Most significantly, consultants examine the design frequently during construction, and contractors suffer as a result of the delay in review and employer permission. The owner does not benefit from the negative consequences of such variation orders. So, it is critical to assess the current project management practices used to reduce the occurrences and effects and investigate the causes and impacts of a variation order in FHC's mixed-use apartment projects. As a result, a deep investigation of current management practices

regarding the issue is beneficial for getting effective solutions for controlling variation orders (Sarhan et al., 2017).

1.4 Objectives of Study

Based on the problem statement, the goal of this research is to assess the current management practices on reducing the occurrence and impact of variation orders in Ethiopian Government building projects, a case study on Federal Housing Corporation mixed-use apartment projects.

The main objective of this research study is: -

- To assess current project administrative practices used on reduction of the negative impact of variation orders, specifically the case of Federal Housing Corporations Mixed Use Apartment projects in Addis Ababa.

The specific objectives of this research study are: -

- To assess the cause for each of the variation orders in FHC's mixed-use apartment projects in Addis Ababa.
- To examine the implications of variation orders in FHCs mixed-use apartment buildings.
- To evaluate the current administrative practices for variation orders in FHCs mixed-use apartment buildings.
- To identify the challenges faced in implementing the management techniques.
- To provide recommendations for improving the management of variation orders in public building projects.

1.5 Research questions

The research investigation was directed by the following questions to get a reliable conclusion:

- i. What are the common causes for variation orders in FHCs mixed-use apartment projects in Addis Ababa?

- ii. What are the most significant consequences of the project's variation orders?
- iii. What are the current methods/ administrative practices used to prevent and reduce variation orders in public building construction projects?
- iv. What are the challenges encountered by the FHC in implementing management techniques to reduce the occurrence and negative impacts of variation?
- v. What new strategies can be implemented to further reduce variation orders?

1.6 Significance of study

This study is significant as it addresses a critical challenge in the construction industry, variation orders, which can severely impact project timelines and budgets. By assessing the current administrative practices of the Federal Housing Corporation of Ethiopia, this research seeks to discuss how effective administration strategies can reduce both the occurrence and impact of these variation orders. By identifying best practices and potential gaps in the existing administrative framework, the study aims to provide actionable recommendations that can enhance operational efficiency. This not only benefits the Federal Housing Corporation but also serves as a model for other public and private entities engaged in similar projects.

The study will help the Federal Housing Corporation to take corrective action to limit the incidence of the problem. The research will also assist the FHC in identifying and implementing corrective steps to reduce the occurrence and impact of variation orders and using better project management practices for the reduction of occurrences and impacts of variation orders as well.

1.7 The Study's Scope

This study focuses on the administrative practices employed by the Federal Housing Corporation of Ethiopia in managing variation orders within mixed-use apartment

projects. It examines specific procedures, stakeholder interactions, and change order management strategies implemented in these projects. The research is limited to ongoing and completed projects under the Corporation's horizon, providing a comprehensive analysis of their effectiveness in reducing the occurrence and impact of variation orders.

The research is restricted to Federal Housing Corporation's, currently active mixed-use apartment projects in Addis Ababa. This scope limitation is necessary owing to funding and time constraints for the research.

1.8 Conceptual Framework

The conceptual framework shown in Figure 1, this thesis revolves around variation order administration practice within the context of construction projects undertaken by the Federal Housing Corporation of Ethiopia.

Through this conceptual framework, the thesis aims to provide a visual representation of the systematic approach to variation order administration, offering insights into the structured processes and decision-making involved in optimizing project outcomes and ensuring efficient project delivery within the construction sector of FHC.

The steps and points mentioned in Figure 1 show the framework are described as follows. Identify Causes: This step focuses on analyzing the factors that lead to variation orders. Examine Implications: This stage assesses the implications of variation orders on cost, time, and quality. Evaluate Practices: This section reviews current administrative strategies. Provide Recommendations: This final step suggests actionable improvements.

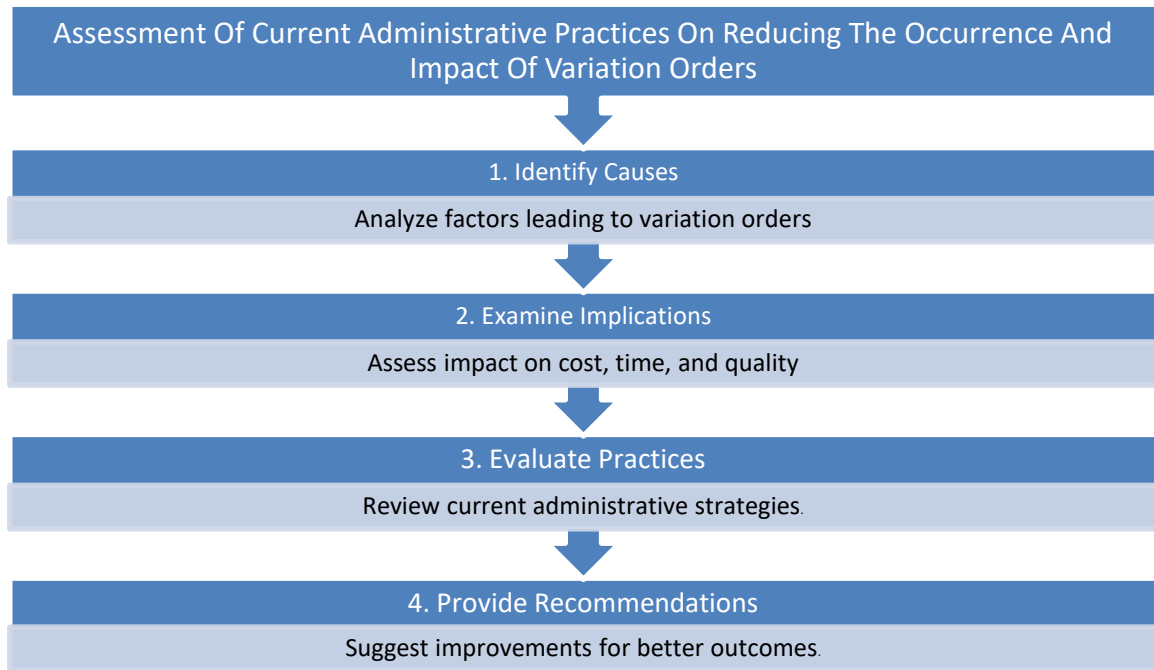


Figure 1 Conceptual framework

Chapter 2 LITERATURE REVIEW

2.1 Introduction

Most construction projects deviate from the approved design to some degree. Modifications may result from customer design changes, a design flaw, or an unforeseen condition. Changes to the contract pricing, timeline, or budget in any case may have an impact on the completion date (Drew, 2012).

Project changes are common and can be perceived as either harmful or beneficial, depending on whether they are viewed as conflicts or valuable lessons. Modifications to a project have both direct and indirect impacts on its budget, schedule, and duration. Despite the abundance of articles and extensive discussion in academic and practical literature, there is a lack of knowledge regarding systematic techniques for managing project changes.

2.2 Public building construction projects

Public building construction projects are typically funded by government entities and involve the construction of buildings that will be used for public purposes, such as schools, courthouses, libraries, and government offices. These projects often have unique challenges due to their large size and complexity and the need to meet strict safety and accessibility standards.

According to a report by the National Institute of Standards and Technology NIST (2019), one of the biggest challenges facing public building construction projects is the need for effective communication among all stakeholders involved in the project. This includes not only architects and contractors but also government officials, end-users of the building,

and members of the local community. Effective communication can help ensure that everyone is on the same page regarding project goals and expectations, which can ultimately lead to a more successful outcome.

Another challenge facing public building construction projects is managing costs. According to a report by the CRS (2008), cost overruns are common in these types of projects due to factors such as changes in design or scope, unforeseen site conditions, and delays caused by weather or other external factors. To mitigate these risks, project managers need to develop realistic budgets and schedules based on a thorough analysis of all relevant factors.

Some government entities are addressing these challenges through the use of Building Information Modelling (BIM) technology. BIM allows designers and contractors to create detailed 3D models of buildings before they are constructed, which can help identify potential issues early in the design process. According to a report by McGraw Hill Construction Bernstein et al. (2014), BIM has been shown to reduce errors and omissions in design documents by up to 80%, resulting in reduced costs and improved project outcomes.

Public building construction projects present unique challenges that require careful planning and management. Effective communication among all stakeholders is crucial for success, as is careful attention to budgeting and scheduling. The use of new technologies such as BIM can also help improve project outcomes by identifying potential issues early in the design process.

Public building construction projects are complex endeavors that require careful planning and execution. According to a report by the NIST (2019), successful public building

projects rely on operative communication and collaboration among all stakeholders, including the owner, designer, contractor, and end-users. In addition, the report emphasizes the importance of using innovative technologies and materials to improve project efficiency and sustainability. Another study by the Construction Industry Institute CII (2017) highlights the need for proper risk management strategies in public building projects to mitigate potential delays and cost overruns. These findings suggest that a holistic approach is necessary for achieving successful outcomes in public building construction projects.

2.3 Definition of Variation Orders in Construction Projects

There is no single universally accepted definition of variation. The term variation as explained and/or defined by several standard forms of contract varies, although the definition and/or meaning is more or less equivalent in concept. A variation in terms of particular acts and activities is usually defined in any standard type of building contract.

Variation orders refer to changes made to the original scope of work in a construction project. These changes can be introduced by the owner, contractor, or architect/engineer (A/E) during the course of the project (Naimah, 2023).

Variation is an instruction given by the engineer, which varies the Works (PPA, 2006). In the context of construction and engineering projects, a variation refers to any change or adjustment to the original scope of works as specified in the contract. According to the Public Procurement Act (2006), variations are instructions issued by the engineer or project manager that alter the nature, quantity, or quality of the works to be performed.

Variation orders, also known as change orders, are common in construction projects. They refer to any changes to the original work scope or contract agreement. However, variation

orders can have significant effects on the project timeline and budget. They can cause delays, increase costs, and affect the quality of work if not managed effectively. Variation orders are a common occurrence in construction projects. They refer to any changes made to the original scope of work and can include additions, deletions, or modifications to the project. Variation orders can arise due to several reasons such as design changes, unforeseen site conditions, or client requests. As stated by FIDIC (2017), “variation” means any change to the works, which is instructed or approved as a variation. Variation orders and variation works are important concepts in construction projects. A variation order refers to a change made to the original scope of work, while variation works refer to the actual execution of those changes. Variation orders are an essential part of any construction project. They are changes made to the original contract agreement, which occur when there is a need for additional work or modifications to the original scope of work. According to the Royal Institution of Chartered Surveyors RICS (2019), variation orders can be defined as “*changes that alter the scope, quality, quantity, timing or cost of the works.*” The RICS also emphasizes the importance of documenting all variation orders as they serve as evidence in case disputes arise.

Variation can be taken to be any, a combination of any or all of the following (Arain & Pheng, 2005):

a) Building project variations can include changing the type or standard of materials to be used in the works, adding, removing, or substituting work, or removing work or materials brought on-site by the contractor for the works other than work or materials not covered by the contract. Variations can also include changing the quantity, quality, or design of the works as shown on the contract drawings and described by or referred to in the contract bills (Arain & Pheng, 2005).

b) Variations in building projects with instructions concerning the nature of the works which are not specifically termed as variations in the contract documents (Arain & Pheng, 2005).

c) Variation of contract in law, i.e. if both parties alter a contract document by agreement after execution of the original contract this is a variation of the contract terms or conditions (Arain & Pheng, 2005).

The American Institute of Architects (2017) states that a variation order must be in writing and signed by both parties. This ensures that all parties involved in the project are aware of any changes made and agree on them. Variation orders are often seen as an inevitable part of construction projects, but they can also create challenges for both clients and contractors.

Therefore, construction professionals must have a clear understanding of variation orders and how to handle them. These changes can be initiated by either the client or the contractor and may involve alterations to the design, materials, or schedule. In conclusion, variation orders play a critical role in construction projects. They allow for flexibility in adapting to changing circumstances during the construction process.

2.4 Nature and types of variation orders in construction projects

Several types of variation orders can occur in construction projects. One type is known as a change order, which involves changes to the scope of work or contract agreement that has been agreed upon by both parties (Sears & Clough, 2015). Another type is a directive change order, which is issued by the client without prior agreement from the contractor (Wu et al., 2004).

According to Naimah (2023), Variation orders can be categorized into three main types:

- i. Additions or omissions to the scope of work;
- ii. Substitutions or alterations to materials or equipment;
- iii. Changes to the sequence or timing of work.

Similarly, as stated by Habtemariam, (2019), there are categories of work that may be subject to variations. These include additions or omissions to the scope of work, changes in materials or equipment specifications, and changes in the project schedule. Each category may require a different approach in terms of managing variation orders.

The nature of variation orders in construction projects can vary depending on factors such as project size and complexity. For example, larger projects may involve more stakeholders and therefore more potential for variations (Alsohiman et al., 2023). Additionally, variations may be more common in projects with longer timelines due to changing market conditions or other external factors.

In addition to understanding the types of variation orders and works that can occur in construction projects, contractors need to understand how variations are priced and managed. According to Derek et al., (2007), pricing variations accurately require an understanding of direct costs such as labor and materials as well as indirect costs such as overheads and profit margins.

In conclusion, consideration of the nature and types of variation orders and works in construction projects is essential for effective project management. By anticipating potential variations and having clear processes in place for managing them, clients and contractors can minimize risks and ensure successful project completion.

Effective management of variations requires clear communication channels between all stakeholders involved in the project. As noted by Sarhan et al., (2017), this includes contractors, suppliers, clients, and other parties affected by the change.

In summary, there are several types of variation orders and works that can occur in construction projects including additions, omissions, substitutions, modifications, corrections, and acceleration orders among others. Effective management requires clear communication channels between stakeholders as well as accurate pricing and proactive identification of potential variations early on in the project lifecycle.

2.5 Purpose of variation orders in construction project

The purpose of variation orders is to accommodate changes requested by clients or other stakeholders during the project lifecycle.

The purpose of variation orders and variation works in construction projects is to allow for changes to the original project plan. These changes may be necessary due to unforeseen circumstances or changes in project requirements and can include modifications to the scope of work, design changes, or additional work required. According to a report by the Construction Industry Training Board CITB (2016), variation orders can help ensure that client requirements are met and that projects are delivered on time and within budget. For example, if a client decides they want additional features or upgrades added to the project, variation orders may be necessary to modify the original plan and incorporate these changes.

Variation works are also used to address errors or omissions in the original project plan. For example, if an error is discovered in the design drawings after construction has begun, a variation order may be needed to correct this error and ensure that the project meets all safety and quality standards.

The purpose of variation works is to implement the changes requested in the variation order while minimizing disruption to the project schedule and budget. As per a study by

Shen et al. (2019), variation works can help improve project outcomes by ensuring that changes are implemented effectively and efficiently.

Managing risks: Variation orders and associated variation works can also be used as risk management tools in construction projects. By accommodating changes requested by clients or other stakeholders, contractors can minimize the risk of disputes, delays, or cost overruns. According to a report by Deloitte (2018), effective management of variations can help reduce overall project risks and improve project outcomes.

Enhancing client satisfaction: Another key purpose of variation orders and associated variation works is to enhance client satisfaction by accommodating their changing needs throughout the project lifecycle. As per a study by Kumar et al., (2023), effective management of variations can help improve client satisfaction levels, leading to increased repeat business and building a positive image of the company.

Accommodating unforeseen circumstances: Variation orders and associated variation works may also be necessary to accommodate unforeseen circumstances that arise during construction projects, such as weather events or unexpected site conditions. According to a report by McKinsey (2020), effective management of variations can help contractors respond quickly and efficiently to unforeseen circumstances, minimizing their impact on project outcomes. Variation orders can serve several purposes in construction projects. One primary purpose is to address unforeseen issues that were not accounted for in the original project plan. For example, if a contractor discovers a problem with the site during construction, a variation order may be necessary to modify the design or scope of work to address this issue.

Overall, variation orders and variation work play an essential role in construction projects by allowing for flexibility and adaptability in response to changing circumstances or requirements. However, effective management of variations is critical for ensuring that they do not lead to cost overruns, delays, or disputes between stakeholders.

2.6 Cause of variation order in construction projects

Variation orders and variation works are common in construction projects, and they can be caused by a variety of factors. Understanding the causes of variation orders is essential for effective project management. There are several causes for variation orders including design errors or omissions, unforeseen site conditions, changes in client requirements or specifications, and contractor-initiated changes (Adel et al., 2009).

Design changes are one of the primary causes of variation orders in construction projects. According to a study by Hassan & Murat (2016), design changes can occur due to various factors such as inaccurate specifications, incomplete drawings, and unexpected site conditions.

One common cause of variation orders is poor initial planning. This can include inadequate design or specifications, unclear project requirements, or incomplete site investigations (Habtemariam, 2019). When these issues arise during construction, it may be necessary to make changes to the original plans. Inadequate planning can result in delays, cost overruns, and other issues that may require variations to be made to the original project plan. Poor project planning is a common cause of variation orders in construction projects. According to a study by Mustapha et al., (2018), inadequate planning can result in unclear project objectives, unrealistic schedules, and insufficient resources.

Changes in client requirements or preferences can also be a cause of variation orders. Clients may request changes to the original plans based on their needs or preferences (Sears & Clough, 2015). While these changes may be necessary to ensure client satisfaction, they can also result in additional costs and delays. One major cause of variations is changes in project scope or design. According to Saad et al., (2015), changes in the client's requirements or unexpected site conditions can lead to variations that require additional work or modifications to the original design. Changes in design are a common cause of variation orders and work in construction projects. According to a study by Aftab et al, (2014), changes in design can occur due to various reasons such as errors or omissions in the original design, new client requirements, or changes in building codes and regulations. These changes can result in additional work for contractors, leading to variation orders and works.

