



ADDIS COLLEGE

SCHOOL OF GRADUATE STUDIES

**ASSESSMENT ON SAFETY MEASURE PRACTICES IN BUILDING
CONSTRUCTION PROJECTS, IN CASE OF BOLE INTERNATIONAL
AIRPORT TERMINAL EXPANSION PROJECT.**

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DECLARATION

I, SINDU ALEMANTE, declare that this research study titled "Assessment on safety measure practices in building construction projects, in case of Bole International Airport Terminal Expansion Project," is my original work, completed under the guidance of Mr Biruk Tibabu (PHD). All the information used in this paper has been properly acknowledged. I also confirm that this research study has not been submitted, in whole or in part, to any other higher education institution for the purpose of earning a Master's Degree in Project Management.

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Abstract

Many accidents and dangers can be seen in construction work. At the same time, as the construction industry grows, there has been an increase in serious injuries and deaths happening on job sites. Because of this, the purpose of this study is to check the safety steps used in construction projects at the Bole International Airport Terminal Expansion Project by looking at the methods that were actually used. The study wants to find out the most important safety steps, as well as the weaknesses and strengths in the system, and the key ideas that help in managing safety well. The research used both numbers-based and word-based surveys, and the main data came from questionnaires and site visits. In total, 70 questionnaires were sent out, and 67 were returned for analysis. The people who answered the questionnaires are from the Addis Ababa area, where the whole project is located. The data was looked at using Microsoft Excel 13 and SPSS 27, and the approach used was descriptive statistics. Overall, the study found that most contractors do not do a good job of following safety steps. According to the answers, the main reasons for accidents on construction sites are carelessness or not knowing the rules, and not using proper safety equipment.

Keywords: Safety measures, hazards, and injuries, construction sites

Acronyms and Abbreviations

OSHAAct	Occupational Safety and Health Act
OHS	Occupational Health and Safety
ILO	International Labor Organization
WHO	World Health Organization
PPE	Personal Protective Equipment
SMS	Safety Management Systems
ISO	International Organization for Standardization
SWMS	Safe Work Method Statements
PFAS	Personal Fall Arrest Systems
GFCIs	Ground Fault Circuit Interrupters
SDS	Safety Data Sheets
BIM	Building Information Modeling
AI	Artificial Intelligence
ML	Machine Learning
EAPs	Employee Assistance Programs
VR	Virtual Reality
AR	Augmented Reality
MNMs	Manufactured nanomaterials
TWH	Total Worker Health
UAVs	Unmanned Aerial Vehicles
BBS	Behavior-Based Safety
DfS	Design for Safety

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The construction industry is very important in both developed and developing countries, helping the economy grow and develop. It's not just about the buildings that get built; it also creates a lot of jobs, both directly and indirectly, and affects the economy at the local and national levels (Wibowo, 2009). In many countries, construction-related activities make up a big part of the economy, usually between 6% and 10% of GDP, according to the Global Powers of Construction 2020 report. The building industry in Ethiopia is a key part of the country's economy and plays an important role in its development. A 2020 thesis by Esayas Demissie Gudeta from St. Mary's University says that the construction sector is a major part of Ethiopia's development plan, supported by steady government investments in energy, roads, and railroads. According to Construct Africa's 2020 market report, Ethiopia's construction industry is worth over US\$7 billion, showing how important it is for meeting the country's needs in housing, transportation, and utilities. In other sectors like manufacturing, agriculture, and services, the construction industry also helps improve productivity. In many emerging economies, construction has grown faster than GDP and population, showing how it helps drive broader economic changes. Ethiopia has a strong history of architectural achievements, seen in places like the ruins of Queen Sheba's palace in Yeha, the Axum obelisks, Lalibela's rock-hewn churches, and the castles of Gondar. As modern civilization started in the late 19th and early 20th centuries, more developments took place. Even though the construction industry in Ethiopia is still relatively new, it is crucial for the country's progress. Today, both public and private groups are working on big projects like the Grand Ethiopian Renaissance Dam, various hydroelectric and irrigation dams, sugar factories, large university campuses, housing developments, and high-rise buildings. However, despite all these efforts, the industry still doesn't meet the quality, performance, safety, and health standards that are expected internationally (MoWUD, 2006). There are still many challenges in areas like construction methods, project management, financing, scheduling, and following safety and health rules. Environmental issues are also a big concern, as construction can cause a lot of damage to the environment (Hendrickson & Horvath, 2000). Workers in the construction industry face many dangers, such as working at height, in tight or underground spaces, and near falling objects. Other risks include

lifting heavy materials, exposure to harmful substances, loud noises, dust, machinery, fire, and electrical hazards. This study will look closely at current safety practices, find out the main problems, and suggest practical ways to improve safety management in future big construction projects.