Contractual issues can also contribute to variations in construction projects. Derek et al., (2007) note that unclear or ambiguous contract terms can lead to disputes between parties, which may result in variations being required to resolve the issue.

Other factors that may contribute to variation orders include poor communication between parties involved in the project, inadequate risk assessment and management practices, and unforeseen events such as weather conditions or laborious disputes (Alsohiman et al., 2023). In a study by Nishadi et al., (2014), it was found that poor communication between clients, consultants, and contractors can lead to misunderstandings about project requirements and specifications. This can result in changes being made during construction or after the completion of work, leading to variation orders.

In addition, external factors such as weather conditions, material shortages, and labor disputes can all contribute to the need for variation orders and variation works. Serdar et

al., (2018) highlight the importance of contingency planning to address these types of issues proactively. For instance, a sudden change in weather conditions may require additional work to be carried out to ensure that the project is completed on time and within budget.

Another common cause of variation orders is unexpected site conditions. This can include issues such as soil instability or contamination, hidden utilities, or unexpected archaeological finds (Wu et al., 2004). Unforeseen site conditions can lead to variation orders and work during construction projects. For example, encountering unexpected soil conditions or discovering hidden obstacles such as underground utilities can require changes to the original design or additional work to be performed. According to a study by Adnan & Faisal (2010), unforeseen site conditions were identified as one of the top causes of variation orders on construction projects. These issues can require changes to the original plans and may result in delays or additional costs.

Inaccurate cost estimating is another cause of variation orders and works on construction projects. When initial cost estimates are not accurate or do not take into account all project requirements or risks associated with the project scope then this may lead to additional costs that may not have been planned for initially thus resulting in variation order claims. According to research by Serdar (2020), inaccurate cost estimating was identified as one of the main causes of variations in infrastructure projects.

Changes in regulatory requirements or safety standards can also lead to variations in construction projects. As noted by Serdar et al., (2018), compliance with these requirements may require modifications to the original project plan or additional work that was not anticipated at the outset of the project.

Contractor performance is also an important factor affecting variation orders in construction projects. According to a study by Afolabi et al., (2018), poor contractor performance can result in delays, cost overruns, and quality issues that may require additional work or modifications. The study found that selecting qualified and experienced contractors who prioritize quality and safety can help minimize the number of variation orders.

In conclusion, many different factors/causes can contribute to variation orders and variation works in construction projects. Understanding the causes of variation orders is essential for effective project management in construction projects. By identifying potential causes such as poor initial planning, unexpected site conditions, changes in client requirements or preferences, poor communication between parties involved in the project design changes, poor project planning, poor contractor performance, and other the above-mentioned factors; clients and contractors can take steps to minimize risks associated with variation orders.

2.7 Originators/Initiators of variation orders and variation works in construction projects

2.7.1 Client's factors

Clients or owners are often the initiators of variation orders in construction projects. According to a study by Chan et al. (2014), clients may request changes to project scope, design, or materials due to changing needs or preferences. The study found that effective communication between clients and contractors can help minimize the number of variation orders by ensuring that project requirements are clearly defined and agreed upon.

The client's lack of clarity in defining project requirements can lead to variation orders and works. According to a study by Nishadi et al., (2014), unclear or incomplete project specifications from the client can result in changes being made during construction or after the completion of work, leading to variation orders.

Clients who frequently change their minds or add new requirements during the project can also cause variations orders and works. According to research by Aftab et al, (2014), clients who make frequent changes to design requirements can result in additional work for contractors, leading to variation orders.

The client's failure to provide timely approvals or feedback can also contribute to variation orders and works on construction projects. In a study by Karukh et al. (2020), it was found that delayed approvals from clients can result in delays in the project schedule which may require additional work or changes to be made later on.

Finally, clients who do not adequately budget for contingencies may be more likely to cause variation orders and work on construction projects due to unexpected expenses arising during the project. According to research by Serdar (2020), inadequate budgeting was identified as one of the main causes of variations in infrastructure projects.

2.7.2 Consultant's factors

Consultants play a crucial role in construction projects as they provide expert advice and guidance throughout the project lifecycle. According to a study by Ghanim, (2017), consultants can help reduce the number of variation orders in construction projects by providing accurate cost estimates, identifying potential risks, and ensuring that the design meets all regulatory requirements. The study also found that consultants can help improve

project performance by providing timely feedback and recommendations to the project team.

A study by El-Mashaleh et al., (2020) found that inexperienced or unqualified consultants can increase the number of variation orders by failing to identify potential issues or providing inaccurate advice. In addition, the study found that some consultants may prioritize their interests over those of the project owner or contractor.

Designers such as architects and engineers can also be initiators of variation orders in construction projects. According to a study by Mustapha et al., (2018), designers may request changes to project design due to errors or omissions in initial design documents.

To ensure that consultants are effective in managing variation orders and work in construction projects, it is important for project owners and contractors to carefully select qualified and experienced consultants who have a proven track record of success. According to a study by Creuza et al., (2018), factors such as education level, professional certifications, years of experience, and communication skills should be considered when selecting a consultant for a construction project.

In conclusion, while consultants can have a significant impact on managing variation orders and work in construction projects, it is important to select qualified and experienced professionals who prioritize the interests of the project owner or contractor over their interests. By doing so, project owners and contractors can ensure that their projects are completed successfully within budget and schedule constraints (Ghanim, 2017). The study by Mustapha et al., (2018), found that effective quality control practices can help minimize the number of variation orders initiated by designers.

2.7.3 Contractor's factors

Contractors play a significant role in executing works in construction projects. According to a study by Odeh & Battaineh, (2002), contractors can help reduce the number of variation orders by ensuring that the design meets all regulatory requirements, identifying potential risks, and providing accurate cost estimates. The study also found that contractors can improve project performance by providing timely feedback and recommendations to the project team.

A study by Kamaruden et al., (2014) found that inexperienced or unqualified contractors can increase the number of variation orders by failing to identify potential issues or providing inaccurate advice. In addition, the study found that some contractors may prioritize their interests over those of the project owner or consultant.

Contractors may also initiate variation orders in construction projects due to unforeseen site conditions or other factors affecting project execution. According to a study by Saki et al., (2022), contractors may request changes to project scope or design due to issues such as material shortages, labor disputes, or equipment breakdowns.

To ensure that contractors are effective in managing variation orders and work in construction projects, it is important for project owners and consultants to carefully select qualified and experienced contractors who have a proven track record of success. According to a study by Marzouk et al., (2013), factors such as experience level, technical capabilities, financial stability, and communication skills should be considered when selecting a contractor for a construction project.

In conclusion, while contractors can have a significant impact on managing variation orders and work in construction projects, it is important to select qualified and experienced

professionals who prioritize the interests of the project owner or consultant over their interests. By doing so, project owners and consultants can ensure that their projects are completed successfully within budget and schedule constraints. The study by Saki et al., (2022) found that effective risk management practices can help minimize the number of variation orders initiated by contractors.

2.7.4 Governments factors

Government regulations play a significant role in managing variation orders and work in construction projects. According to a study by Wong et al. (2018), government regulations can help reduce the number of variation orders by ensuring that all designs meet regulatory requirements, providing clear guidelines for project management, and enforcing penalties for non-compliance. The study also found that government regulations can improve project performance by providing a framework for effective communication between stakeholders.

However, excessive or unclear government regulations can increase the number of variation orders and slow down project progress. According to a study by Saki et al., (2022), overly strict regulations can result in additional costs and delays due to increased paperwork and bureaucracy. In addition, unclear or ambiguous regulations may lead to misunderstandings between stakeholders and result in disputes.

To ensure that government regulations are effective in managing variation orders and work in construction projects, governments need to work closely with stakeholders to develop clear guidelines that balance regulatory requirements with practical considerations such as cost and schedule constraints. According to a study by Hu et al., (2017), effective stakeholder engagement can help ensure that government regulations are practical, enforceable, and aligned with industry best practices.

While government regulations can have a significant impact on managing variation orders and work in construction projects, governments need to work closely with stakeholders to develop clear guidelines that balance regulatory requirements with practical considerations such as cost and schedule constraints. By doing so, governments can ensure that their regulations are effective in promoting project success while minimizing unnecessary costs and delays.

In conclusion, clients, designers, contractors, and the government are among the key initiators of variation orders in construction projects. Effective communication between stakeholders, clear project objectives and expectations, careful contractor selection, as well as proper risk management practices, can help minimize the number of variation orders while ensuring successful project outcomes.

2.8 Impacts of variation orders and variation work in construction projects

Variation orders and their related variation works can have weighty impacts on construction projects. One of the primary impacts is on project cost, as variations often require additional work or modifications to the original plan, which can result in cost overruns.

Variation orders can have significant impacts on a construction project's cost, schedule, and quality.

Variation orders can significantly affect construction project quality by altering specifications, potentially leading to substandard materials or workmanship (Holt et al., 2000). They increase complexity, which can cause miscommunication and errors if not managed well (Mok et al., 2015). Resource reallocation for variations may result in

shortages or the use of lower-quality materials, while time constraints can lead to rushed work, compromising quality (Kumaraswamy & Dulaimi, 1997).

The cost impact includes additional material and labor costs as well as overhead expenses. Schedule impacts include delays due to rework or additional work while quality impacts include potential defects resulting from rushed work (Adel et al., 2009). As noted by Mustapha et al., (2018), inadequate planning can result in delays, cost overruns, and other issues that may require variations to be made to the original project plan.

According to a study by Alsohiman et al., (2023), variation orders are a major cause of disputes in construction projects. This is because they often lead to delays, cost overruns, and disagreements over responsibility for the changes. However, proper management of variation orders can help minimize these issues.

In addition, variations can also impact the project schedule, as additional work or modifications may cause delays in project completion. This delay can lead to further costs being incurred due to extended labor or equipment rental. Variation orders can also affect project schedules for construction projects. According to a study by Saki et al., (2022), variation orders can cause delays due to changes in project scope or design, as well as additional material or labor requirements. The study found that effective communication between stakeholders and careful planning can help minimize the impact of variation orders on the project schedule.

Quality may also be affected by variation orders in construction projects. According to a study by Chan et al. (2014), variation orders can result in changes to project design or materials, which may affect the quality of the final product. The study found that effective quality control practices can help minimize the impact of variation orders on project

quality. Variations can impact project quality, as changes to the original plan may affect the overall quality of the finished product. This impact is particularly true when variations are made late in the project timeline, as it may be challenging to incorporate changes without affecting other parts of the project.

Furthermore, variations can also result in disputes between parties involved in the construction project. Disputes arising from unclear contract terms or disagreements over pricing for variation works can lead to delays and additional costs.

In conclusion, variation orders can have significant impacts on project cost, schedule, quality, and disputes between contracting parties in construction projects.

2.9 Strategies to minimize variation orders and variation works in construction projects

Variation orders and variation works can have significant impacts on construction projects, including cost overruns, delays, and disputes. As such, it is essential to implement strategies to minimize the occurrence of variations in construction projects.

Early identification and communication of potential changes: One of the most effective ways to minimize variation orders is to identify potential changes as early as possible in the project lifecycle. This can be done by conducting thorough site surveys, engaging with stakeholders, and communicating effectively with all parties involved. According to a study by Sarhan et al., (2017), early identification of potential changes can help reduce the number of variations and their associated costs.

Clear scope definition: One strategy for minimizing variation orders is to ensure that the project scope and design are well-defined at the outset of the project. This strategy requires

careful planning and communication between stakeholders to ensure that all parties understand the project goals and requirements. A clear scope definition is essential for minimizing variation orders in construction projects. This includes defining project objectives, deliverables, timelines, budgets, and roles and responsibilities. According to a report by Deloitte (2018), a clear scope definition can help reduce variations by up to 40%. Mustapha et al., (2018) found that effective project planning can help minimize the number of variation orders by ensuring that all stakeholders have a clear understanding of project requirements and expectations.

Robust change management processes: Establishing strong change management processes is crucial for minimizing variation orders in construction projects. This includes having clear procedures for assessing, approving, and implementing changes. As per a study by Goh Y.M. et al. (2017), robust change management processes can help reduce variations by up to 60%. By establishing clear procedures for managing changes to the project plan, stakeholders can minimize the impact of variations on the project schedules and costs.

Effective risk management: Anticipating and managing risks effectively can also help minimize variation orders in construction projects. This involves identifying potential risks early on in the project lifecycle and developing contingency plans. According to a report by PwC (2019), effective risk management can help reduce variations by up to 50%. By identifying potential risks early in the project timeline, stakeholders can take proactive steps to mitigate these risks before they lead to variations. Effective risk management practices, communication between stakeholders, careful planning and selection of contractors, as well as proper quality control practices can help mitigate these impacts while ensuring successful project outcomes.

Collaboration among stakeholders: Collaboration among stakeholders is critical for minimizing variation orders in construction projects. This includes engaging with contractors, subcontractors, suppliers, consultants, clients, and other relevant parties throughout the project lifecycle. As per a study by Chan et al. (2018), collaboration among stakeholders can help reduce variations by up to 30%. (Ryan et al., 2013). This communication should be ongoing throughout all stages of the project and should include regular updates on project progress, potential issues or risks, and any changes to the original plan. The study by Habtemariam, (2019) found that effective communication between stakeholders, including architects, engineers, and contractors, can help reduce the number of design changes and subsequent variation orders. Also, Afolabi et al., (2018) said, that effective communication between stakeholders, clear project objectives and expectations, careful contractor selection, as well as proper risk management practices can help minimize the number of variation orders while ensuring successful project outcomes.

Good risk management practices can help minimize the impact of variation orders on project costs (Mustapha et al., 2018).

According to a study by Alsohiman et al., (2023), variation orders are a major cause of disputes in construction projects. This is because they often lead to delays, cost overruns, and disagreements over responsibility for the changes. However, proper management of variation orders can help minimize these issues.

Chan et al., (2014) explain variation orders can result in changes to project design or materials, which may affect the quality of the final product. The study found that effective quality control practices can help minimize the impact of variation orders on project quality.

Overall, effective strategies for minimizing variation orders require a hands-on tactic that includes clear communication channels between stakeholders, accurate pricing strategies for variation work, contingency plans for addressing unexpected issues as they arise, and proper planning and management throughout all stages of the project.

2.10 Management of variation orders and variation works in construction projects

Dynamic management of variation orders is essential for the successful completion of construction projects. This involves a range of activities, including identifying potential variations, assessing their impact on project scope, timeline, and budget, and implementing appropriate changes. The best management of variation orders and variation works is essential in ensuring that construction projects are completed on time, within budget, and to the satisfaction of all stakeholders. According to Mustapha et al., (2018), effective management requires a proactive approach that involves identifying potential variations early on in the project lifecycle. The first step in managing variation orders is to have a well-defined contract that outlines the procedures for handling changes. This includes identifying who has the authority to approve variations, how they will be documented and communicated, and how they will be priced.

Once a variation order is approved, it is essential to communicate the change effectively with all stakeholders involved in the project. This includes notifying contractors, suppliers, and other parties affected by the change. It is also important to update project schedules and budgets accordingly.

Effective management of variation orders requires clear communication between all parties involved in the project as well as proper documentation and good record-keeping

practices. This includes maintaining accurate records of all variations issued along with associated costs and time impacts (Vasugi, 2018). Another important aspect of managing variation orders is tracking them throughout the project timeline. This can be done using software tools such as Building Information Modelling (BIM) or other project management systems.

One way to manage variation orders is through clear communication between all parties involved. This includes contractors, suppliers, clients, and other parties affected by the change. It is important to document all variations systematically and update project schedules and budgets accordingly. This includes documenting any changes in writing and obtaining approval from both the client and contractor before proceeding. As noted by Habtemariam, (2019), this can help ensure that everyone is on the same page regarding the scope of work and any associated costs. One key aspect of managing variation orders is communication between clients and contractors. Regular meetings and progress reports can help ensure that all parties are aware of any potential changes to the project (Aibinu & Jagboro, 2002). Operational communication also helps build trust and collaboration between parties. Effective communication between all stakeholders involved in the project is also critical for managing variations successfully. Serdar et al., (2018) highlight the importance of clear communication channels between contractors, clients, suppliers, and other parties affected by the change.

Another important aspect of managing variation orders is documentation. Clear documentation can help track changes to project scope or budget and ensure accountability for any associated costs (Habtemariam, 2019). This may involve detailed change order forms or updated drawings or specifications. As stated by Shrestha et al. (2019), these tools allow for real-time updates on changes and can help prevent errors or misunderstandings.

While variation orders are inevitable in construction projects, they can be managed effectively through clear communication, documentation, and tracking. By doing so, contractors and clients can avoid disputes and ensure successful project completion.

In addition to these activities, effective management of variation orders may also involve risk assessment and mitigation. This can help identify potential risks associated with variations and develop strategies to minimize their impact on the project (Alsohiman et al., 2023).

Effective management of variation orders may vary depending on factors such as project size and complexity. For example, larger projects may require more detailed documentation and approval processes than smaller ones (Sears & Clough, 2015).

One important aspect of managing variation orders is having a clear process for requesting, approving, and implementing changes. As noted by Saad et al., (2015), this process should be outlined in the contract and include details such as the timeframe for responding to requests and the documentation required for approval.

Another important aspect of managing variations is accurately pricing the work. Derek et al., (2007) note that this requires an understanding of direct costs such as labor and materials as well as indirect costs such as overheads and profit margins. The pricing of variations is typically based on the cost of materials, labor, and overheads required to execute the change. This includes any additional costs such as site preparation or equipment rental. It is important for contractors to accurately estimate these costs and communicate them clearly with clients before proceeding with any variation works.

In addition to these specific strategies, there are several general best practices for managing variations effectively. These include maintaining accurate records of all variation requests

and approvals, regularly reviewing project plans to identify potential variations, and having contingency plans in place to manage unexpected changes.

In conclusion, effective management of variation orders is essential for the successful completion of construction projects. Overall, effective management of variation orders and variation works requires a proactive approach that includes clear processes for requesting, approving, and implementing changes as well as accurate pricing strategies and effective communication channels between stakeholders. The management requires clear communication channels, well-defined contracts and procedures for handling changes, proactive identification of potential variations early on in the project lifecycle, good record-keeping practices, and updating project schedules accordingly (Sarhan et al., 2017).

By ensuring clear communication between clients and contractors, documenting all changes to project scope or budget, assessing potential risks associated with variations, and implementing appropriate changes or mitigation strategies where necessary, clients and contractors can minimize risks and ensure successful project completion. Construction professionals must remain proactive in identifying potential variations early on in the project lifecycle. This helps avoid surprises later on in the project and allows for better planning and management of changes. It is essential to manage them effectively through proper documentation and prompt compensation to ensure successful project completion within budget and timeline constraints (Saad et al., 2015).

2.11 Skills required by the management team for reducing variation orders in construction project

Variation orders and variation works require a range of skills to manage effectively in construction projects. These skills include project management, communication, risk management, and contract administration (Sears & Clough, 2015).

Communication skills: Effective communication is crucial for managing variation orders and associated variation works in construction projects. This includes the ability to communicate clearly with clients, subcontractors, suppliers, and other stakeholders. According to a report by the Chartered Institute of Building CIOB (2017), effective communication can help ensure that all parties involved in a project are aware of any changes or variations requested. Communication skills are critical for managing variation orders and variation works. Effective communication between stakeholders is essential for ensuring that all parties understand the impact of variations on the project timeline and budget. Clear communication channels can help minimize misunderstandings and disputes between stakeholders.

Project management skills: Variation orders and associated variation works require strong project management skills to ensure that changes are implemented effectively while minimizing disruption to the project schedule and budget. As per a study by Shen et al. (2019), effective project management can help ensure that variation works are completed on time and within budget. Construction professionals need to understand how variations are priced and managed. Effective project management skills are essential for managing variation orders and variation works. This includes the ability to plan, organize, and control all aspects of the project, including changes to the original plan. Project managers must also be able to manage resources effectively to ensure that variations do not lead to cost

overruns or delays. Risk management skills are also important for managing variation orders and variation works. Project managers must be able to identify potential risks associated with variations, such as cost overruns or delays, and develop contingency plans to mitigate these risks.

Technical expertise: Technical expertise is essential for managing variation orders and associated variation works in construction projects. This includes knowledge of relevant building codes, regulations, and industry standards. According to a report by the Royal Institution of Chartered Surveyors RICS (2018), technical expertise can help ensure that variations are implemented safely and efficiently.

Problem-solving skills: Variation orders and associated variation works often require creative problem-solving skills to address unexpected challenges or issues that arise during construction projects. As per a study by Sarhan et al., (2017), effective problem-solving can help minimize the impact of variations on project outcomes. Contract administration skills are also critical for managing variation orders and variation works. This includes an understanding of contract terms and conditions related to variations, as well as an ability to negotiate changes with clients or contractors when necessary.

Attention to detail: Attention to detail is critical for managing variation orders and associated variation works in construction projects. This includes ensuring that all changes requested are documented accurately and that any potential impacts on project outcomes are identified early on. According to a report by McKinsey (2020), attention to detail can help contractors respond quickly and effectively to variations, minimizing their impact on overall project outcomes.

Variation orders and variation works require a range of skills that go beyond technical expertise in construction. Project managers must have strong communication, technical, risk management, Problem-solving, contract administration, and project management skills to ensure that variations are managed effectively without impacting the overall success of the project (Sears & Clough, 2015).

2.12 Contractual provision related to variation orders and variation works in construction projects

Contractual provisions related to variation orders and variation works are essential in construction projects as they provide a framework for managing changes to the original scope of work. According to Sarhan et al., (2017), the contractual provisions should clearly outline the process for requesting, approving, and implementing variations.

Contractual provisions related to variation orders are also important for both clients and contractors in construction projects. These provisions outline the process for initiating, approving, and managing variations, as well as the responsibilities of each party involved

One common contractual provision related to variation orders is the requirement for written approval from both parties before any changes can be made (Wu et al., 2004). This helps ensure that all parties are aware of any potential impacts on the project scope, timeline, or budget. As noted by Saad et al., (2015), written notice is typically required before any variation work can be carried out. This notice should include details such as the nature of the variation, its impact on cost and schedule, and any other relevant information.

Another important provision is the requirement for clear documentation of all variations and associated costs. This can include detailed change order forms, updated drawings or specifications, and regular progress reports (Habtemariam, 2019). Documentation is

essential for tracking project changes and ensuring accountability. Derek et al., (2007) note that this should be based on a clear understanding of direct and indirect costs associated with the variation work. It's worth noting that contractual provisions related to variation orders may vary depending on factors such as project size and complexity. For example, larger projects may require more detailed documentation and approval processes than smaller ones (Sears & Clough, 2015).

The timeframe for implementing variations is also an important consideration in contractual provisions. According to Serdar et al., (2018), contracts should specify a timeframe for responding to variation requests as well as a timeframe for completing the work once it has been approved.

In addition to these specific provisions, contracts should also include general clauses related to variations such as change control procedures and dispute resolution mechanisms. As noted by Mustapha et al., (2018), these clauses help ensure that all parties involved in the project understand their roles and responsibilities when it comes to managing variations.

There may also be clauses in the contract related to dispute resolution in the case of disagreements over variations. For example, some contracts may require mediation or arbitration before legal action can be taken (Alsohiman et al., 2023).

In conclusion, understanding contractual provisions related to variation orders is essential for effective project management in construction projects. By having clear processes in place for initiating and managing variations, as well as documenting all associated costs and changes, clients and contractors can minimize risks and ensure successful project completion. Effective management of variations in construction projects requires clear

contractual provisions that outline the process for requesting, approving, pricing, and implementing changes to the original scope of work. These provisions should be tailored to each project's specific needs and take into account factors such as timeline, cost implications, and dispute resolution mechanisms.

2.13 Variation orders in Ethiopian construction projects

Ethiopia is experiencing growth in its construction industry, which has led to the frequent occurrence of variation orders in construction projects. Despite the construction industry's growth, Ethiopia faces challenges in managing variation orders. A study by Teshome et al. (2019) identified delays caused by variation orders as a primary contributor to project delays in the Ethiopian construction sector. These delays can lead to cost overruns and disputes among stakeholders, highlighting the need for robust variation order management processes.

However, effective management is often delayed by limited resources and inadequate contract management practices, which can lead to inefficiencies and misunderstandings. There are significant gaps in the effective administration of variation orders, partly due to a lack of skilled personnel and insufficient training in contract management.

The study emphasizes the importance of effective communication among all parties involved in managing variation orders to ensure that changes are properly documented and approved (Andualem, 2017). Clear communication channels can help prevent misunderstandings and ensure that all stakeholders have a shared understanding of the project's goals and constraints.

The construction industry plays a crucial role in the economic development of Ethiopia, yet many federal road projects face significant challenges due to variations in project

scope. Tadesse Ayalew (2009) identifies key causes of these variations, including right-of-way issues, changes in defined scope, inadequate planning, and financial difficulties faced by contractors. These variations often lead to increased project costs, delays in completion times, and disputes among stakeholders, highlighting the need for effective management strategies. Ayalew emphasizes that variations not only disrupt timelines but also strain relationships between clients and contractors, making it essential to address these issues proactively.

To mitigate the adverse effects of variations, Ayalew (2009) suggests implementing proactive measures during the planning and execution phases of construction projects. Effective communication and coordination among stakeholders, thorough evaluation of tender documents, and active client involvement during the design phase can significantly reduce the incidence of variations. Additionally, establishing clear guidelines for managing change orders and ensuring timely decision-making is crucial for maintaining project integrity. Ayalew's findings underscore the importance of addressing the root causes of variations through strategic planning and stakeholder engagement, ultimately contributing to improved performance in Ethiopian federal road construction projects.

In conclusion, the effective management of variation orders in Ethiopian construction projects requires a multifaceted approach that includes clear communication, strong negotiation skills, a thorough understanding of contract terms, and the use of technology to streamline processes. By addressing these areas, the Ethiopian construction industry can improve its ability to manage variation orders and enhance project outcomes, ultimately contributing to the sector's continued growth and development.

2.14 Research Gap

Identifying the research gap in the assessment of current administrative practices on reducing the occurrence and impact of variation orders, particularly within the context of the Federal Housing Corporation (FHC) mixed-use apartments in Ethiopia, reveals a significant lack of empirical studies that specifically address the administrative efficiency and variation order management in the Ethiopian construction sector. While existing literature highlights the occurrence of variation orders and their negative effects on project timelines and budgets, there is a shortage of focused research examining how administrative practices can mitigate these issues. This gap signifies an opportunity to explore how administrative frameworks can be optimized to reduce variation orders, thereby enhancing project delivery outcomes in Ethiopia's growing construction industry.

Some studies have explored the causes and effects of variation orders within the context of construction projects in Ethiopia. Notably, Andualem (2016) examined the factors contributing to variation orders and their subsequent impacts on public building projects. Similarly, Haimanot (2021) focused on the relationship between variation orders and construction project performance, specifically analyzing road construction projects in Addis Ababa. Dejene (2020) contributed to this discourse by assessing the causes and impacts of variation orders in public building construction projects within the Jimma Zone. Furthermore, Tewodros (2015) investigated the causes and effects of variation orders in road construction projects, particularly those administered by the Addis Ababa City Roads Authority. Ayalew (2009) also provided valuable insights by assessing the causes and effects of variations in Ethiopian federal road projects.

Given the significance of these findings, there is a pressing need to evaluate the current administrative practices employed to minimize the occurrence and impact of variation

orders. This assessment should aim to identify best practices that project administrators can adopt to effectively mitigate the risks and negative consequences associated with variation orders in building projects. By doing so, stakeholders can enhance project performance and ensure more efficient management of resources in the construction industry. Therefore, this research target is to explore the current project administration practices in minimizing the occurrence and impact of variation orders on public building projects especially on FHC's mixed-use apartment projects. This could involve assessing the management processes used in reducing the occurrences and impacts of variation orders and examining their effectiveness in improving building project performance.

2.15 Summary of literature review

The literature review emphasizes the complexities of project variations and the need for effective administration strategies. It begins with a definition of project changes, categorizing them as foreseeable or unforeseeable. Project changes are further classified into omissions, additions, and alterations, with causes identified as internal (like design errors) and external (like material shortages). Various stakeholders, including clients and contractors, can initiate variations, leading to significant implications such as cost overruns and time claims. The review advocates for a comprehensive administration approach that includes effective communication and documentation, along with strategies to minimize negative impacts through early identification, clear scope definition, and stakeholder collaboration, ultimately promoting better project outcomes.

Chapter 3 **RESEARCH METHODOLOGY**

3.1 Introduction

This chapter describes the research instruments and techniques that are employed. The research methodology approach explains the practical organization of the entire study effort (O’Leary, 2004). A plan of action must be prepared that outlines how the problems will be researched, what information will be gathered using which methods, and how this information will be analyzed to reach findings and produce suggestions (Walliman, 2005).

The problem examined in this research is the assessment of current administrative practices used to reduce the occurrence and impacts of variation works on public building projects in Ethiopia, the study specifically focused on Federal Housing Corporation’s mixed-use apartment projects.

3.2 Research Method

The qualitative approach offered a comprehensive framework that made it possible to thoroughly investigate complex issues about perception, real-world experiences, and human behavior (Khan, 2014). This method enabled a thorough investigation of the subtleties and complexities present in various fields, leading to a thorough comprehension of the topic.

The techniques used to gather data influence the final analysis, results, conclusions, values, and validity of the study. The qualitative method, from a theoretical standpoint, tries to gather insights and comprehend people's perspectives who are engaged in the selected projects. This study is qualitative.

It is qualitative since the study pursued to ascertain public building construction stakeholders' perception of variation works. Desk studies from the FHC head office contract administrative team were collected and from certain projects in FHC Mixed-use apartment projects were done. The desk studies on the selected locations included the project's size, the observation of site papers, variation order letters & site diaries, project participants' views, and physical investigation. Interviews from the head office personnel are taken regarding the general point of view of the title and for triangulation of desk study and literature. The study has a qualitative nature since it focuses on variables discovered in the literature, desk study, and interviews to provide answers to the set questions.

Interviews from FHC, contractors, and consultants were conducted to gather respondents' responses. The interview questions used in the study were an open-ended semi-structured type. The study investigates current administrative practices, the causes, consequences, skills required by project managers, and strategies for minimizing variation orders on FHC mixed-use apartment projects. A review of relevant literature is conducted, along with desk study and interviews to collect information on variation works on FHC mixed-use apartment projects, to achieve the study objectives. Current administrative practices, causes, implications, skills required by administration, and strategies for minimizing variation in work were identified through the literature review and desk studies. Interviews were conducted which serve as the foundation for the research development.

FHC records were used to obtain empirical data on variation works. The archival documents were from ongoing projects and included variation documents, financial reports, correspondence letters, and consultancy reports, all of which were crucial in identifying the variation orders issue in FHC mixed-use apartment projects.

The triangulation strategy was used between the desk study, interview, and literature to strengthen the validity of the findings of this research. This method uses qualitative methodology.

3.3 Research Design and Rational

This study employed a qualitative approach, adopting a case study research design to delve deeply into the issue of variation orders in Ethiopian Federal Housing Corporation (FHC) construction projects. Qualitative methodologies were chosen to allow for a comprehensive exploration of how individuals attribute significance to various aspects related to variation orders within the context of FHC projects. Through qualitative investigation, data were collected using multiple methods including interviews, observations, and document analysis. These diverse data sources enabled the identification of substantive patterns and themes relevant to the phenomenon under study (Patton, 2015).

In employing a case study methodology, the aim was to construct detailed and rich narratives focusing on the specific context of FHC construction projects. This approach ensures that the subject matter is not examined through a singular perspective but rather through the lens of various stakeholders, allowing for a nuanced understanding of the complexities surrounding variation orders (Yin, 2014).

The rationale behind utilizing the case study tradition lies in its capacity to shed light on intricate situations and elucidate the interconnections between them (Yin, 2014). By examining multiple cases within the FHC construction projects, the researcher aimed to enhance the validity of their findings by triangulating information from diverse sources. The triangulation approach facilitates a comprehensive exploration of the factors contributing to variation orders and their impacts on project outcomes (Lewis, 2015).

The qualitative research method offered a platform for participants to express their perspectives openly and provide detailed insights into their experiences with variation orders in FHC construction projects. Unlike quantitative techniques, qualitative approaches allowed for immediate follow-up inquiries, enabling researchers to investigate deeper into participants' responses and gain a nuanced understanding of the phenomenon under investigation.

3.4 Methodology

The utilization of qualitative research methods was deemed appropriate for this study due to the nuanced insights they offer into individuals' thoughts, motivations, and experiences. Qualitative research endeavors to delve into the intricacies of human behavior and skills within real-life contexts, aiming to understand the underlying dynamics of the phenomena under investigation (Barnham, 2015). Researchers employing qualitative methodologies often seek to uncover and appreciate the complexities of individuals' behaviors and actions about their environment (Barnham, 2015).

Qualitative researchers employ a variety of techniques to gather data, including individual interviews, focus groups, and document analysis, all conducted within the natural settings of participants (Patton, 2015). In the present study, a deliberate sampling strategy was employed, selecting participants purposefully to ensure a diverse range of perspectives and experiences related to variation orders in Ethiopian Federal Housing Corporation (FHC) construction projects. Data collection was carried out through face-to-face semi-structured individual interviews, allowing for in-depth exploration of participants' insights, experiences, and perceptions regarding variation orders. Additionally, a document review was conducted to supplement the interview data and provide a comprehensive understanding of the issue. In qualitative research, open-ended questions are integral as

they allow for individual variations and facilitate rich, detailed responses from participants (Patton, 2015). For this case study, the primary method of data collection employed was semi-structured interviews. Each interview followed a similar protocol, ensuring consistency in data collection procedures. Audio recording of the interviews was utilized to enhance the reliability and validity of the data and subsequent findings (De Vault, 2015). The semi-structured nature of the interviews provided flexibility, enabling participants to elaborate on their responses and provide nuanced insights into their experiences with variation works within Ethiopian Federal Housing Corporation (FHC) projects.

During the review process, participants were allowed to verify the accuracy and significance of their contributions, further ensuring the trustworthiness of the data collected. To achieve a comprehensive understanding, the researcher employed a combination of data collection methods, including record assessment and individual interviews, to enhance the reliability and validity of the study findings (Yin, 2014).

The findings of this study shed light on both the causes of variation orders in FHC construction projects and the strategies employed for their administration. Through qualitative inquiry, a rich tapestry of perspectives emerged, revealing the multifaceted nature of variation order challenges within the FHC context. By adopting a qualitative approach, this study was able to uncover not only the surface-level manifestations of variation orders but also the underlying factors contributing to their occurrence and the nuanced strategies employed to address them. Overall, qualitative research methods proved instrumental in uncovering the complexities inherent in the management of construction variation orders in the context of Ethiopian Federal Housing Corporation projects.

3.5 Sampling and participant selection

In conducting research on administrative practices related to variation orders within the Federal Housing Corporation's (FHC) mixed-use apartment projects, a purposive sampling approach was employed to select participants directly involved in variation works across all ten active projects under Phase 1 and Phase 2. As interviews progressed, it became clear that data saturation was reached, with responses beginning to exhibit redundancy, indicating that core issues were thoroughly explored. Ultimately, a total of 40 participants were chosen, representing a balanced array of perspectives from clients, contractors, and consultants, ensuring a rich dataset that allowed for meaningful conclusions about the effectiveness of current administration practices in handling variation orders.