1.2 Statement of the Problem

Construction projects, especially big ones like expanding the Bole International Airport terminal, can be very dangerous for workers because of the risks involved in building. Keeping workers safe is really important, not just for them but also for making sure the project finishes on time and without problems. Earlier research has shown that good safety management is key in construction. Udo et al. (2016) found that not following safety rules and not knowing enough about safety were big reasons why there are so many accidents in Nigeria's construction industry. Manu et al. (2018) also noticed that things like not getting enough training, not enforcing safety rules properly, and not having enough safety tools make it hard to keep workers safe in construction projects in Ghana. In countries like Ethiopia, it's usually hard to put strong safety practices in place because of things like not having enough money, poor training, weak enforcement of safety rules, and attitudes that don't value safety enough. The Bole International Airport terminal expansion is a big project, so it's probably going to have similar challenges when trying to keep workers safe. That's why this study looks at the safety practices used in the Bole International Airport terminal expansion, finds out what the main problems are, and gives advice on how to improve safety management for big construction projects in the future.

1.3 Research Questions

1. What were the key safety measures and protocols implemented in the Bole International Airport terminal expansion construction project?
2. How effective were the implemented safety measures in ensuring the health and well-being of construction workers on the Bole International Airport terminal expansion project?
3. What are the challenges faced in the effective implementation of safety practices in the Bole International Airport terminal expansion construction project?
4. What recommendations can be provided to enhance the safety management system for similar large-scale construction projects in the future?

1.4 Objective of the Study

1.4.1 General objective

The general objective of this research is to assess the safety measures practices employed in the building construction project of the Bole International Airport terminal expansion.

1.4.2 The specific objectives

1. To identify the key safety measures and protocols implemented in the Bole International Airport terminal expansion construction project.
2. To evaluate the effectiveness of the safety measures in ensuring the health and well-being of construction workers.
3. To analyze the challenges and barriers faced in the effective implementation of safety practices in the construction project.
4. To forward intervention or technique to enhance the safety management system for similar large-scale construction projects in the future.

1.5 Scope of the Study

The scope of this research study is focused on the assessment of safety measures practices in the Bole International Airport terminal expansion construction project in Addis Ababa, Ethiopia. The study will have the following boundaries:

- 1. Thematic Scope:** The research would concentrate on the assessment of safety measure practices, including the identification of key safety measures, evaluation of their effectiveness, and analysis of the challenges in implementation. It will not delve into other aspects of the construction project, such as project management, cost, or schedule performance.
- 2. Geographical Scope:** The research would conduct within the confines of the Bole International Airport terminal expansion construction site in Addis Ababa, Ethiopia. It will not include other construction projects or sites outside of this specific location.
- 3. Temporal Scope:** This study focuses exclusively on the year 2025, assessment of safety measure practices, including the identification of key safety measures, evaluation of their effectiveness, and analysis of the challenges in implementation from that year.

By clearly defining the thematic boundaries, the geographical and temporal scope of this study will ensure a focused and in-depth assessment of the safety measure practices in the Bole International Airport terminal expansion construction project, which can provide valuable insights and recommendations for similar large-scale construction projects in the future.

1.6 Limitations of the study

The paper was completed while balancing other personal and social responsibilities. So, time constraint was a restraining factor; the study only tries to address the assessment of safety measure practices in the Bole International Airport terminal expansion construction project in Addis Ababa, Ethiopia.

During data collection, even if there were grade 1 contractors working in Addis Ababa, most of them were not active, and the rest, who were active, were closed due to material shortage and price escalation. Therefore, to resolve this limitation, the researcher tried to take samples from different sites of the same construction companies.

1.7 Significance of the Study

This research on safety practices in the Bole International Airport terminal expansion project is very important for a few key reasons:

- **Protecting Workers:** The study will look at the safety steps taken during the project, helping find ways to improve them. This can make the work environment safer and better for everyone involved.
- **Helping the Project Succeed:** Good safety practices are essential for finishing a construction project on time and without issues. By looking at how safety is handled and solving any problems, this research can help make the airport expansion project more successful and set a good example for other big construction projects.
- **Guiding Policies and Rules:** The study's results can give government officials and those who set rules in Ethiopia a clearer picture of how safety is handled in construction. This could lead to better or stronger safety rules and laws to protect workers.
- **Contributing to Learning:** The research adds to what we know about safety in construction, especially in countries like Ethiopia that are still developing. This can help teachers,

researchers, and people working in the industry to improve how safety is managed in construction.

In the end, the study has the chance to make construction work safer, help projects go smoothly, and shape better safety laws and policies in Ethiopia's construction industry.