3.6 Procedures for data collection

The primary objective of data collection in this study was to acquire comprehensive information pertaining to the specific attributes of individuals and phenomena related to the cause and management of construction variation orders within the Ethiopian Federal Housing Corporation (FHC) projects. To accomplish this, record gathering was utilized as a research instrument, yielding thoughtful insights into the intricacies of the phenomenon under investigation. This approach was complemented by the triangulation of information, which served to reinforce the validity and reliability of the research results by cross-referencing data from multiple sources (Stephen, 2016). The comprehensive nature of data collection aimed to ensure that a full spectrum of information was captured, enabling a thorough examination of the complexities surrounding construction variation orders within the FHC context.

To achieve data saturation, a critical milestone in qualitative research, it was imperative to ensure that the sample comprised participants possessing sufficient knowledge and experience to provide insightful responses to the research questions (Morse, 2015). In the context of this study, data saturation signaled the point at which subsequent interviews yielded only redundant information, indicating that no new insights were emerging. This point of saturation served as an indicator that data collection had reached its completion, affirming that a comprehensive understanding of the causes and administration strategies associated with variation orders in FHC projects had been achieved (Morse, 2015). Through meticulous data collection methods and the pursuit of data saturation, this study aimed to provide a robust analysis of the factors influencing variation orders in FHC projects and the approaches employed to address them, ultimately contributing to a deeper understanding of this critical issue in construction management.

3.7 Data Analysis Plan

The qualitative research methodology provided a comprehensive framework for delving into the intricate aspects of variation order administration within the Ethiopian Federal Housing Corporation (FHC) projects, encompassing human behavior, perception, and lived experiences. Employing a case study research design facilitated the exploration of complexities inherent in variation order management and guided the formulation of pertinent research questions for further data collection and analysis (Morse, 2015). The primary aim of the case study was to present findings based on collected data, highlighting the nuanced understanding derived from the research process (Morse, 2015).

To ensure the reliability of the information gathered, careful data analysis procedures were followed. MS Excel and MS Word software were utilized to assist in coding and organizing ideas and accounts, aiding in the identification of patterns within the data. Each

participant's responses were allocated a unique alphanumeric code, ensuring confidentiality and facilitating organization. The data were stored securely on a password-protected computer, with each participant's code serving to chronologically organize their contributions.

Efforts to streamline information management included the creation of a comprehensive database using MS Excel, which tracked participant details, consent forms, record assessments, and interview schedules. This qualitative study database played a crucial role in organizing case study information, procedures, and interview questions, contributing to the mitigation of bias and enhancing the validity of the study design.

Through the process of coding and labeling, common and recurring themes within the data were identified, shedding light on the strategies employed to address variation orders and their impact on project outcomes.

3.8 Issues of trustworthiness

In qualitative research, maintaining trustworthiness is paramount to ensure the accuracy and integrity of the study. This involves addressing key aspects such as credibility, reliability, validity, and ethical procedures. Drawing from previous discussions on variation order management within the Ethiopian Federal Housing Corporation (FHC) projects, this paper explores how these elements contribute to the overall trustworthiness of qualitative research.

3.8.1 Credibility

Credibility refers to the believability and accuracy of the research findings. In this study, credibility was upheld through meticulous data collection methods, including semi-structured interviews and record gathering. By utilizing open-ended questions and

conducting interviews with knowledgeable participants, we ensured the depth and richness of the data, thereby enhancing the credibility of our findings.

3.8.2 Reliability

Reliability concerns the consistency and stability of the research findings over time and across different contexts. To achieve reliability, we employed consistent data collection and analysis procedures. The use of standardized interview protocols and audio recording of interviews contributed to the reliability of the data. Additionally, efforts were made to document and track all research procedures meticulously, minimizing the potential for errors or inconsistencies.

3.8.3 Validity

Validity refers to the extent to which the research accurately measures what it intends to measure. In our study, validity was ensured through triangulation of data sources and methods. By corroborating information obtained from interviews with document analysis, we strengthened the validity of our findings. Furthermore, the use of MS Excel software facilitated systematic data organization and analysis, contributing to the validity of the study outcomes.

3.8.4 Ethical Procedures

Ethical considerations are paramount in qualitative research to protect the rights and well-being of participants. Throughout the research process, ethical procedures were strictly adhered to. Informed consent was obtained from all participants, and their confidentiality was safeguarded through the use of alphanumeric codes to anonymize data. Additionally, efforts were made to minimize any potential harm or discomfort to participants during data collection and analysis.

Chapter 4 DATA ANALYSIS AND INTERPRETATION

4.1 Introduction

In the context of building projects, efficiently handling variation orders is critical to guaranteeing the timely and economical completion of projects. To improve project outcomes and stakeholder satisfaction, it is critical to comprehend and optimize administrative practices related to variation orders in the context of the Federal Housing Corporation of Ethiopia (FHC). The management of variation orders that arise in FHC's building projects is the main topic of this study. Variation orders provide serious difficulties, including as delays, cost overruns, and strained client-contractor relationships. They might result from modifications in the project's scope, requirements, or unanticipated events. This study explores the nuances of FHC's administrative procedures using qualitative thematic analysis, highlighting important themes, areas of strength, and areas for development in the administration of variation orders. Through a critical examination of existing procedures, this study aims to offer practical recommendations.

4.2 Demographic profile of research participants

The demographic information supplied provides a thorough look into the diverse backgrounds of interviewees working on Federal Housing Corporation of Ethiopia (FHC)-supervised building projects. There is a clear diversity in educational backgrounds among the participants; some have either a bachelor's or master's degree. The wide range of educational backgrounds highlights the diverse range of knowledge that those with degrees bring to the table, in addition to those with advanced degrees. In addition, the participants have a diverse spectrum of experience, ranging from four years in very junior jobs to almost 25 years in seasoned ones. This wide range of experience provides a rich tapestry

of the respondents' depth of understanding and abundance of perspectives. The wide range of positions highlights the complex nature of the building projects that FHC undertakes, from Chief Contract Administrators supervising contractual concerns to Project Managers directing project execution and resident engineers managing operations on-site. Furthermore, the participants' geographical distribution throughout the many project sites Tezenia, Kokebe-Tsibah, Kebena, Aware, Bole, Mekanisa, Sumale Tera, and Gerji emphasizes the breadth of FHC's development attempts. This extensive participation highlights the organization's dedication to tackling housing shortages and infrastructure development in Ethiopia's many regions. The interviewees at FHC exhibit a diverse range of educational backgrounds, experience levels, roles, and site involvements, which highlights the importance of a collaborative and multidisciplinary approach for successful project delivery in the construction industry.

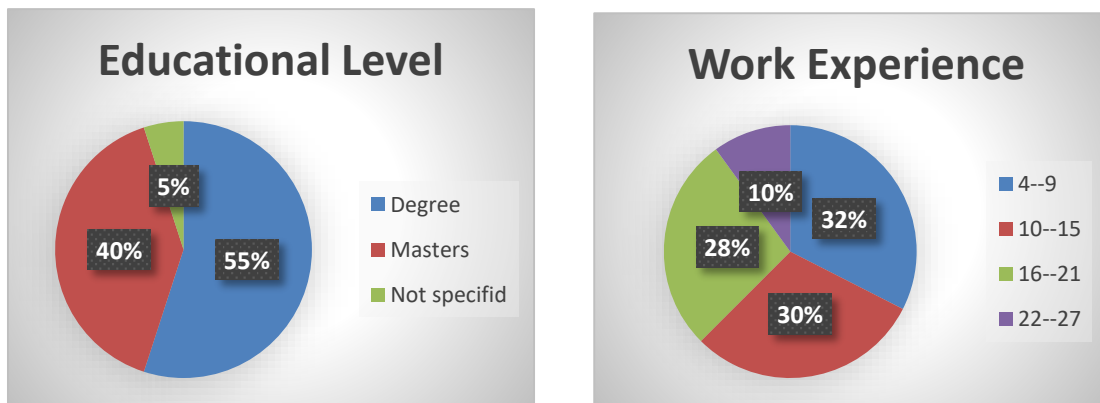


Figure 2 Demographic profile of research participants

The provided table offers valuable insights into the demographic composition of interview participants at the Federal Housing Corporation of Ethiopia (FHC), detailing their educational backgrounds, work experience, and roles within their respective companies.

4.2.1 Educational Background:

The participants exhibit a diverse range of educational qualifications, with individuals holding either degree or master's degree qualifications. Degree holders are prevalent among Consultants, Clients, and Contractors, while master's degree holders are found across similar roles within the organization.

4.2.2 Work Experience:

Participants bring varying levels of experience to their respective roles, with years of experience ranging from 4 years to over 25 years. This indicates a breadth of expertise and tenure within the construction industry, underscoring the depth of knowledge and skills possessed by interview participants.

4.2.3 Work Roles:

Across the board, participants assume a multitude of roles within their companies, reflecting the complex and multifaceted nature of construction projects undertaken by FHC. These roles encompass Resident Engineers (RE), Chief Contract Administrators, Project Coordinators, Contract Engineers, Site Engineers, Project Managers, Senior Office Engineers, Assistant Counterpart Engineers, and more.

Table 2 Roles of interview participants

Role	Participants
Resident Engineer from the consultant side	P1, P4, P14, P19, P35, P36
Resident Engineer from client side (Counterpart engineer)	P5, P6, P12, P15, P16, P20, P23, P31
Site Engineer	P17
Senior Office Engineer	P18
Senior Structural Engineer	P22
Office Engineer	P34, P40
Project Coordinator	P7, P25, P29, P30, P33, P39
Project manager & Coordinator	P9, P11, P13, P21, P26, P32, P37, P38
Chief contract admin	P2
Legal & contract administration	P3
Contract Engineer/ Contract administrator	P8, P10, P24, P27, P28

In summary, the demographic data of interview participants at FHC highlights the rich diversity in educational backgrounds, extensive work experience, and multifaceted roles within the organization. This diversity underscores the collective expertise and collaborative effort required to successfully manage and execute construction projects undertaken by FHC.

4.3 Frequency of occurrence of variation

In the analysis of the frequency and causes of variation orders in construction projects at the Federal Housing Corporation of Ethiopia (FHC), a detailed exploration into professional accounts provides critical insights. This exploration surveyed a group of professionals, where nearly 80% of the interview participants mentioned that variation orders frequently occurred on the projects.

The responses regarding the causes of variation were structured into three main categories: types of variations, causes of variations, and sources of variations. This categorization

helped in understanding the multifaceted nature of variation orders and their impact on project management.

For the remaining 20% of the participants in the survey conducted among professionals at the Federal Housing Corporation of Ethiopia (FHC), their perspectives provided a contrasting view on the frequency of variation orders. These professionals indicated that variation orders, while part of the project landscape, are less frequently encountered or less disruptive than their counterparts suggested. This smaller group might experience fewer issues with variations due to differences in their project roles, the types of projects they are involved in, or their personal thresholds for what constitutes a significant disruption.

This divergence in viewpoints highlights the variability in experiences and perceptions among professionals dealing with construction projects. It underscores the importance of tailoring project management strategies to account for the full spectrum of experiences to effectively anticipate and mitigate the impacts of variation orders. Understanding this range of experiences helps in formulating more robust and adaptable project administrative practices that can handle variations more efficiently across different project scenarios within the corporation.

4.4 Type of variations

The Federal Housing Corporation of Ethiopia (FHC) is currently overseeing several construction projects, each exhibiting varying levels of completion and complexity. Among these, the Tezenia project stands out with an impressive execution rate of 99.90%. Initially contracted for 353,723,090.66, it has experienced significant variations, with additions amounting to 86,547,525.29, representing 24.47%, and omissions totaling 43,080,943.65, or 12.18%. Supplementary works have further contributed to total

variations of 142,346,771.43, which is 40.24% of the initial contract amount. Despite the high execution rate, the project has exceeded its original timeline, taking 1,184 days instead of the planned 600.

Similarly, the Mekanisa project, also at 99.30% execution, has a contract amount of 351,062,658.58. It has seen additions of 88,920,524.29 (25.33%) and omissions of 31,107,004.50 (8.86%), with total variations reaching 57,813,519.79, or 16.47%. This project has taken 1,229 days to date, surpassing its 720-day schedule.

The Bole project, with a 99.40% execution rate and an initial contract amount of 217,733,344.46, has recorded additions of 27,143,414.21 (12.47%) and omissions of 11,106,599.60 (5.10%). The total variations here are 16,036,814.61, accounting for 7.30% of the contract, and it has also exceeded its timeline, taking 1,229 days.

In contrast, the Aware project has achieved a completion rate of 99.90% with a contract amount of 34,511,848.03. It has recorded only additions amounting to 34,511,848.03 (20.31%) and no omissions, resulting in total variations of the same amount. This project has adhered closely to its timeline, taking 1,228 days against an initial 540-day contract.

The British Embassy project, however, presents a different scenario, with only 45.00% execution. Initially contracted for 473,889,277.99, it has not recorded any variations and has been suspended before any variations could be approved. The project remains at the 600-day mark.

The Kebena project, achieving 97.50% execution, has a contract amount of 251,214,192.22. It has seen minor additions of 3,599,224.72 (1.43%) and omissions of 1,180,872.00 (0.47%), totaling variations of 2,418,352.72, or 0.96%. This project has taken 700 days, slightly below its 720-day timeline.

The Misrak Atekalay project, with a 73.00% execution rate and a contract amount of 359,464,434.33, has not recorded any variations to date. It remains within its timeline, taking 810 days against a planned 720.

Kokebe Tsibah has achieved an 88.00% execution rate, with an initial contract of 229,733,266.23. It has seen minor additions of 1,293,185.99 (0.56%) and no omissions, resulting in total variations of 1,293,185.99. The project has adhered to its timeline, completing in 540 days.

Lastly, the Sumale Tera project, with a significantly lower execution rate of 30.00%, has a contract amount of 2,142,613,137.26 but has not recorded any variations. It remains on schedule at 900 days.

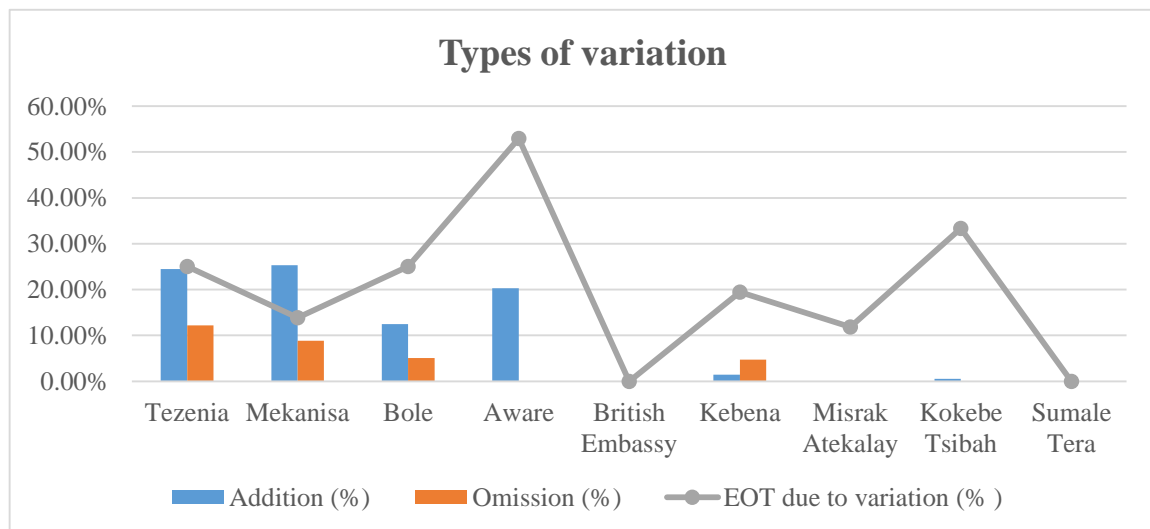


Figure 3 Type of variation and their corresponding extension of time due to variation on FHC projects

Overall, while many projects are nearing completion, the British Embassy project has been suspended. The presence of various additions and omissions across several projects reflects the dynamic nature of construction management, emphasizing the need for ongoing adjustments to meet deadlines and budget expectations.

4.5 Cause of Variation

A closer examination of the common causes of variation orders, as outlined by FHC professionals, shows a spectrum of factors contributing to their emergence. Material unavailability on the market emerges as a notable factor, reflecting challenges in sourcing essential construction materials within specified timelines. Similarly, instances, where missed items and new items from contract documents in the initial design and specifications, triggered variation orders, leading to discrepancies between anticipated and actual costs due to prices are not adequately quoted were reported.

Moreover, 10% of the participants mentioned the omission of work items from contracts, including:

- Earthwork (bulk excavation, fill around mat and footings, backfill around shear walls with selected excavated material)
- Thermal and Moisture Protection (Supply, apply, test, and commission acrylic copolymers based elastic coating applied as liquid & cures to form a durable, protective waterproofing membrane on balcony slab, sump wall, subsurface manholes, gutters, and flat roofs & under basement mat slab)
- Metalworks (Aluminum balustrades, guardrails to verandah of bedrooms, and staircase handrails)
- Flooring works (Cement sand screed with grouted joints in color for lobby, verandah & circulation areas, marble skirting, marble tread with chamfer, marble riser)
- Plastering work (Third coat cement plastering for all wall surfaces)
- Painting work (Granite paint to external plastered surfaces)
- Sanitary works (Installation of pipe works, i.e., High Density Polyethylene PE-HD-PN4 pipe for drainage, vent pipe, rainwater pipe, cold and hot water

distribution/multilayer pipe, stop valve, domestic booster water pump, plumbing, waste water drainage pipe, 50m³ septic tank)

- Electrical works (MATV system)
- Exterior improvement (Precast C-15 concrete pavement)

Particularly those of functional importance underscore the particulars involved in project planning and execution. The introduction of new technologies or methodologies during project implementation necessitates alterations to original plans, thereby giving rise to variation orders. When new technologies or methodologies are introduced during a project's implementation, it may require changes or variations to the original project plans.

Mainly, 96% of participants pointed out material unavailability on the market as a crucial cause, reflecting significant challenges in sourcing essential construction materials within specified timelines. Furthermore, 65% of participants cited missed items and new items in design as key triggers for variation orders, leading to discrepancies between anticipated and actual project costs.

Additionally, 32% of professionals noted the omission of work items from contracts, such as crucial earthworks and various finishes, which are often overlooked in the initial phases but essential for project completion. Discrepancies between design specifications and the Bill of Quantities (BOQ) were highlighted by 22% of participants, further intensifying the likelihood of financial variations.

Client-requested changes, mentioned by 25%, both adding layers of complexity to project management. Unforeseen site conditions, including geological surprises or environmental issues, were pointed out by 15% of the professionals as pivotal in driving variations. Errors

and omissions in initial planning and design stages were noted by 12%, requiring adjustments during the construction phase to align with actual conditions.

Supply chain disruptions, although affecting a smaller percentage (8%) of the projects, and other factors (16%), including economic fluctuations and labor issues, also play significant roles in necessitating variation orders. Collectively, these insights illustrate the diverse and interconnected nature of challenges that lead to variation orders, emphasizing the need for proactive management and flexibility in construction project practices to accommodate these inevitable changes.

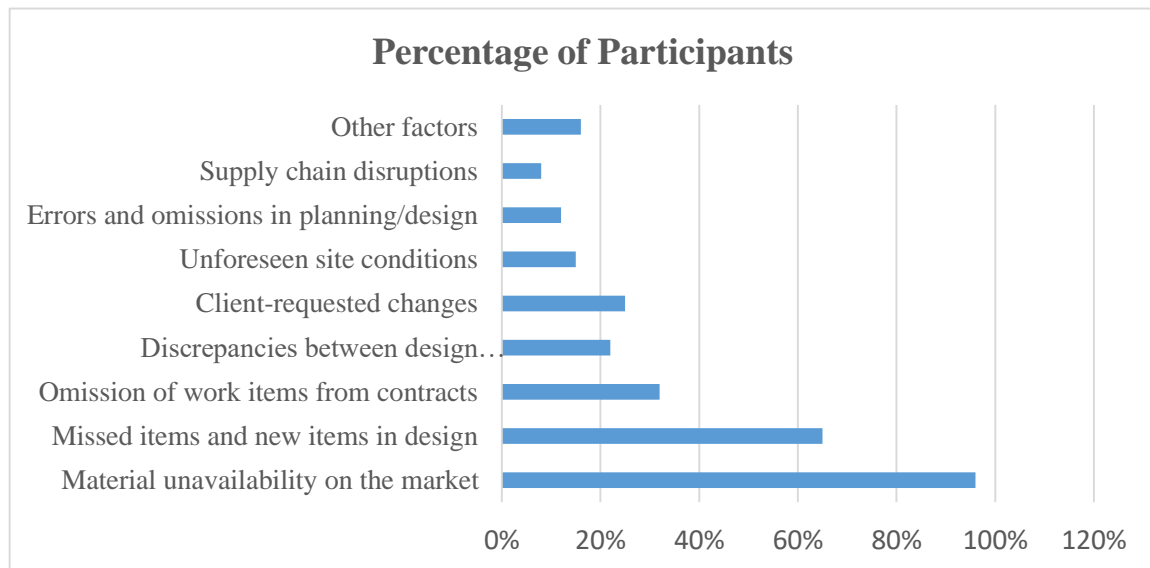


Figure 4 Participants response on the cause of variation on FHC projects

4.6 Sources of variation

According to 5% of the participants, which emphasize the interaction between project scope and budgetary constraints, financial constraints, specifically foreign currency shortages, are a significant driver for variation orders. Some work items, especially sanitary fixtures in the Bill of Quantities (BOQ), rely on the availability of foreign currency to purchase imported materials, equipment, or services. A shortage of foreign currency can

disrupt the planned procurement and implementation of the project. This shortage forces project managers to either delay procurement until funds are available or seek alternative solutions, such as substituting imported materials/equipment with locally available alternatives. These substitutions often require modifications to the original contract documents, leading to new items being added to the contract, thereby generating variation orders.

Furthermore, unanticipated inflation and a lack of available lines of credit (LC) for contractors to supply imported items specified in the contract documents were also found to be contributing factors to variation orders in Federal Housing Corporation (FHC) construction projects. Additionally, alterations to the design, specifications, and project scope; modifications resulting from client preferences; and increasing project requirements can lead to the need for variations.

Geotechnical reports are conducted during the project planning phase to assess the soil and ground conditions at the project site. When these reports reveal that the soil conditions differ from the original assumptions, it may necessitate modifications or changes to the planned construction or foundation work. For example, the soil may require additional excavation, stabilization, or reinforcement to support the proposed structures, leading to the need for variation orders.

Lastly, the instability of the country as a result of war, making it challenging to obtain materials from those war-torn areas of Ethiopia, adds to the complexity. The war-torn areas where materials are sourced become inaccessible or unsafe, making it difficult for the project team to obtain the necessary materials as originally planned. The instability and conflict in the region can disrupt transportation networks, supply chains, and the overall logistics of moving materials to the project sites.

A project manager among the participants further elaborates with this matter as *“The war and ongoing conflict has significantly disrupted the supply of critical construction materials in the affected regions of Ethiopia. This includes shortages of marble, cement, and granite - materials that are vital for the country's infrastructure development. As a result, the sources and availability of these raw materials have become highly variable across different parts of the country.*

The Kelem Wellega and Tigray regions have been the primary sources of high-quality marble in Ethiopia. However, the prevailing security challenges in these areas have introduced technical difficulties in extraction and processing. Firstly, on-site production is no longer feasible, as these materials require specialized processing facilities typically located in urban centers. The raw marble material from Wollega is processed and polished on Holleta area. The raw marble material from Adigrat is processed and polished on Adwa area, but the conflict has prevented the transportation of necessary machinery and equipment to these sites for continued raw material production. Even the existing stockpiles of processed marble products cannot be safely transported out of these conflict zones.

Consequently, the Federal Housing Corporation (FHC) has had to explore alternative material options, including the increased use of locally-produced ceramics and the importation of materials such as granite. Even Bahir Dar, which had its own reliable sources of granite, is now facing similar supply chain disruptions.

The delays and uncertainties caused by the conflict have had a cascading effect on construction projects. Project timelines have been extended, leading to cost overruns for contractors and additional expenses for the government. Factors such as the time value of

money, increased fuel and labor costs, overhead costs, and potential liquidated damages have all contributed to these cost escalations.

Similarly, the major cement production centers in Ethiopia have been significantly impacted. The Mesebo cement factory in Tigray, which had a production capacity of around 13 million metric tons and was the primary supplier for the country's construction needs, now only produces approximately 2.8 million metric tons per year, resulting in a severe shortage. Other cement factories have also been unable to maintain sufficient output levels, leading to a sharp rise in cement prices. This price increase is directly linked to the rising costs of raw materials, such as calcium carbonate, which is primarily sourced from the Ziway area, where transportation has been disrupted by the security situation.

The supply chain disruptions, with delays in material arrivals and the reduced operational capacity of factories, have forced cement producers to increasingly rely on imported raw materials. While the FHC has secured supply arrangements with companies like Dangote Cement, the demand from other construction firms has meant that the available supply cannot fully meet the country's requirements.

Gypsum, another essential construction material, is primarily sourced from the Amhara region (Abay area) and Tigray, as well as the Burayu area near Addis Ababa, which should be able to meet the overall demand. However, the security challenges in the Adama-Wolenchiti region have also impacted the availability of imported construction materials, as transportation from China takes 5-6 days, and any disruptions at the borders with Somalia and Afar can further disrupt the supply chain.

Delays in the delivery of one material can subsequently delay the progress of another preceding work, leading to overall project delays and cost escalations. E.g. the delay of

doorsill work also causes delays in aluminum/ wooden door work, delay of windowsill work also causes delays in aluminum window work since they can't be done parallel.

In summary, the ongoing conflict in Ethiopia has severely impacted the availability and supply of critical construction materials, creating significant challenges for the country's infrastructure development and necessitating the exploration of alternative sourcing options and material substitutions. The cascading effects of these disruptions have resulted in project delays, cost overruns, and additional financial burdens for both contractors and the government.”

Table 3 Participants response on the source of variation on FHC projects

Factors Contributing to Variation Orders	Details
Financial Constraints	Foreign currency shortages impact procurement of imported materials, equipment, or services.
	Shortages force delays in procurement or necessitate substitutions with local alternatives, leading to contract modifications.
Unanticipated Inflation	Rising costs can lead to adjustments in project budgets and scopes, contributing to variation orders.
Lack of Available Lines of Credit (LC)	Difficulty in securing credit affects contractors' ability to supply imported items as per contract specifications.
Design and Specification Changes	Client preferences and increasing project requirements may necessitate alterations, resulting in variation orders.
Geotechnical Report Findings	Discrepancies in soil conditions may require additional excavation or reinforcement, leading to modifications.
Instability Due to War	Conflict in regions affects material sourcing, disrupting supply chains and logistics, complicating project execution.

4.7 Implication of variation order

The detailed analysis of accounts from professionals at the Federal Housing Corporation of Ethiopia, insights into the frequency, common causes, legal implications, challenges, and risks associated with variation orders have emerged.

Among the common causes identified by FHC professionals, most of them highlighted several factors. Material unavailability, design changes, missed items, financial constraints, new technology integration, and pricing discrepancies were mentioned as the key triggers for variation orders. These factors underscore the complexity involved in project planning and execution and the importance of meticulous documentation and alignment in project management processes. In all these impacts of variation order no legal implications concerning regulatory compliance, disputes, and contractual obligations issues were reported in all the sites surveyed.

Almost all participants reported the main implications of the variation order on construction, which entails negative impacts. These impacts were identified as additional costs and time delays.

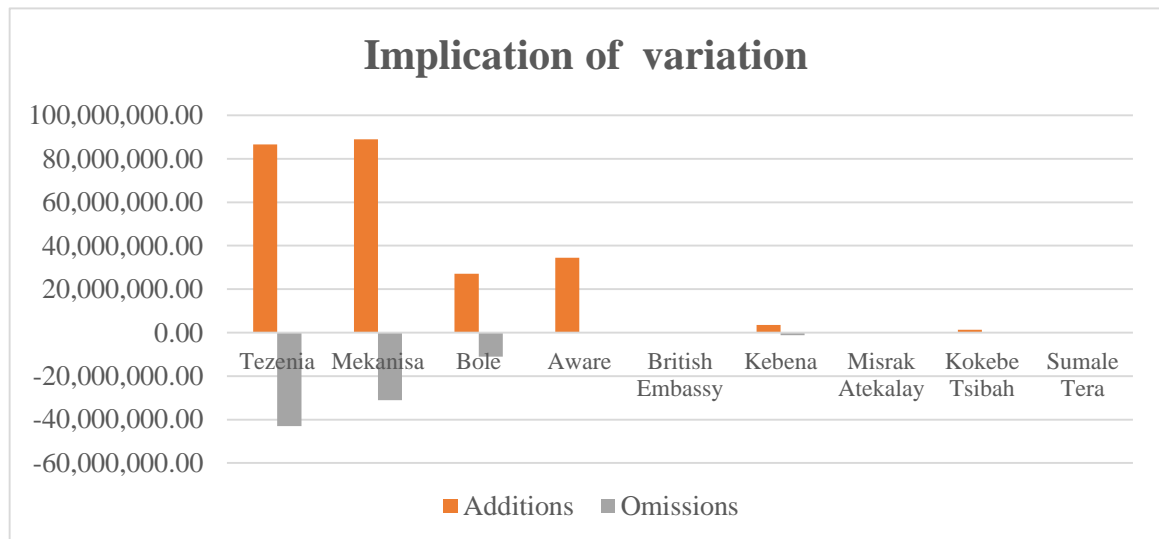


Figure 5 Cost Implication of variation on FHC projects by Addition and Omission

Table 4 Cost implication of variation on each project

Lot	Project	Contract Amount (ETB)	Addition (ETB)	Addition (%)	Omission (ETB)	Omission (%)	Net Variation Amount (ETB)	Net (%)
1	Tezenia	353,723,090.66	86,547,525.29	24.47	43,080,943.65	12.18	43,466,581.64	25.00
2	Mekanisa	351,082,658.58	96,478,595.53	27.48	31,107,004.50	8.86	65,371,591.03	18.62
3	Bole	217,733,344.46	29,548,613.88	13.57	11,106,599.60	5.10	18,442,014.28	8.47
4	Aware	169,914,387.78	35,888,504.16	21.12	1,378,892.00	0.81	34,509,612.16	20.31
5	British Embassy	473,889,277.99	The project was terminated due to performance and related issues and subsequently awarded to another contractor upon termination. As of the current date, the project remains stalled with no variation orders or progress.					
6	Kebena	251,214,192.22	38,863,000.83	15.47	1,180,872.00	0.47	37,682,128.83	15.00
7	Misrak-Atekalay	359,464,744.33	39,541,121.88	11.00	-	-	39,541,121.88	11.00
8	Kokebe-Tsibah	229,733,266.23	29,865,324.61	13.00	-	-	29,865,324.61	13.00
9	Sumale Tera	2,142,613,137.26	As of the data gathering time, this project has no variation orders.					
10	Gerji	3,066,405,712.50	Since this project is DB, the contract does not entertain Variation orders.					

Table 5 Time implication of variation on each project

Lot	Project	Contract Duration (days)	EOT due to variation (days)	EOT due to variation (%)
1	Tezenia	600	150	25.00%
2	Mekanisa	720	100	13.89%
3	Bole	600	150	25.00%
4	Aware	540	286	52.96%
5	British Embassy	600	-	-
6	Kebena	540	105	19.44%
7	Misrak-Atekalay	720	85	11.81%
8	Kokebe-Tsibah	540	180	33.33%
9	Sumale-Tera	900	-	-
10	Gerji Village	540	-	-

Additionally, the participants report highlights other implications of variation orders such as

- **Untimely completion of work;** Variation orders, changes or additions to the original project scope, can disrupt the project timeline and sequence. Introducing new or modified requirements through variation orders can delay completing the original work, requiring resource reallocation and plan adjustments. Delays caused by variation orders can extend the project timeline, leading to untimely project completion.
- **Subsequent rework leads to schedule delays;** Introducing a variation order in a project often leads to changes in scope, design, or specifications, requiring the team to revisit completed tasks. This can cause delays, disruptions, and resource diversions affecting the project timeline. Variation orders may result in extensive rework as the team needs to undo and redo parts of the work to align with new requirements, disrupting timelines and causing cascading delays in project completion.
- **Subsequent rework leads to quality standard difficulties;** Reworking a project due to changes can cause quality problems. Rushing through modifications can lead to lower quality because there's not enough time for testing. It can also disrupt the workflow, causing coordination issues and quality control gaps.

- **Miscommunication among stakeholders;** Miscommunication may arise due to new project requirements, leading to different interpretations and expectations among stakeholders. This can result in conflicts and disruptions in communication channels. Stakeholders need clear communication and coordination to avoid misalignment
- **Over budget;** when a variation order needs more materials or labor, the project's costs go up. For example, if the client asks for a design change that needs new materials, the contractor has to buy and use them, costing more money.

Despite the negative impacts and challenges posed by variation orders, they can also yield positive impacts on projects. Around 12% of the respondents identified them, they include opportunities for adopting new technologies, utilizing superior quality materials, enhancing future property value, rectifying design errors, implementing ambitious designs, lessons for next projects/ next phase, keeping client's preferences, improving safety measures, and facilitating dispute resolution.

4.8 Study of the project's variation orders

4.8.1 Lot 1/ Tezenia

In this narrative, the story of Variation Orders in the "Tezenia" project is demonstrated as follows:

Variation works were encountered in this project due to various causes. Changes were introduced through Variation Orders, resulting in modifications to the construction. These changes affected in addition of Concrete works, Thermal and Moisture Protection, Plumbing, Earthwork, Floor finishing, Guard rail, Duct cover, Aluminum ceiling, Signage board, Masonry work, Steel structure, Plastering work, Tiling, Painting, Sanitary installation, Electrical works, Aluminum works, and other additional miscellaneous works. Additionally, the variation orders led to the omission of certain items from the contract,

mostly by substituting the item/material with an equivalent or better quality. Items such as Thermal and Moisture Protection, Balustrades and Staircase Rails, plastering work, painting work, and sanitary installation were omitted.

As a result of these Variation Orders, an additional amount of 86,547,525.29 Birr was added, which accounts for 24.47% of the contract amount. Simultaneously, an amount of 43,080,943.65 Birr was omitted, representing 12.18% of the contract amount. Consequently, the net addition amount is 43,466,581.64 Birr, equivalent to 12.29% of the total contract amount. Furthermore, these Variation Orders led to an extension of time to accommodate the additional scope. A total of 150 days of Extension of Time was granted for this project, extending the contract duration by 25% of the original contract days.

4.8.2 Lot 2/ Mekanisa

Variation works were encountered in this project due to various causes. Changes were introduced through Variation Orders, resulting in modifications to the construction. These changes affected in addition of Concrete works, Thermal and Moisture Protection, Plumbing, Earthwork, Floor finishing, Guard rail, Duct cover, Aluminum ceiling, Signage board, Greenery, Checkered tiles, Fence work, Steel structure, Painting, Sanitary installation, Electrical installation works, Glass Reinforced Plastic/GRP foundation, Floor finishing and wall finishing works. Additionally, the variation orders led to the omission of certain items from the contract, mostly by substituting the item/material with an equivalent or better quality. Items such as Thermal and Moisture Protection, Plumbing, Earthwork, Tiling, Balustrades and Staircase Rails, painting work, electrical installation, and sanitary installation were omitted.

As a result of these Variation Orders, an additional amount of 96,478,595.53 Birr was added, which accounts for 27.48% of the contract amount. Simultaneously, an amount of

31,107,004.50 Birr was omitted, representing 8.86% of the contract amount. Consequently, the net addition amount is 65,371,591.03 Birr, equivalent to 18.62% of the total contract amount. Furthermore, these Variation Orders led to an extension of time to accommodate the additional scope. A total of 100 days of Extension of Time was granted for this project, extending the contract duration by 13.89% of the original contract days.