1.8 Organization of the Study

The paper is divided into five chapters. The first chapter is an introduction that begins with an explanation of the study's background and a description of the problem being studied. It also includes the research questions, the general and specific goals of the study, the significance of the research, the scope of the study, and its limitations. The second chapter reviews the related literature, covering both empirical and theoretical research. Chapter three explains the research methodology, including the overall research strategy, the design of the study, how the data will be analyzed, and how the research paper will be written. The fourth chapter presents the discussion and analysis, covering the findings related to the causes and effects of safety measures, and the rate of accidents at the Bole International Airport terminal expansion project. The final chapter summarizes the study, presents the conclusions, and offers recommendations. This can act as a guide for stakeholders in the construction industry.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

In this section, the researcher will present a review of related literature that focuses on safety measures. The researcher starts by going over the background and fundamentals of construction safety, as well as the significance of the topic and its implications for the building sector. The researchers look at the current state of construction safety and the procedures that are being used. In addition, there is information about construction safety and accidents in the construction industry. Other literature relevant to the topic and demonstrating empirical results is also evaluated and regarded as a source of evidence and for ensuring the accuracy of the research findings.

2.2 History of Safety

"We must seek to understand the hazard we encounter." This was possibly the first documented safety statement made by E. I. du Pont when he established the gunpowder factory in the United States of America in 1802. It had the first safety precautions that were taken into account during the building's design and construction (Klein, 2009). However, it was a one-time act by the employer, not a law or regulation.

From the beginning until 1916, every employment was governed by "common laws," which required individuals to be responsible for themselves and the hazards associated with their jobs. Workers' compensation laws were enacted by the government after 1916, requiring companies to be accountable for the safety and health of their employees. Employers were then compelled to supply and pay for medical care and lost earnings as a result of on-the-job accidents. Before being a duty, this is a moral responsibility (Reese, 2003). However, because the law requires employers to pay for injuries that occur on the job, it will be more cost-effective to prevent injuries from occurring in the first place. The first step in creating an organized industrial safety movement was to eliminate the hazards that were present in the workplace. The death rate fell dramatically during the first twenty (20) years of the safety movement (Petersen, 1971). The Occupational Safety and Health Act (OSHAct) went into force in April 1971, affecting about five million enterprises and sixty million people in the United States (Hammer & Price, 2000).

The safety, health, and well-being of workers are protected at work by occupational health and safety (OHS). A common definition of occupational health has been agreed upon by the International Labor Organization (ILO) and the World Health Organization (WHO). The definition reads:

“Occupational health should aim to promote and maintain the highest level of physical, mental, and social well-being for workers in all occupations; to prevent workers from becoming ill as a result of their working conditions; to protect workers in their employment from risks resulting from factors that are harmful to their health; and to place and keep workers in an occupational environment that is suited to their physical abilities.”, (Guidotti, 2011).

2.2.1 Safety, Safety Management, and Accident

Safety is the condition of being protected from any kind of incident or accident that people would see as harmful. This is achieved by managing dangers so that the level of risk is acceptable. According to Mwombeki (2005), an accident is an unexpected and unplanned event that might lead to injury, property damage, or loss of life. Safety involves dealing with outside dangers and the feeling that you are safe from these threats. The Business Dictionary says safety is a state where people feel relatively safe from harm, injury, or loss, whether the danger comes from intention or accident. Lingard (2005) describes safety as the absence of danger, a condition of being protected, and a state without risk. In construction project management, it is well known that each construction project is different. Because of this, the number of incidents can vary from one project to another, meaning some construction sites may be more dangerous than others (Zekri, 2013). Also, the workplace environment is always changing, and the types of dangers present can change regularly (Jannadi & Bu-Khamsin, 2002). Safety on a construction site means making sure that no one involved in building activities gets hurt or injured. It also means taking steps to protect workers from serious injuries or death. Pouliakas and Theodossiou (2010) point out that with the rise of competition in the globalized and modern world, the dominance of service industries, and the growing job insecurity in flexible labor markets, safety has become more important than ever. According to Zekri (2013), an accident is a sudden, unplanned, and unintentional event that can cause physical harm to people or property damage. In this study, the term "accident" refers to an incident that causes harm or damage to the body due to an exchange of mechanical, chemical, physical, or other environmental energy that exceeds the person's ability to handle.

2.3 Theoretical Review

2.3.1 General Principles of Safety

A wide range of arrangements, such as skills, knowledge, and analytical capacities, are necessary to manage and implement all of the major parts that make up national OHS systems so that both employees and the environment are protected. To keep up with technological and economic changes, measures and procedures for preventing, regulating, lowering, or eliminating occupational hazards and risks have been created and applied regularly over the years (Alli, 2008).

Occupational safety is a broad, multidisciplinary topic that typically includes medical and other scientific subjects, as well as engineering, legislation, technology, economics, and industry-specific concerns. Despite the multiplicity of occurrences, certain fundamental principles have been found (ILO, 2001).

Table 1:- General Principles of Safety from ILO

General Principles of Safety	
1)	Certain privileges are granted to all employees. Workers, corporations, and governments all have a role to play in ensuring that these rights are protected and that decent working conditions are encouraged.
2)	Occupational health and safety policies must be implemented. These rules must be implemented at the federal and state levels, as well as in the private sector. They must be notified to all or any relevant persons clearly and concisely.
3)	It is necessary to consult with social partners such as employers, workers, and other stakeholders. This could be done at all stages of policy development, implementation, and evaluation.
4)	Initiatives in occupational health and safety must emphasize prevention and protection. Workplace primary preventive actions must be prioritized. Workplaces and settings that are safe and healthy should be planned and developed.

5)	Information is critical for the development and implementation of effective programs and policies. Gathering and disseminating accurate information on hazardous substances, conducting workplace surveillance, and monitoring compliance with legislation and best practices are all crucial.
6)	Health promotion is the most important part of workplace health and safety practice. Employees' physical, mental, and social well-being should all be prioritized.
7)	Compensation, rehabilitation, and curative therapy must be offered to employees who suffer from job accidents, injuries, or diseases. Occupational hazards should be avoided to the greatest extent practicable.
8)	A safe and productive workplace relies heavily on education and training. Employees and employers must understand the importance of implementing safe working methods as well as how to do it.
9)	Employees, employers, and competent authorities all have responsibilities and obligations.
10)	Workers must follow prescribed procedures, corporations must provide a safe working environment, and authorities must provide health and safety policy advice, communication, and auditing.
11)	Policies must be enforced and an inspection mechanism must be in place to verify compliance with occupational health and safety policies.

Source: (ILO, 2001)

2.3.2 General Safety Rules for Construction.

Table 2: Summary of general safety rules recommended by ILO and OSH safety manuals.

NO	Safety rules
1)	Always keep materials in a safe place. To prevent heaps from toppling, rolling, or moving, secure or support them if necessary.

2.	Allowing shavings, dust fragments, oil, or grease to enter the system is not a good idea. Housekeeping will be required as part of the job. Garbage and garbage should be removed as soon as feasible.
3)	Any nails that have been utilized or removed from a Structure, as well as any Loose materials from stairwells, walkways, ramps, platforms, and other locations, should be removed or bent over.
4)	Use ramps, stairs, walkways, ladders, and other methods to avoid taking shortcuts. Aisles, traffic lanes, fire exits, gangways, and staircases should not be blocked.
5)	Standard guardrails must be provided in all floor holes, and excavations must be walled.
6)	Remove or destroy any warning banners or danger signs, as well as any protective equipment or practice supplied for your or other workers' use.
7)	To avoid injury to yourself / material damage, get help with weighty or bulky items or materials.
8)	Platforms, scaffolding, shaft openings, and other sharp edges should be kept away from all tools. And only use tools for the purpose for which they were created.
9)	Hand and power tools should be used carefully, and tools with split, broken, or loose handles should be avoided. Make certain you're using the appropriate tool for the job.
10)	In the event of a fire, know where to look for firefighting equipment and how to activate a fire alarm. Flammable liquids should only be used in small amounts on the job site and under the supervision of certified safety officers.
11)	Protection or shields must be provided before utilizing any power tool. Power tools and extension cords must be properly insulated and grounded. Damaged cords must be removed and replaced as soon as possible. If you haven't been trained how to use or approach a power tool or piece of equipment, don't use it.

Source: (ILO, 2001)

2.3.3 Construction Safety in Ethiopia

Construction safety in Ethiopia is a pressing concern, particularly within the construction industry, which is characterized by high rates of work-related injuries. A systematic review indicated a pooled prevalence of 46.78% for work-related injuries among construction workers, with significant factors including lack of safety training and personal protective equipment (PPE) usage (Ashuro et al., 2021). The situation is exacerbated by inadequate enforcement of safety regulations and the absence of clear health and safety policies in construction companies (Fekele et al., 2016).

Prevalence of Injuries

- The prevalence of injuries among construction workers in Addis Ababa was reported at 38.3% (Tadesse & Israel, 2016).
- The highest injury rates were observed in urban areas, such as Addis Ababa, highlighting regional disparities in safety practices (Ashuro et al., 2021).

Contributing Factors

- Major factors contributing to injuries include:
- Lack of occupational safety training (OR: 2.43) (Ashuro et al., 2021).
- Non-use of PPE (OR: 2.32) (Ashuro et al., 2021).
- Poor safety awareness among management (Fekele et al., 2016).

Recommendations for Improvement

- Implementing comprehensive safety training programs.
- Establishing clear health and safety policies for construction projects (Fekele et al., 2016).
- Enhancing enforcement of existing safety regulations (Yeniale, 2022).

Despite these challenges, some argue that the construction sector's economic contributions may overshadow safety concerns, leading to a culture of negligence regarding worker safety. This perspective highlights the need for a balanced approach that prioritizes both economic growth and worker protection.