4.8.3 Lot 3/ Bole

Variation works were encountered in this project due to various causes. Changes were introduced through Variation Orders, resulting in modifications to the construction. These changes affected in addition of Concrete works, Thermal and Moisture Protection, Plumbing, Floor finishing, Guard rail, Duct cover, Signage board, Greenery, Fence work, Masonry work, Steel structure, Plastering work, Tiling, Painting, Sanitary installation, Electrical works, floor finishing and wall finishing works. Additionally, the variation orders led to the omission of certain items from the contract, mostly by substituting the item/material with an equivalent or better quality. Items such as Thermal and Moisture Protection, Balustrades and Staircase Rails, Tilling, plastering work, sanitary installation, and Metalwork and finishing works were omitted.

As a result of these Variation Orders, an additional amount of 29,548,613.88 Birr was added, which accounts for 13.57% of the contract amount. Simultaneously, an amount of 11,106,599.60 Birr was omitted, representing 5.10% of the contract amount. Consequently, the net addition amount is 18,442,014.28 Birr, equivalent to 8.47% of the total contract amount. Furthermore, these Variation Orders led to an extension of time to accommodate the additional scope. A total of 150 days of Extension of Time was granted for this project, extending the contract duration by 25% of the original contract days.

4.8.4 Lot 4/ Aware

Variation works were encountered in this project due to various causes. Changes were introduced through Variation Orders, resulting in modifications to the construction. These changes affected in addition of Broom brushing finished pigmented reinforced concrete, Contextra external painting work, Final coat Gypsum plastering, Basement main gate, Passenger Lift steel structure support work, Sanitary works (PPR and UPVC pipes), Fence Demolishing work, Galvanized steel fittings/Reducers, Design, supply, & installation of Signage board, Greenery works, Finishing and Septic Tank. Additionally, the variation orders led to the omission of certain items from the contract, mostly by substituting the item/material with an equivalent or better quality. Items such as Balustrades and Staircase Rails were omitted.

As a result of these Variation Orders, an additional amount of 35,888,504.16 Birr was added, which accounts for 21.12% of the contract amount. Simultaneously, an amount of 1,378,892.00 Birr was omitted, representing 0.81% of the contract amount. Consequently, the net addition amount is 34,509,612.16 Birr, equivalent to 20.31% of the total contract amount. Furthermore, these Variation Orders led to an extension of time to accommodate the additional scope. A total of 286 days of Extension of Time was granted for this project, extending the contract duration by 52.96% of the original contract days.

4.8.5 Lot 5/ British Embassy

The project was terminated due to performance and related issues and subsequently awarded to another contractor upon termination. As of the current date, the project remains stalled with no variation orders or progress.

4.8.6 Lot 6/ Kebena

Variation works were encountered in this project due to various causes. Changes were introduced through Variation Orders, resulting in modifications to the construction. These changes affected in addition of Concrete works, Thermal and Moisture Protection, Plumbing, Floor finishing, Guard rail, Masonry work, Steel structure, Plastering work, Tiling, Painting, Sanitary installation, and Electrical works. Additionally, the variation orders led to the omission of certain items from the contract, mostly by substituting the item/material with an equivalent or better quality. Items such as Thermal and Moisture Protection, Balustrades and Staircase Rails, plastering work, painting work, and sanitary installation were omitted.

As a result of these Variation Orders, an additional amount of 38,863,000.83 Birr was added, which accounts for 15.47% of the contract amount. Simultaneously, an amount of 1,180,872.00 Birr was omitted, representing 0.47% of the contract amount. Consequently, the net addition amount is 37,682,128.83 Birr, equivalent to 15.00% of the total contract amount. Furthermore, these Variation Orders led to an extension of time to accommodate the additional scope. A total of 105 days of Extension of Time was granted for this project, extending the contract duration by 19.44% of the original contract days.

4.8.7 Lot 7/ Misrak Atekalay

Variation works were encountered in this project due to various causes. Changes were introduced through Variation Orders, resulting in modifications to the construction. These changes affected in addition of Concrete works, Thermal and Moisture Protection, Plumbing, Floor finishing, Guard rail, Duct cover, Aluminum ceiling, Signage board, Masonry work, Steel structure, Plastering work, Tiling, Painting, Sanitary installation, Electrical works, Aluminum works, and other additional miscellaneous works.

As a result of these Variation Orders the net addition amount is 39,541,121.88 Birr, equivalent to 11.00% of the total contract amount. Furthermore, these Variation Orders led to an extension of time to accommodate the additional scope. A total of 85 days of Extension of Time was granted for this project, extending the contract duration by 11.81% of the original contract days.

4.8.8 Lot 8/ Kokebe Tsibah

Variation works were encountered in this project due to various causes. Changes were introduced through Variation Orders, resulting in modifications to the construction. These changes affected in addition of Concrete works, Thermal and Moisture Protection, Plumbing, Floor finishing, Guard rail, Duct cover, Aluminum ceiling, Signage board, Masonry work, Steel structure, Plastering work, Tiling, Painting, Sanitary installation, Electrical works, and Aluminum works.

As a result of these Variation Orders, the net addition amount is 29,865,324.61 Birr, equivalent to 13.00% of the total contract amount. Furthermore, these Variation Orders led to an extension of time to accommodate the additional scope. A total of 180 days of Extension of Time was granted for this project, extending the contract duration by 33.33% of the original contract days.

4.8.9 Lot 9/ Sumale Tera

As of the current date, the project has no variation orders.

4.8.10 Lot 10/ Gerji

Since this project is DB, the contract does not entertain Variation orders.

4.9 Overview of Variation Handling Process

Variation handling is conducted by below mentioned procedures. This process ensures that any deviations from the original plan are controlled and documented properly.

4.9.1 Identification of Need for Change:

Changes can be identified by project managers, architects, engineers, or clients. Once a need for a change is identified, it is assessed for its impact on project objectives, costs, and timeline.

4.9.2 Evaluation and Approval:

The proposed variations undergo cost-benefit analysis, feasibility studies, and impact assessments. Key stakeholders, including clients, consultants, and contractors, review these changes to ensure that they are necessary and that they align with the project's goals.

4.9.3 Documentation:

Approved variations are documented thoroughly. This documentation includes updated drawings, revised specifications, and amended contracts. Proper documentation is crucial for clarity and legal compliance, and it provides a reference point for future audits or disputes.

4.9.4 Implementation:

Once documented and approved, the changes are implemented on the ground. This might require ordering new materials, rescheduling labor, and updating timelines. Effective project management is vital here to integrate changes without disrupting ongoing operations.

4.9.5 Monitoring and Control:

After implementation, the impact of these variations is monitored. Project managers ensure that the variations adhere to the new specifications and that they are completed within the newly agreed timelines and budgets. Regular progress reports and meetings help in keeping all stakeholders updated on the changes.

4.10 Administration of variation order

4.10.1 Current Administration Practices for Reviewing and Approving Variation Orders

4.10.1.1 Variation order management process

The management/ administrative process of variation orders and works in FHC's currently active projects steps are as follows: there are categorized common three types of variation work happened in the FHC's projects. 1st variation due to material unavailability on the market, 2nd variation occurred due to a new item/ scope change, and 3rd variation due to exceeding quantity. Each has its procedure and process from initiation to execution and payment stage.

- a. **Variation as a result of the unavailability of material in the market (New item):** - has been primarily observed in FHC projects due to the country's instability caused by war and related circumstances. For instance, the war has significantly impacted the common production area of marble, leading to a severe scarcity and lack of consistent marble available in the market. Consequently, contractors have been compelled to replace marble with granite and other equivalent materials. This material change necessitates the procurement of an equivalent or superior alternative, which can result in additional time and budgetary resources being expended. This necessitated a change in the item, requiring the procurement of an equivalent or superior material. The process of searching for such material incurs additional time and budgetary resources. The steps involved in managing this type of variation are as follows:
 - The identification of the material specified in the contract but not available in the market stock is carried out by the contractor. The need for a variation order is identified, either by the client or the consultant.
 - Subsequently, at least three "*out of stock Performa*" from reputable suppliers who are known to provide the unavailable materials are submitted by the contractor.

- The consultant then verifies the contractor's request and assesses the reliability of the market for these materials using their own professionals. Subsequently, the assigned project Resident Engineer (RE) prepares a variation order request in the site book. This request includes comprehensive details of the proposed changes, the reasons for the changes, and other necessary points.
- The contractor is requested by the consultant to submit an equivalent material to replace the unavailable item, along with a detailed cost breakdown document. The contractor then requests approval of the ordered variation work from the RE during daily site inspections. This request includes a Cost Breakdown Document (CBD) for the new items.
- Market research is conducted by the contractor, and an equivalent material is submitted for approval, accompanied by the cost breakdown document. The requested variation orders and CBD are analyzed by the consultant office, considering their alignment with the project timeline and budget.
- The newly submitted item is analyzed for material approval and cost breakdown document by the engineer, approving it if it meets the minimum desired requirements. The owner is notified of this approval. The Engineer/Consultant project team reviews the variation order request, evaluating its feasibility and necessity. The request is then submitted, along with the corresponding CBD, to the client for approval. If approved, the variation order is formally documented in an agreement that outlines the changes, cost implications, and timeline for completion. This agreement must be signed by both parties to ensure mutual agreement on the terms and conditions.
- The implementation, testing methods, and supervision of the new item are carried out in a manner similar to other main contractual works. Finally, monitoring and controlling of the changes continue to ensure their implementation as per the agreement. This includes tracking the progress of the changes, monitoring costs, and updating the project schedule.
- Upon completion of the new item work, payment aligned with IPC (Interim Payment Certificate) requests for the variation of the new item is requested by the contractor.

- The payment request is analyzed by the consultant and further approval is obtained from the client before effecting payment.
- b. **Variation due to scope/design change (New Item/ New methodology):** - occurs when the client does not accurately set preferences from the planning stage, experiences a change in preference (due to new technologies, qualities or ideas discovered in the industry), or when the design consultant overlooks items in the contract documents, such as design drawings or specifications. This leads to an increase in the cost and time required for the work. The steps involved in managing this type of variation are as follows:
 - The identification of the need for a variation order is done by either the client or the consultant.
 - A variation order request is prepared in the site book by the assigned project Resident Engineer (RE). This request includes details of the proposed changes, reasons for the changes, methodology changes, quality changes and other necessary points.
 - The contractor requests approval of the ordered variation work from the RE during daily site inspections. This request includes a Cost Breakdown Document (CBD) for the new items.
 - The requested variation orders and CBD are analyzed by the consultant office, considering their impact on the project timeline and budget.
 - The variation order request is reviewed by the Engineer/Consultant project team, evaluating its feasibility and necessity. It is then submitted, along with the corresponding CBD, to the client for approval.
 - If approved, the variation order is documented in a formal agreement that outlines the changes, cost implications, and timeline for completion. This agreement must be signed by both parties to ensure mutual agreement on the terms and conditions.
 - Monitoring and controlling the changes continue to ensure their implementation as per the agreement. This includes tracking progress, monitoring costs, and updating the project schedule.
 - Finally, payment for variation works is requested to be incorporated with interim payments. The consultant reviews the request according to the approved variation order (which is later included as part of the contract)

and other necessary documents. After final approval from the client, payment is made to the contractor.

- c. **Variation works due to exceeding quantity from contract:** - are caused when the BOQ in the contract document is underestimated, resulting in a difference in quantity when the actual work is completed. Such cases predominantly occur when the geotechnical soil report does not align with the actual ground condition and when the quantity surveyor underestimates the quantity in the contract BOQ. This leads to an increase in the volume of actual work required. Steps carried out by FHC projects to administer such case is under-described below.
- The as-built quantity of the actual work is checked by the contractor, who cross-checks it with the BOQ amount and requests a variation for the exceeding amount. The contractor verifies the actual quantity of work completed on-site align with the design, comparing it to the Bill of Quantities (BOQ) amount. If there is a discrepancy, the contractor requests a variation for the amount that exceeds the initially planned quantity. This process ensures that payments are based on the actual work done.
 - Subsequently, the assigned project Resident Engineer (RE) justify the exceeding quantity and other necessary points.
 - The contractor then requests approval of the extended quantity work from the RE during daily site inspections. This request includes a as built takeoff for the exceeding items.
 - The requested variation quantity is analyzed by the consultant office, considering their alignment with the project timeline and budget.
 - The Engineer/Consultant project team reviews the variation work and evaluate it. The request is then submitted to the client for approval.
 - Then the variation work is formally documented in an agreement that outlines the changes, cost implications, and timeline for completion. This agreement must be signed by both parties to ensure mutual agreement on the terms and conditions.
 - Finally, monitoring and controlling of the changes continue to ensure their implementation as per the agreement. This includes tracking the progress of the changes, monitoring costs, and updating the project schedule. The

administrative process of variation orders in construction projects is crucial to ensure that changes to the scope of work are managed effectively.

In each of the cases, the contractor requests an extension of time for works that require additional time. The consultant then analyzes the requested Extension of Time (EOT) and approves or rejects it using appropriate conditions. This analysis is done by referring to the contract documents, master schedule, work order, and other necessary documents. By following this process, proper documentation and approval of necessary extensions of time are ensured while maintaining control over project timelines and contractual obligations.

4.10.1.2 Review of variation order management process

Participants state that within the Federal Housing Corporation, a traditional management system is currently in place for reviewing and approving variation orders. The system is in place to have a structured approach to handling variations in construction projects, with the aim of maintaining project integrity and meeting client expectations. The practices embedded within this system are not designed to fully ensure that variation orders are thoroughly evaluated, approved, and implemented in a manner that minimizes disruptions and maximizes project efficiency. Adding that variation order initiation protocol is different for different cases and there is no defined policy on that.

4.11 Current project administrative practices used on reduction of the occurrence and negative impact of variation orders

In the Federal Housing Corporation's Mixed Use Apartment projects in Addis Ababa, the current administration has implemented with set of practices aimed at minimizing the occurrence and negative impacts of variation orders. These practices are designed to address potential changes and ensure project stability and efficiency.

4.11.1 Pre-Construction Planning and Design Reviews

While FHC has implemented design and specification reviews during the pre-construction phase, there is still room for improvement. Currently, the examination of design documents may not be as thorough as necessary, leading to incomplete or inaccurate designs. To better mitigate design-related variations, it is essential to enhance stakeholder engagement by involving architects, engineers, contractors, and clients more effectively during the planning and design phases. A more inclusive approach that actively gathers diverse inputs can help anticipate potential changes, creating a collaborative environment where issues are proactively addressed.

4.11.2 Robust Contract Documentation

Although FHC aims to create clear and detailed contract documentation, ambiguities still exist that can lead to misunderstandings or omissions. The current contracts may not always precisely define the scope of work and expectations, increasing the likelihood of variations. Furthermore, while Bills of Quantities (BOQs) are prepared, they may not always be based on comprehensive site investigations and design evaluations. Improving the accuracy of these documents is crucial to minimize discrepancies between planned and actual quantities, thereby reducing variation risks associated with inaccurate estimates.

4.11.3 Risk Management

FHC recognizes the importance of risk management but did not conducting early risk assessments consistently. As a result, potential uncertainties and risks were not identified and addressed proactively. Strengthening the development of mitigation strategies for these risks is vital to prevent them from evolving into significant changes during the project. A more systematic approach to risk management could significantly enhance the organization's ability to anticipate and manage variations.

4.11.4 Market Analysis and Material Procurement Strategies

Understanding the market and implementing effective material procurement strategies are crucial for minimizing variations related to material availability. While FHC understands the importance of market analysis and material procurement strategies, there are gaps in implementation that lead to variations related to material availability. Current market research efforts might not sufficiently assess material availability and pricing, particularly in unstable regions. Enhancing these strategies to better anticipate potential material

shortages and implementing more flexible procurement options could help the organization respond quickly to changes, minimizing delays and disruptions.

4.11.5 Change Control Procedures

FHC has a variation administration process, but the current protocols for submitting, reviewing, and approving variation requests may lack clarity and consistency. This can result in unnecessary changes being implemented without adequate justification. Regular site inspections, while conducted, might not be thorough enough to identify potential issues early on. Strengthening these procedures and ensuring timely interventions could prevent minor issues from escalating into significant variations.

4.11.6 Performance Monitoring and Evaluation

Continuous performance monitoring against the planned schedule and budget is a key practice for identifying variations early and taking corrective actions promptly. There are inconsistencies in identifying deviations early on FHC projects. A more robust reflective approach that captures lessons learned and integrates them into future projects can help reduce the recurrence of similar issues and foster a culture of continuous improvement.

4.11.7 Training and Capacity Building

Professional development programs for project managers and staff enhance their skills in project management, contract administration, and risk management. While FHC invests in training and capacity building, there may be gaps in the professional development programs offered to project managers and staff. Enhancing these programs to cover key areas such as project management, contract administration, and risk management more thoroughly could strengthen the organization's ability to handle variations. Additionally, fostering better knowledge sharing among project teams can promote the distribution of best practices and effective strategies for managing variations.

4.11.8 Adoption of New Project Delivery Methods

To further reduce the likelihood of variations, FHC is considering the adoption of new project delivery methods, such as the design-build approach. This method, where a single entity is responsible for both design and construction, reduces the likelihood of variations due to misalignment between design and construction teams, streamlining the project delivery process.

This table summarizes the current practices, their status, and recommended improvements for reducing variation orders in the Federal Housing Corporation's projects.

Table 6 The current practices, their status, and recommended improvements for reducing variation orders in the FHC projects

Practice	Current Status	Recommendations
Pre-Construction Planning	Design reviews are implemented but lack thoroughness.	Enhance stakeholder engagement and gather diverse inputs to anticipate potential changes.
Robust Contract Documentation	Ambiguities exist in contracts, leading to misunderstandings.	Improve clarity in scope and expectations; ensure BOQs are based on comprehensive evaluations.
Risk Management	Early risk assessments are inconsistent; potential risks are not proactively addressed.	Develop systematic mitigation strategies to manage risks before they evolve into significant changes.
Market Analysis and Procurement	Gaps in market analysis lead to material availability issues.	Enhance market research and implement flexible procurement strategies to anticipate shortages.
Change Control Procedures	Variation administration process lacks clarity; site inspections may not be thorough.	Strengthen protocols for variation requests and ensure timely interventions to prevent escalation.
Performance Monitoring	Inconsistencies in early deviation identification; need for a reflective approach.	Implement robust monitoring and integrate lessons learned into future projects for continuous improvement.
Training and Capacity Building	Gaps exist in professional development programs for staff.	Enhance training in key areas and promote knowledge sharing among project teams.
Adoption of New Delivery Methods	Considering new methods like design-build to reduce variations.	Implement design-build approach to align design and construction efforts more effectively.

4.12 Effectiveness of Reviewing and Approving Practices

Since the participants acknowledged the process to be time-consuming, reflecting the complexity and thoroughness required in evaluating variation requests, the current practices for reviewing and approving variation orders are generally perceived as good within FHC but not effective enough said by 78% of the respondents.

Three participants or 7.5% of the participants mentioned challenges include using premature management stage which can hinder effective collaboration and decision-making. Establishing and maintaining trust-based relationships require ongoing efforts to foster open communication, transparency, and mutual respect among project participants.

4.13 Best Practices for Managing Variation Orders and Their Sources

To enhance variation management practices within FHC, several respondents suggested best practices identified based on industry standards and organizational requirements. Approximately 32.5% of participants emphasized the importance of incorporating industry standards and organizational needs to improve variation management practices within the Federal Housing Corporation (FHC). They suggested that engaging all professionals in the planning phase is essential to ensure a comprehensive consideration of diverse perspectives and expertise, facilitating the identification of potential variations and the development of effective mitigation strategies.

In addition to these suggestions, it was proposed that the injection of loan finance could further strengthen variation management practices within FHC projects. By securing additional financial resources through loans or other financing mechanisms, FHC could better address variations without compromising project timelines or quality standards. This financial flexibility would enable FHC to adapt to unexpected changes or challenges more effectively, minimizing the impact of variations on project outcomes. Furthermore, it was recommended that clients (as a government side) provide foreign currency to mitigate the risks associated with currency or exchange rate fluctuations. By ensuring that project funds are denominated in stable or preferred currencies, clients can minimize the financial risks associated with variations in exchange rates, thereby enhancing project stability and predictability.

Additionally, clients should have contingencies in place to address unforeseen circumstances or changes in project requirements. By setting aside reserves or contingency funds, clients can mitigate the impact of variations on project budgets and timelines, ensuring that projects remain on track despite unexpected challenges or changes.

Some participants suggested that a thorough review of tender documents must be conducted to reduce variation orders. The specifications must be realistic, and the quantities must be accurate. This is crucial for minimizing variations during the construction phase. A client team review of tender documents enhances accuracy, completeness, and compliance with project requirements, thereby reducing the likelihood of variations.

Furthermore, approximately 10% of participants suggested that the design-build project delivery system is a best practice because it eliminates the grounds for variation orders. Additionally, around 7.5% of participants raised the concept of extending working hours, as they explained that the work culture regarding time management is poor.

4.14 Technology Usage to Manage Variation Orders

Incorporating technology into variation management processes is essential for modernizing practices, enhancing efficiency, and improving decision-making. Approximately 17.5% of participants stated that through the use of Building Information Modeling (BIM), stakeholders can minimize variations and related costs by evaluating design options, anticipating conflicts, and optimizing construction sequencing. Additionally, 5% of participants noted that the client team at FHC made efforts to schedule and visualize project components, allowing for the proactive identification and resolution

of any variations. However, due to a shortage of trained personnel, this was not done to the fullest extent possible.

Around 5% of participants mentioned that software tools such as Primavera and MS Project are employed for cost estimation, resource planning, and project scheduling. These tools provide comprehensive insights into project timelines, resource allocations, and budgetary requirements, enabling informed decision-making and efficient variation management. Excel is also utilized for cost estimation, leveraging a database of information to enhance accuracy and efficiency in variation management processes. By organizing project data, tracking cost fluctuations, and conducting scenario analyses, Excel enables stakeholders to assess the financial implications of variations and make informed decisions accordingly.

Furthermore, approximately 10% of participants reported that the utilization of modular aluminum formwork can significantly impact cost estimation and variation management. This innovative construction method offers numerous benefits, including reduced construction time, labor costs, and material wastage.

4.15 New Trends in the Administration of Variation Orders

Emerging trends in variation order management/ administration reflect a proactive approach towards embracing innovation, enhancing collaboration, and adapting to industry changes.

The use of modern technology, such as advanced project management software and digital collaboration platforms, streamlines variation management processes, enhances communication, and improves decision-making efficiency as stated by all participants.

One participant said provision of online courses for professionals facilitates continuous learning and skill development, enabling stakeholders to stay abreast of industry developments, best practices, and emerging trends in variation management.

Other professional mentioned that readiness to adapt to changes is crucial for effectively managing variations in dynamic construction environments. By embracing flexibility, agility, and innovation, FHC can navigate evolving challenges and capitalize on emerging opportunities to optimize variation management practices and achieve project success.

4.16 Summary of data analysis

The summarized findings are described below from the perspective of the respondents;

As a current administration practices, FHC operates within a traditional management framework, emphasizing established systems and procedures for overseeing variation orders. This approach underscores the importance of meticulous planning, stakeholder involvement, timely decision-making, and trust-building among project participants. Additionally, the integration of Building Information Modeling (BIM) technology serves as a progressive step towards reducing variations and enhancing project efficiency.

The involvement of key stakeholders, including the Client, Consultant, and Contractor, is central to managing variation orders effectively. Each stakeholder carries distinct responsibilities, such as early issue identification, collaboration, contract administration review, and accurate quantity determination. By delineating roles and fostering collaboration among stakeholders, FHC aims to streamline variation management processes and ensure project alignment with objectives.

When we come to effectiveness of variation management practices; while current practices are believed scarcely effective, they are also acknowledged to be time-consuming. Challenges such as trust issues among stakeholders and the procurement of trustworthy suppliers pose notable hurdles. Despite these challenges, the existing practices serve as a foundation for addressing variations and maintaining project integrity within FHC's construction projects.

To optimize variation order management, respondents emphasize several best practices. These include the involvement of all professionals in planning, collaboration between the client and stakeholders using DB project delivery system, and thorough review of tender documents. By adhering to these best practices, FHC aims to minimize variations, enhance project coordination, and mitigate associated risks.

The adoption of technology, particularly BIM for scheduling and software like Primavera and MS Project for cost estimation, underscores FHC's commitment to leveraging digital tools for efficient project management. By harnessing technological advancements, FHC aims to enhance decision-making, streamline processes, and improve project outcomes. FHC embraces emerging trends in variation order management, such as the adoption of modern technology and provision of online courses for professional development. This forward-thinking approach reflects FHC's readiness to adapt to industry changes, innovate, and enhance its competitive edge in the construction sector.

4.16.1 Desk study outcome

The demographic profile of interview participants at the Federal Housing Corporation of Ethiopia (FHC) indicates a diverse range of educational backgrounds, with many holding bachelors and master's degrees. This diversity enhances the knowledge base within the organization, as participants possess varying levels of experience, from four to twenty-five

years, and occupy multiple roles such as Resident Engineers, Project Managers, and Chief Contract Administrators. The geographical distribution of participants across several project sites emphasizes FHC's extensive efforts in addressing housing shortages and infrastructure development in Ethiopia.

In analyzing variation orders in FHC's construction projects, nearly 80% of professionals reported frequent occurrences of these orders, attributed to factors such as material unavailability, design changes, and client-requested modifications. While some participants noted fewer disruptions, the variability in experiences underscores the need for tailored project management strategies. The analysis of specific projects revealed significant variations in execution rates and contract amounts, with projects like Tezenia and Mekanisa experiencing notable additions and omissions, leading to extensions of time and increased costs.

The implications of variation orders include additional costs, delays, and potential quality issues stemming from rework and miscommunication among stakeholders. However, some professionals identified positive impacts, such as opportunities for adopting new technologies and improving safety measures. The administrative practices currently in place for managing variations at FHC involve structured processes for identifying, evaluating, and approving changes, but many participants noted that these practices are often time-consuming and not fully effective.

To enhance variation management, participants suggested best practices such as engaging all professionals during the planning phase, securing financial resources, and ensuring accurate tender documents. The adoption of technology, particularly Building Information Modeling (BIM), was also highlighted as a means to improve efficiency and decision-making in managing variation orders. Overall, the findings emphasize the importance of a

collaborative approach and systematic practices to effectively address variations in construction projects.

The charts in the document below outlines the process of variation orders in the construction industry. These three charts are divided into several sections, including the nature and types of variation orders, causes of variation orders, originators of variation orders, and implications of variation orders. The document also provides a detailed explanation of each section, which is summarized below.

Nature and Types of Variation Orders

The chart outlines the nature of variation orders, which can be either foreseeable or unforeseeable. Foreseeable variation orders are those that can be anticipated and planned for, such as design errors or inadequate specifications. Unforeseeable variation orders, on the other hand, are those that cannot be anticipated, such as unforeseen site conditions or changes in regulations.

The chart also outlines the types of variation orders, which include omission, addition, and alteration. Omission variation orders are those where work is omitted from the original scope of work, while addition variation orders are those where additional work is added to the original scope of work. Alteration variation orders are those where the scope of work is changed, such as a change in design or specifications.

Causes of Variation Orders

The chart outlines the causes of variation orders, which can be either internal or external. Internal causes include design errors, inadequate specifications, poor initial planning, and unclear project requirements and objectives. External causes include unforeseen site conditions, changes in client requirements, weather conditions, labor disputes, material shortages, and changes in regulations.

Originators of Variation Orders

The chart outlines the originators of variation orders, which can be the client, consultant, or contractor. The client may initiate a variation order due to a preference change, change of mind, unclear requirement, or approval delay. The consultant may initiate a variation order due to unqualified personnel, errors or omissions on design, education level, professional certificate, and years of experience, communication, or failure to identify potential issues. The contractor may initiate a variation order due to unqualified personnel, material shortage, labor dispute, equipment breakdown, experience level, technical capabilities, financial stability, communication, or prioritizing their interest.

Implications of Variation Orders

The chart outlines the implications of variation orders, which can include cost overruns, time overruns, material changes, quality changes, and disputes or claims.

Management of Variation Orders

The chart outlines the management of variation orders, which includes the application of change management, communication, documentation, risk assessment and mitigation, clear process of request, approval and implementation, accurate pricing, accurate records of request and approval, regular review of plan and schedules, identification of potential variations, and contingency.

The skills required for managing variation orders include project management, risk management, communication, problem solving, technical, and attention to detail. The strategies for minimizing variation orders include early identification to changes, clear scope definition, strong change management, effective risk management, and collaboration among stakeholders.

In summary, the chart in the document provides a comprehensive overview of the process of variation orders in the construction industry, highlighting the steps involved from initiation to final implementation. The third Figure below also outlines the causes, types, and implications of variation orders, as well as the skills required and strategies for minimizing variation orders.