2.3.4 Safety measures in Ethiopian construction

In countries that are not as developed, like Ethiopia, building projects need more workers than in wealthier places like the United States. Most of these workers are paid low wages and do not have special skills. There is not much difference in how safe large and small construction companies are in Ethiopia, and most of them do not have strong safety rules. (Adane et al., 2013) On the other hand, most contractors are mainly interested in making more money. Unsafe situations happen on both big and small construction sites, and workers face many dangers. In many places, there are no training programs for the workers, so new employees are not properly introduced to the job, risks are not known, and there are no safety meetings. Workers are expected to learn from what happens to them. Also, there is not enough medical care, poor working areas, and bad cleanliness. Workers are in danger while working, and the following problems are common:

1. There is not enough support or protection when digging deep pits.
2. Most laborers do the concrete work, and burns from cement are common because workers are not given proper safety gear, like gloves or boots.
3. Workers fall from high places because the scaffolding is not secure enough, and they don't have safety belts.
4. Workers suffer injuries to their heads, fingers, eyes, feet, and faces due to not having proper safety equipment. Construction workers in Ethiopia work in terrible conditions.

This is because there are few safety rules and poor relations between workers. Many dangers are present on construction sites because most safety measures are missing. Most hurt workers are not given proper compensation because there is a complicated system of work between the main builders and the smaller companies, making it hard to know who is responsible (Limenih, 2010)

2.3.5 Accidents in the Construction Industry

An accident is any action that could have been avoided by workers or a failure in machinery, tools, or other equipment that causes disruption in work and can lead to injuries or damage. In many places, construction projects are a big cause of workplace accidents.

The construction industry is known for being a high-risk workplace (Zekri, 2013). The nature of construction projects makes them dangerous. They take place in open spaces, are affected by weather,

involve many unskilled workers, often have tight schedules, and face worker turnover because of market issues. Workers also face risks like working at heights, in small spaces, and in environments that are both physically and mentally stressful (Imriyas et al., 2007). Common accidents in construction include falls from scaffolding, ladders, or working at heights. These might happen because of objects falling, working with equipment, tripping, or falling into holes or excavations. Other dangers include excavation collapses, injuries from hand tools, electrical shocks, explosions, exposure to harmful chemicals or drugs, lifting heavy materials, poor working conditions in small spaces, being hit by vehicles, and structural failures (Fasil, 2017).

Construction site falls include falls from scaffolding, from roofs, from flooring gaps, from cranes, from shafts, and from falling objects. Crane accidents can result in deaths due to lightning, high winds, crane breakdowns, or electrocution, which are common when working at heights.

Scaffolding is a temporary structure used to support workers and materials during building or maintenance work. About 65% of construction workers use scaffolding regularly. Scaffolding is an important part of the construction industry. Many people who have scaffolding accidents blame the problem on unstable planks or poor support, which leads to sliding or injuries from falling objects. Workers can be run over or injured by construction equipment. These incidents happen often because of the busy environment on construction sites. The danger is higher when heavy machinery is used on highways or near busy roads. Electrical accidents are a big problem on construction sites. Each year, around 350 construction workers die from electrical accidents, according to OSHA. These include electric shocks, contact with power lines, and steam accidents. Workers on scaffolding or cranes near electrical lines are especially at risk. Trenching is an important part of underground construction. A trench is a long, narrow hole that is deeper than it is wide. To keep workers safe when digging trenches, measures must be taken to prevent collapses or falls. Fires and explosions on construction sites kill over 200 people and injure more than 5,000 each year, according to OSHA. If a building or another structure collapses, it can no longer support its usual weight. This can cause serious damage and even death. These accidents can happen when safety is ignored for profit or when poor design leads to failure. Contractors and designers are responsible for their work. Research shows that the construction industry has more workplace accidents than other industries. The most common type of accident is falling from height, such as from roofs, scaffolding, or ladders. Many fall injuries involve heavy lifting and the use of tools. Construction requires a high level of safety, which is an important part of contracts

for those in charge and workers. Good safety programs help contractors find and manage risks before they cause incidents. These programs also help improve awareness, communication, record-keeping, and save costs. Worker turnover is common in the building and housing industries, leading to serious accidents. Both employers and workers need to work together to keep the workplace safe and prevent injuries and health issues. Employers are responsible for the whole work environment, but workers also have a role, such as following instructions and using the protective gear provided by the employer.

2.3.6 Factors Affecting Safety and Health Performance

An in-depth review of existing literature has been done to find out what factors influence safety measures in construction projects.

Project Cost: In the usual way that buildings are bought and paid for, professional fees are linked to the total cost of the project. Because of this, it makes sense to look into using different materials, techniques, and safety methods. However, under these standard ways of buying and making contracts, the time and money spent looking for alternatives might not be able to be recovered from the project owner (Zekri, 2013).