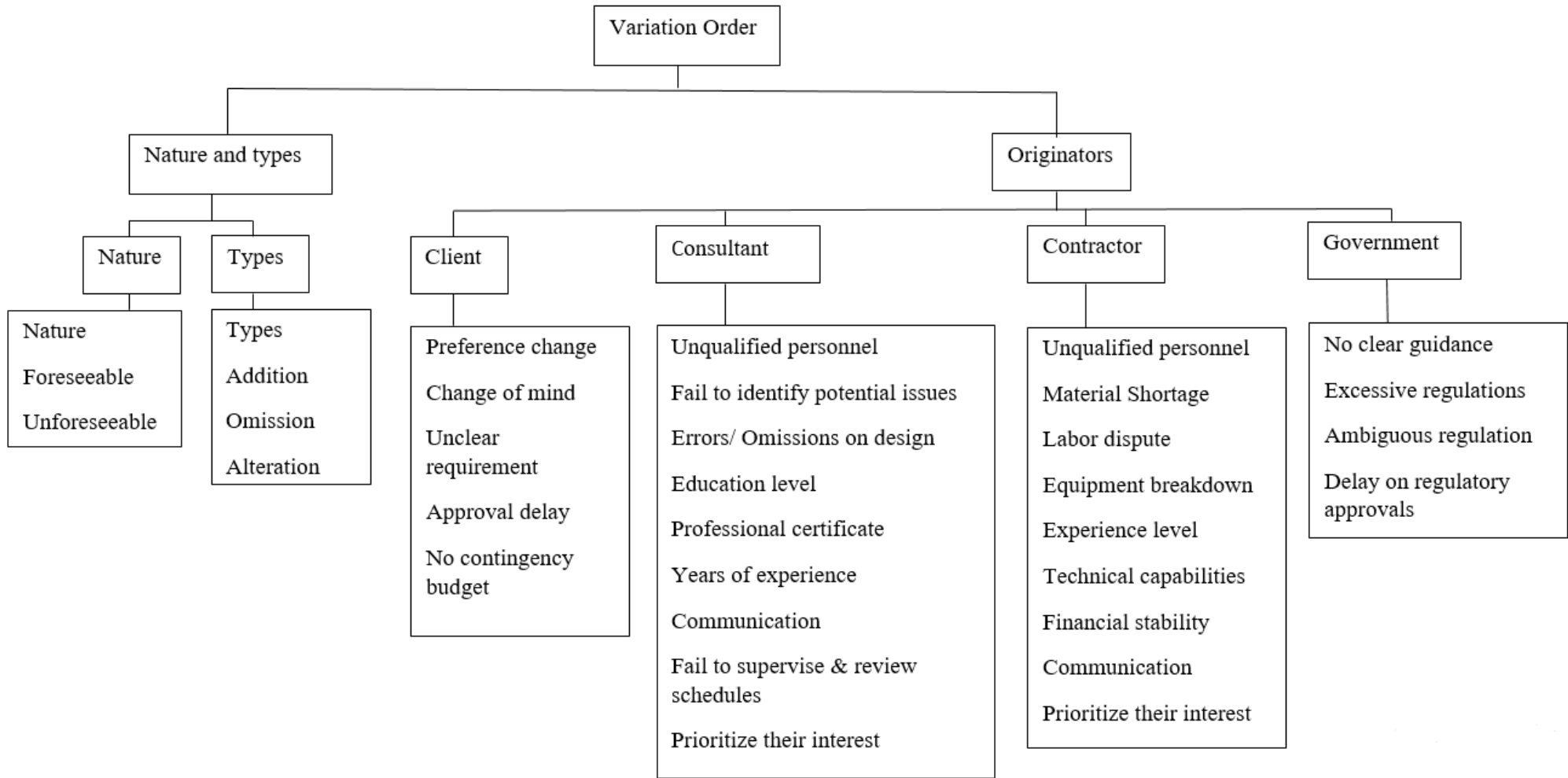


Figure 6 Illustrative chart 1 on the outcome of desk study

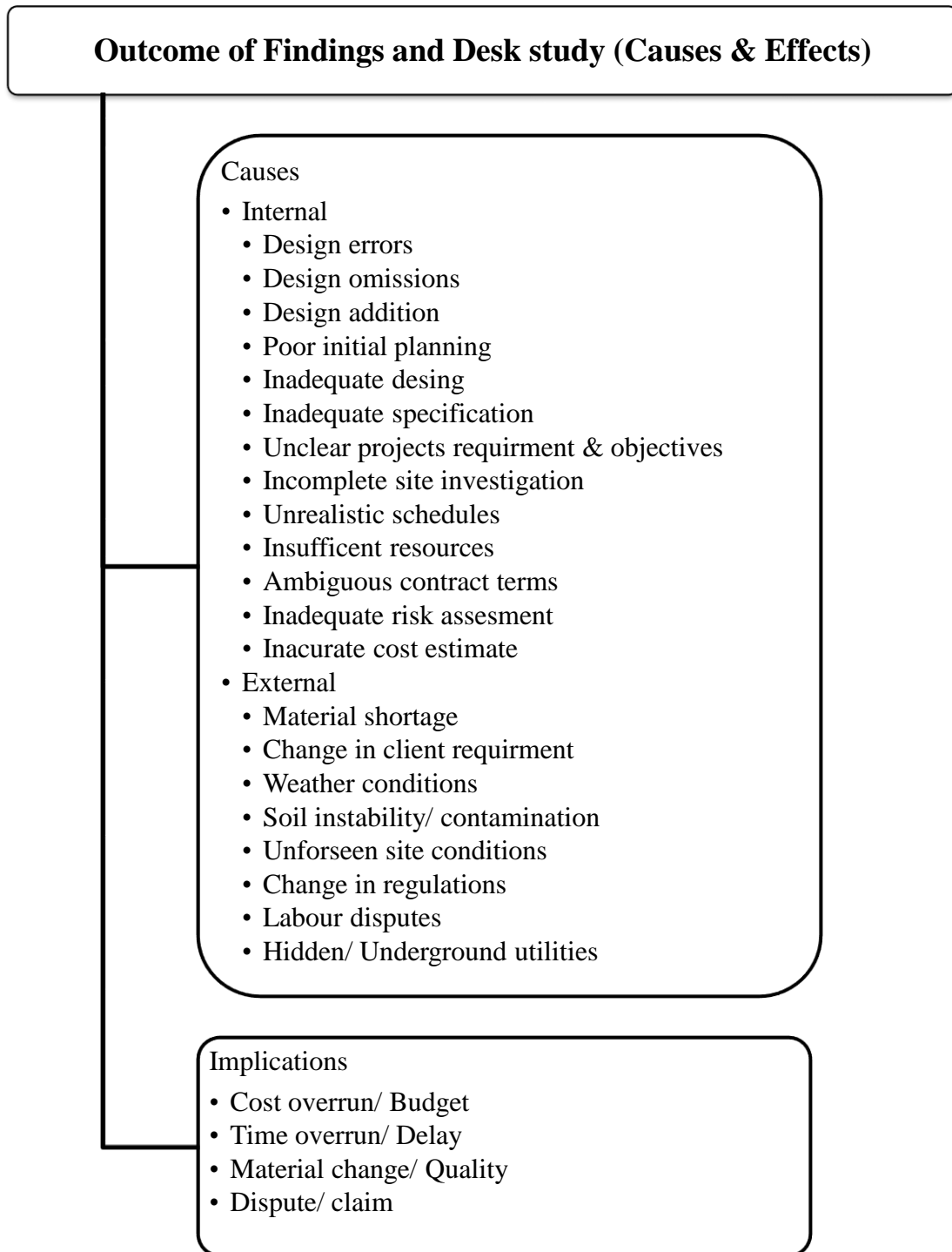


Figure 7 Illustrative chart 2 on the outcome of findings and desk study

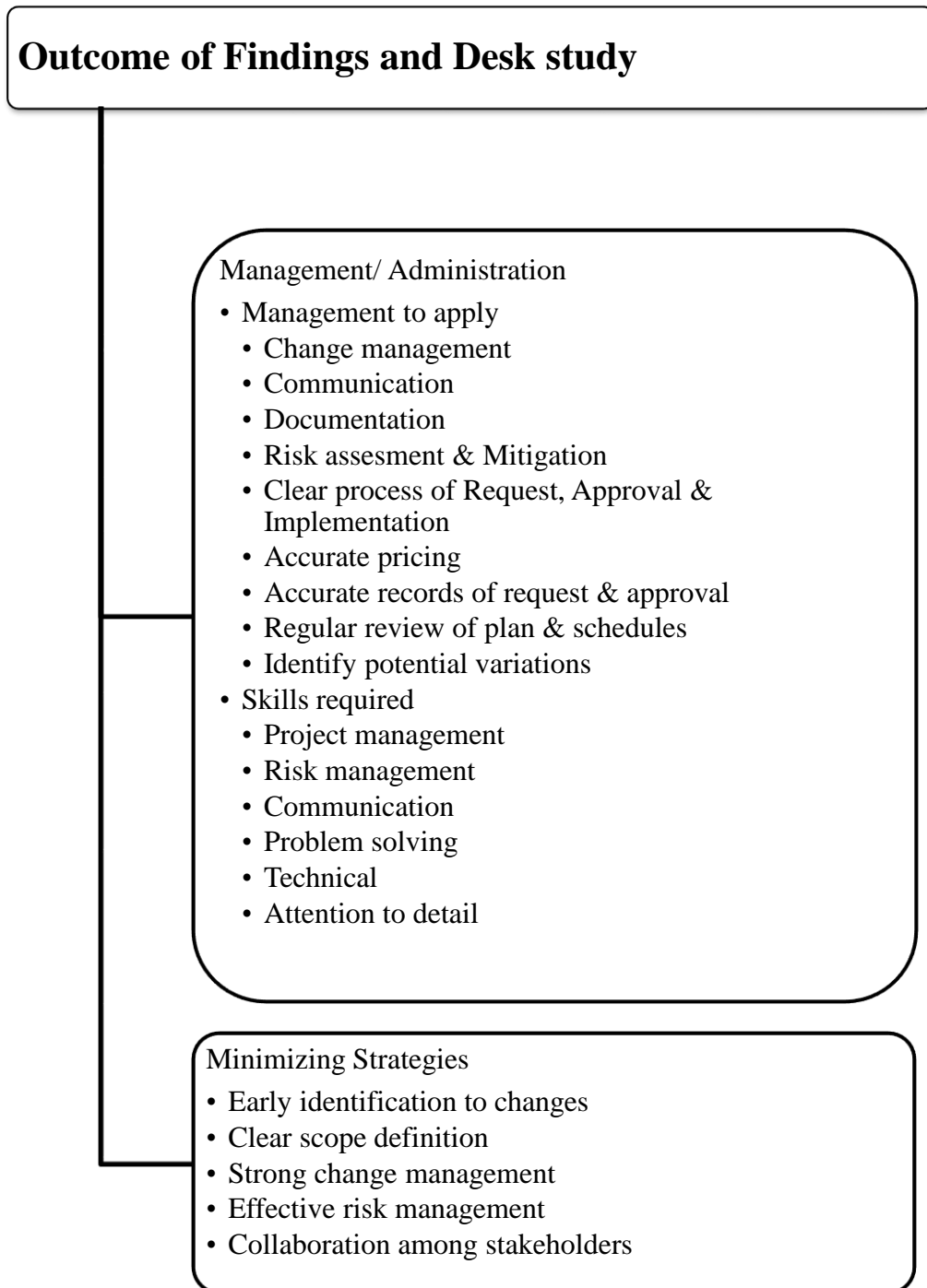


Figure 8 Illustrative chart 3 on the outcome of findings and desk study

4.17 Validation of findings with empirical studies

The key findings from this thesis, empirical study, and desk study on variation orders in the Federal Housing Corporation (FHC) mixed-use apartment projects, reveal several significant implications.

The validation of findings from this research on variation orders within the Federal Housing Corporation (FHC) is reinforced by several empirical studies conducted in the Ethiopian context. These studies highlight the prevalence of variation orders and their implications in construction projects, aligning with the insights gathered in this research.

A study by Andualem E. (2014) examined the causes of variation orders in five public building projects in Addis Ababa, Ethiopia. Key findings revealed that design changes initiated by clients were a primary factor, as modifications to the original design during construction necessitated variation orders. Additionally, unforeseen site conditions, particularly unexpected soil issues, were identified as significant contributors, mirroring findings in the FHC thesis. Incomplete or ambiguous specifications in initial project documents also led to variations for clarification during construction. Furthermore, delays in decision-making by clients or consultants regarding proposed changes exacerbated the occurrence of variation orders. These findings align with those discussed in the FHC case study, providing empirical support for the challenges associated with variation orders in construction. Overall, the case study underscores the importance of effective management of variation orders for project success.

Similarly, Haimanot (2021) focused on the relationship between variation orders and construction project performance, specifically analyzing road construction projects in Addis Ababa. The study revealed that variations often lead to significant delays and cost

overruns, corroborating the findings in this research regarding the detrimental effects of variation orders on project timelines and budgets.

Dejene (2020) assessed the causes and impacts of variation orders in public building construction projects within the Jimma Zone. The study identified similar triggers for variations, such as design changes, unforeseen site conditions, and client-requested modifications, which resonate with the findings of this research.

Furthermore, Tewodros (2015) investigated the causes and effects of variation orders in road construction projects administered by the Addis Ababa City Roads Authority, revealing that inadequate planning and poor design significantly contribute to the frequency of variations. This aligns with the current study's emphasis on the importance of robust pre-construction planning and comprehensive design reviews to minimize variations.

Lastly, Ayalew (2009) highlighted key challenges faced in federal road projects, including right-of-way issues and inadequate planning, which often result in variations. This reinforces the need for effective administrative practices to address these challenges as identified in this research.

Overall, the findings of this study are validated by existing literature, demonstrating a consistent pattern of challenges associated with variation orders in Ethiopian construction projects. By integrating insights from these empirical studies, the current research contributes to a more comprehensive understanding of the administrative practices necessary to mitigate the occurrence and impact of variation orders within the FHC's mixed-use apartment projects.

Chapter 5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The analysis of variation order administration within the Federal Housing Corporation (FHC) of Ethiopia reveals critical factors essential for managing the complexities of construction projects, particularly in mixed-use apartment initiatives. Variation orders, which include omissions, additions, and alterations, arise from both internal and external factors. Internal causes consist of inadequate planning, insufficient specifications, imprecise project needs, and design flaws, while external factors include material shortages, unforeseen site conditions, and changes in client specifications.

Variation orders are initiated by various stakeholders: clients may request changes due to shifting preferences or unclear project criteria; consultants may contribute through underqualified staff or poor communication; and contractors may face challenges from material shortages or prioritizing their interests. The impact of these variations is significant, often resulting in time claims, delays, and cost overruns.

The study indicates a high frequency of variation orders, with around 80% of participants reporting frequent occurrences. Major causes include material unavailability, design changes, and discrepancies in the Bill of Quantities (BOQ), highlighting the need for improved planning and communication among stakeholders. The implications of these variations are substantial, with some projects experiencing contract increases of over 25%, affecting both budgets and timelines.

Effective management of variation orders necessitates comprehensive strategies, including change management, transparent communication, thorough documentation, and proactive risk assessment. The findings underscore the importance of diverse skills such as project

management and problem-solving for successful variation handling. However, current administrative practices at FHC are inadequate, marked by unclear documentation, inconsistent risk assessments, and insufficient stakeholder engagement during planning.

Despite FHC's existing structure for managing variations, there is a need for enhanced efficiency and collaboration. Clients must set clear objectives and provide timely approvals, while consultants should focus on proactive planning and design reviews. Contractors need to prioritize project interests and adopt efficient methods to mitigate risks associated with negligence.

Best practices for improving variation administration include utilizing Building Information Modeling (BIM) and other technological tools to streamline processes and enhance communication. Engaging all stakeholders during the planning phase and maintaining clear communication are vital for reducing variation orders.

A multifaceted approach is essential to address the challenges of variation orders, combining improved administrative practices, stakeholder collaboration, and innovative technologies. By implementing these strategies, FHC can enhance its variation management capabilities, leading to better project outcomes and increased stakeholder satisfaction. The study emphasizes the importance of clearly defined roles and responsibilities, prompt decision-making, and trust-based relationships for effective management. Addressing the identified challenges and adopting the recommended strategies will enable FHC to optimize its practices and adapt to industry changes.

5.2 Recommendations

To enhance variation order administration practices on reducing the occurrence and impact within the Federal Housing Corporation of Ethiopia (FHC), the following recommendations are proposed:

Adopt Technological Solutions

Leverage modern technologies such as advanced project management software and Building Information Modeling (BIM) to streamline variation order processes. These tools can provide insights into project schedules and resource allocations, enabling informed decision-making and proactive identification of variations.

Boost Cooperation and Information Exchange

Foster an environment of open communication and trust among stakeholders clients, consultants, and contractors. Establish clear communication channels, hold regular meetings, and encourage information sharing to align project objectives and facilitate collective problem-solving.

Implement Robust Risk Assessment and Mitigation

Conduct thorough risk assessments during the planning phase to identify potential sources of variation. By addressing design flaws and insufficient specifications proactively, FHC can mitigate the impact of variations on project timelines and budgets.

Provide Continuous Professional Development

Invest in ongoing training for FHC personnel to equip them with the skills needed for effective variation order management. Training programs should cover problem-solving strategies, change management, and industry best practices.

Monitor and Evaluate Performance

Implement a performance monitoring system to evaluate the effectiveness of variation administration practices. Regular feedback loops should be established to identify areas for improvement.

Establish Strong Variation Order Protocols and Enhance Documentation Practices

Develop clear procedures for the initiation, evaluation, and approval of variation orders. This will promote consistency, transparency, and timely decision-making, reducing delays and enhancing project control. Develop standardized documentation procedures to ensure clarity and consistency in recording variation orders. This will help mitigate misunderstandings and provide a reliable reference for all parties involved.

Secure Adequate Financial Resources

Explore additional funding options, such as loans or emergency reserves, to provide FHC with the flexibility to address modification requests without compromising project schedules or quality.

Define Roles and Responsibilities:

Clearly outline the roles and responsibilities of clients, consultants, and contractors to promote accountability and facilitate prompt decision-making. Trust-based relationships among stakeholders should be encouraged to enhance collaboration.

Encourage Future Research

Future researchers should explore the following gaps:

- The impact of specific technological tools on variation management efficiency.
- Longitudinal studies analyzing the effects of improved stakeholder engagement on project outcomes.
- Comparative studies between organizations with different variation management practices to identify best practices.
- The role of organizational culture in facilitating or hindering effective variation management.

By addressing these recommendations and research gaps, FHC can significantly enhance its capacity to manage variation orders, leading to improved project outcomes and greater stakeholder satisfaction in future construction endeavors.

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APPENDIX A

Interview Questions

1. What is your role in this project, what years of experience, education level, and on which side are you working on FHC projects?
2. How often do variation orders occur in this project, and what types of variations are most common?
3. What are the primary causes of variation orders in this project, and what is their main source?
4. What are the current administration practices for reviewing and approving variation orders in this project? How effective are these reviewing and approving practices?
5. In your opinion, how did the administration reduce the occurrence and negative impacts? What are the roles and responsibilities of different stakeholders in managing variation orders in this project?
6. How do variation orders and works impact the project? What are the legal implications of variation orders in this project?
7. What are the common challenges in managing variation orders in this project?
8. What are the best practices for managing variation orders in this project, and what are their sources?
9. How can technology be used to manage variation orders in this project?
10. What potential risks were encountered associated with variation orders in this project, and how were they mitigated?
11. What new trends do you know in the management of variation orders in this project?
12. What recommendation would you give to project managers on how to effectively manage variation orders in this project?

APPENDIX B

Order #	Variation Types	Lots	1	2	3	4	5	6	7	8	9	
		Projects	Tezenia	Mekanisa	Bole	Aware	British Embassy	Keberna	Misrak Atekalay	Kokebe Tsibah	Sumale Tera	
Order #1	Addition Order #1											
	Concrete work	BIRR	112,465.09	370,452.56	204,345.00	3,355,943.67					99,974.91	
	Thermal and Moisture Protection	BIRR	3,532,714.82	5,550,939.86	2,900,505.79				3,099,493.29		1,193,211.08	
	Plumbing	BIRR	2,138,170.45	1,416,421.21	1,146,690.11	5,105,775.23			499,731.43			
	Earth work	BIRR	702,589.61	17,312,962.49								
	Summary of Addition 1		6,485,939.97	24,650,776.13	4,251,540.90	8,461,718.90	-	-	3,599,224.72	-	1,293,185.99	-
	Omission Order #1											
	Thermal and Moisture Protection	BIRR	962,302.50	1,086,750.00	2,589,672.00				1,180,872.00			
	Plumbing	BIRR		575,000.00								
	Earth work	BIRR		15325000								
Summary of Omission 1		962,302.50	17,186,750.00	2,589,672.00	-	-	-	1,180,872.00	-	-	-	

Order #	Variation Types	Lots	1	2	3	4	5	6	7	8	9	
		Projects	Tezenia	Mekanisa	Bole	Aware	British Embassy	Keberna	Misrak Atekalay	Kokebe Tsibah	Sumale Tera	
Order #2	Addition Order #2											
	Floor finishing	BIRR	12,530,431.74	7,728,089.00	249,777.00							
	Guard rail	BIRR	6,562,212.27	4,931,157.24	2,543,874.80							
	Duct cover	BIRR	2,589,719.37	7,387,230.78	3,109,147.91							
	Aluminium ceiling	BIRR	2,635,830.59	1,695,273.19								
	Signage board	BIRR	75,576.00	75,576.00	75,576.00							
	Greenery	BIRR		452,425.00	378,340.00							
	Checkered tiles	BIRR		548,760.00								
	Fence Work	BIRR		125,250.00	269,538.00	258,226.28						
	Summary of Addition 2		24,393,769.97	22,943,761.21	6,626,253.71	258,226.28	-	-	-	-	-	-
	Omission Order #2											
	Balustrades & Staircase Rails	BIRR	8,332,680.00	3,224,635.00								
	Tiling	BIRR		2,249,800.00	95,700.00							
	Summary of Omission 2		8,332,680.00	5,474,435.00	2,950,380.00	-	-	-	-	-	-	-

Order #	Variation Types	Lots	1	2	3	4	5	6	7	8	9	
		Projects	Tezenia	Mekanisa	Bole	Aware	British Embassy	Keberna	Misrak Atekalay	Kokebe Tsibah	Sumale Tera	
Order #3	Addition Order #3											
	Masonry work	BIRR	2,392,321.32									
	Steel Structure	BIRR	1,590,220.64	1,177,638.94	1,328,368.04	675,479.96						
	Plastering work	BIRR	17,771,103.49			773,300.38						
	Tiling	BIRR	2,868,404.92		2,509,169.14							
	Paint	BIRR	12,359,000.00	12,431,700.00		296,199.44						
	Sanitary Installation	BIRR	12,563,345.78	11,301,629.46	7,251,303.64							
	Additional Work	BIRR	3,592,311.19			112,959.00						
	Electrical Installation	BIRR	2,531,108.01	7,121,061.14	474,387.43							
	GRP Foundation	BIRR		475,115.00								
	Floor Finishing and wall finishing	BIRR		8,818,842.41	4,702,391.35							
	Summary of Addition 3		55,667,815.35	41,325,986.95	16,265,619.60	1,857,938.78	-	-	-	-	-	-
	Omission Order #3											
	Plastering work	BIRR	21,036,366.96									
	Paint	BIRR	492,602.24	3,560,000.00								
	Sanitary Installation	BIRR	4746003.95	4,482,474.50	1,865,570.00							
	Electrical Installation	BIRR		403,345.00								
	Metal Work	BIRR			2,735,590.00							
Finishing	BIRR			965,387.60								
Summary of Omission 3		26,274,973.15	8,445,819.50	5,566,547.60	-	-	-	-	-	-	-	
Todate Addition Amount		86,547,525.29	88,920,524.29	27,143,414.21	10,577,883.97	-	-	3,599,224.72	-	1,293,185.99	-	
Todate Omission Amount		35,569,955.65	31,107,004.50	11,106,599.60	-	-	-	1,180,872.00	-	-	-	
Net Addition Omission (Add-Omi)		50,977,569.64	57,813,519.79	16,036,814.61	10,577,883.97	-	-	2,418,352.72	-	1,293,185.99	-	