Safety and Health Policy: A policy is a type of belief or decision that guides an organization. It can be a series of actions or a decision that has been thought through carefully. Zekri (2013) identified several factors that affect the safety of construction sites. The findings show that factors from the organization's policies are the biggest category of influences on safety performance in the UK construction industry. Also, the study found that 69 percent of construction companies in the UAE did not fully understand the importance of having safety and health policies. Additionally, all small construction firms, and 80 percent of medium-sized ones, do not have a clear safety and health policy (Shibani et al., 2012). **Accidents / Incidents / Near Miss Report:** According to studies, managers in big companies can use accident and incident reports that are broken down by individual projects. This allows them to compare projects based on how often accidents happen or other measures of accident rates. This way, managers are always aware of where accidents are most common so they can direct their response efforts to the areas that need it most (Hassanein & Hanna, 2008).

Evacuation Plan / Fire Drill: Evacuation plans are made to make sure that everyone in a building can leave safely and in an organized way. A fire drill is a practice session for evacuating a building during

a fire or any emergency. Before a construction project begins, the contractors must assess possible dangers that might happen on the site. They should also make sure that the people responsible for fire safety on site know how to use the firefighting equipment (Zekri, 2013).

Safety and Health Training: It is well known in the construction industry that training is important for making work safer. Worker orientation is often the first part of training and continues as workers learn more about their specific jobs. For instance, training is given to people who are in charge of setting up or managing scaffolding, which is one of the most dangerous tasks on a construction site. These training sessions can be done in different ways, like worker orientation, safety inductives, toolbox talks, and communication programs. These sessions can cover topics such as worker rights and duties, falls from heights, working with fire, electrical safety, personal protective gear, first aid and emergency procedures, entering tight spaces, and other related issues. Whether the information is new or a refresher, these trainings help workers perform safely and effectively. They also promote a positive attitude toward safety by making it part of the company's goals for production and quality (Hinze & Gambatese, 2003). Additionally, training helps workers do their jobs better and builds a sense of safety in the workplace (Kartam et al., 2000).

Safety and Health Inspections: Safety and health inspections are a way for managers to understand the conditions of safety and health on the construction site. Having safety inspections done by trained personnel helps lower the number of work-related injuries (Hinze & Gambatese, 2003). In addition, companies that do safety inspections tend to have fewer accidents compared to companies that do not do them (Reese, 2003).

Safety Signals, Signs, and Barricades: All construction sites must have a clear and consistent signaling system that everyone involved understands. Safety symbols should be placed in the right locations and included in a safety guide. It is up to the contractor to make sure that all those involved are familiar with the signals and what they mean (Tam et al., 2003).

Work Environment: Rules set by authorities often help manage the work environment and processes to offer a better level of protection. However, it is not enough to just follow the basic rules and guidelines set by the authority. Stakeholders need to go further and create their own standards. They also need to take on more responsibility and involve everyone in ensuring a safe work environment (Zekri, 2013).

Role of Government and Engineering Societies: The government and engineering organizations have an important role in ensuring that safety and health rules are followed. This includes approving

standards and norms that protect workers and property. Companies should be legally required to follow these rules, with strong consequences for not doing so. The government should regularly check sites with expert safety engineers and issue warnings or penalties if hazards or unsafe conditions are found. Engineering organizations can also help spread knowledge by raising awareness among engineers about safety and health issues (Fang et al., 2004).

2.3.7 Assessment of safety measures practices in building construction projects

A comprehensive assessment of safety measures practices in building construction projects requires a deep dive into various aspects, including the identification of common hazards, the implementation of safety management systems, the challenges encountered, and the overall impact on project success. The literature consistently highlights the construction industry as one of the most hazardous sectors globally, underscoring the critical need for effective safety interventions.

1. The Hazardous Nature of Building Construction

The construction industry is known for being constantly changing, complicated, and often short-term, which naturally leads to a lot of accidents, injuries, and even deaths (Adhikari et al., 2024; Mustapha et al., 2025). Many of the main dangers that are talked about in studies include:

- **Falls from Height:** This is the biggest cause of serious injuries and deaths, especially when working on scaffolds, roofs, open areas without protection, or ladders (NASP, 2024; OSHA, 2023).
- **Struck-by Incidents:** Workers can get hurt by moving vehicles, heavy machines, falling items, or swinging objects (IRJET, 2022)
- **Electrocution:** This happens when electrical equipment is not handled properly, wiring is damaged, or safety steps like lockout/tagout are not followed (IRJET, 2022; NASP, 2024).
- **Caught in/Between Incidents:** Workers can get trapped or crushed between equipment, collapsing buildings, or the walls of a trench (NASP, 2024).
- **Slips, Trips, and Falls at the Same Level:** These often happen because of poor cleaning, uneven ground, or scattered materials (NASP, 2024).
- **Exposure to Hazardous Materials:** Longterm problems like lung disease or poisoning can occur from breathing in dust like silica, asbestos, lead, or other harmful chemicals if they are not controlled properly (NASP, 2024).

- **Noise and Vibration:** Over time, these can cause hearing loss and problems with bones and muscles (NASP, 2024).
- **Confined Spaces:** Entering enclosed areas without proper ventilation or monitoring poses risks of asphyxiation, toxic gas exposure, and engulfment (NASP, 2024).

Beyond these immediate hazards, underlying factors contributing to accidents include worker negligence, overconfidence, lack of awareness, inadequate training, poor communication, insufficient management commitment, tight deadlines, and defective equipment (Adhikari et al., 2024; BiblioMed, 2023).

2. Safety Measure Practices and Management Systems

Effective safety measure practices are rooted in proactive rather than reactive approaches, emphasizing early risk identification and mitigation (ResearchGate, 2024). The literature identifies several key practices and the components of robust safety management systems (SMS):

- **Safety Planning and Risk Assessment:** A fundamental step involves developing project-specific safety plans, identifying potential hazards, assessing their risks, and formulating preventative measures. This includes pre-construction safety reviews and job safety analyses (IRJET, 2022; PepTalk, 2023).
- **Safety Training and Education:** Continuous and comprehensive training is critical for all workers, covering hazard recognition, safe operating procedures for equipment, proper use of PPE, and emergency response. Specialized training for high-risk tasks is also emphasized (Mustapha et al., 2025; ResearchGate, 2024; EcoOnline, 2024). The use of innovative methods like virtual reality (VR) simulations for immersive training is gaining traction.
- **Personal Protective Equipment (PPE):** Mandating and enforcing the correct use of appropriate PPE (e.g., hard hats, safety shoes, gloves, eye protection, fall harnesses) is a cornerstone of site safety (ResearchGate, 2024; EcoOnline, 2024).
- **Site Safety Inspections and Audits:** Regular inspections by safety personnel and management are essential for identifying and rectifying unsafe conditions and behaviors. Audits help evaluate the effectiveness of safety programs (Adhikari et al., 2024; PepTalk, 2023). Digital systems can facilitate these inspections and capture valuable data (ALICE Blog, 2023).

- **Hazard Control and Prevention:** Implementing a hierarchy of controls (elimination, substitution, engineering controls, administrative controls, PPE) is crucial. This includes measures like barricades, guardrails, proper material storage, and maintaining clean work areas (IRJET, 2022; ResearchGate, 2024).
- **Emergency Preparedness:** Establishing clear emergency response plans, including first aid facilities, medical personnel, and evacuation procedures, is vital for managing incidents effectively (ResearchGate, 2024; OSHA, 2023).
- **Safety Management Systems (SMS):** A structured SMS, often based on principles like ISO 45001 or OSHA's recommended practices, provides a systematic framework. Key components include:
 - ❖ **Safety Policy and Objectives:** Defining management commitment, accountabilities, and safety goals (ALICE Blog, 2023; PepTalk, 2023).
 - ❖ **Safety Risk Management:** Proactive identification, assessment, and control of risks (ALICE Blog, 2023).
 - ❖ **Safety Assurance:** Continuous evaluation and improvement of the SMS through audits and feedback (ALICE Blog, 2023).
 - ❖ **Safety Promotion:** Fostering a positive safety culture through communication, worker involvement, and incentives (ALICE Blog, 2023; PepTalk, 2023).
- **Behavior-Based Safety (BBS):** Programs that focus on observing and analyzing worker behavior to promote safe practices through feedback and positive reinforcement (ARC Journals, 2017).
- **Near-Miss Reporting:** Encouraging the reporting and investigation of near-misses is crucial for learning from potential incidents and preventing future accidents (OSHA, 2023).

3. Challenges in Implementing Safety Practices

Despite widespread recognition of safety's importance, several persistent challenges hinder the effective implementation of safety measures in construction projects:

- **Lack of Awareness and Experience:** Workers and even some management personnel may lack sufficient knowledge or appreciation of safety protocols (Adhikari et al., 2024; BiblioMed, 2023).

- **Inadequate Resources:** Financial constraints can limit investment in proper equipment, technology, training, and sufficient safety personnel (Mustapha et al., 2025; ResearchGate, 2024).
 - **Communication Barriers:** Language differences, hierarchical structures, and informal communication channels can impede the flow of safety-critical information (Mustapha et al., 2025; MDPI, 2025).
 - **Profit Motives and Tight Schedules:** Pressure to complete projects quickly and cheaply can lead to shortcuts that compromise safety (BiblioMed, 2023; Quickbase, 2025).
 - **Transient Workforce:** The high turnover and diverse nature of the construction workforce make consistent training and safety culture development challenging (ASSP, 2024).
 - **Resistance to Change:** Workers may resist adopting new safety practices or wearing PPE if they perceive them as inconvenient or time-consuming (MDPI, 2025).
 - **Lack of Enforcement:** Inconsistent enforcement of safety rules by management or regulatory bodies can undermine their effectiveness (BiblioMed, 2023).
 - **Dynamic Work Environments:** The constantly changing conditions on construction sites make it difficult to maintain consistent safety measures and require continuous adaptation (ASSP, 2024; ResearchGate, 2021).
4. Impact of Safety Practices on Project Outcomes

The literature unequivocally demonstrates a strong positive correlation between effective safety practices and various aspects of project success:

- **Reduced Accidents and Injuries:** The most direct benefit is a decrease in fatalities, serious injuries, and occupational illnesses, thereby protecting human life and well-being (ResearchGate, 2024; OSHA, 2023).
- **Improved Productivity and Efficiency:** Fewer accidents lead to reduced downtime, fewer work disruptions, and a more consistent workflow. Workers who feel safe are more focused and productive (Mustapha et al., 2025; IRJET, 2022).
- **Cost Savings:** Proactive safety measures lead to significant cost reductions. These include lower direct costs (medical expenses, workers' compensation, legal fees, property damage) and indirect costs (investigation time, loss of morale, reputational damage, project delays) (ResearchGate, 2021; SiteDocs, 2023).

- **Enhanced Reputation and Brand Image:** Companies with strong safety records gain a competitive advantage, attracting more clients and skilled labor, and fostering a positive public image (ResearchGate, 2021).
- **Increased Worker Morale and Retention:** A safe work environment fosters trust, boosts morale, and leads to higher worker satisfaction and lower turnover rates (IRJET, 2022; SiteDocs, 2023).
- **Legal and Regulatory Compliance:** Adherence to safety regulations avoids fines, penalties, and potential legal action, ensuring smooth project operations (SiteDocs, 2023; SafetyAmp, 2023).
- **Improved Project Quality:** A commitment to safety often reflects a broader commitment to quality and excellence in project execution, reducing errors and rework (Quickbase, 2025).

2.3.8 Key safety measures and protocol implemented in building construction

Building construction is one of the most dangerous industries in the world, so it's important to have strong safety measures and rules to keep workers safe and make sure projects go well. A detailed review of existing research shows that construction safety involves many different approaches. It has moved from old, standard practices to include new and better technologies.

i. Core Safety Frameworks in Construction Creating

a safe environment starts with strong support from the organization and taking a proactive approach to safety.

- **Safety Management Systems (SMS) and Policies:** A key idea in construction safety is having a strong SMS. This includes a clear safety policy that shows the company's commitment to worker safety, and defines who is responsible and what roles each person has. Rules from places like the Occupational Safety and Health Administration (OSHA) in the U.S. and the Health and Safety Executive (HSE) in the U.K., along with international standards like ISO 45001:2018 (Occupational Health and Safety Management Systems), help create effective SMS (ISO, 2018). These systems encourage moving from just reacting to accidents to taking steps to find and prevent dangers before they happen, leading to better safety results over time (OSHA, n.d.).
- **Assessing Risks and Identifying Hazards:** Before starting any construction work, it's important to do a detailed risk assessment. This process helps find possible dangers, evaluate how likely they are to happen and how serious the consequences could be, and decide which ones need to be controlled first. Hazards can be obvious, like falling from high places or working with heavy

equipment, or they can be less obvious, such as exposure to chemicals, loud noises, physical strain, or even mental health issues (Kamardeen, 2017). These assessments help create site-specific safety plans and Safe Work Method Statements (SWMS) for high-risk activities (Teo et al., 2021)

- **Safety Culture and Leadership:** A common theme in safety research for construction is the importance of a good safety culture. Studies show that when safety is a shared value and part of how the company operates, accidents decrease and safety improves (Fung et al., 2005; Zou & Sunindijo, 2010). Good safety leadership is key, and it means that management shows their support for safety, leads by example, encourages open communication, and makes it safe for workers to report concerns or close calls without fear of being punished (Lingard & Rowlinson, 2005; Winge et al., 2023).

ii. Core Safety Measures and On-Site Protocols

These are the real actions and steps taken every day to keep workers safe.

- **Personal Protective Equipment (PPE):** PPE is the main way to protect workers from dangers. Everyone must use the right gear, like hard hats, safety glasses, ear protection, bright clothes, gloves, and steel-toed shoes. These are required in all safety standards and guides (Srujana, 2019; U.S. Department of Labor, 2024). It's important to check and take care of PPE regularly so it works properly.
- **Fall Protection:** Falls are one of the biggest causes of deaths and serious injuries in construction. To prevent this, we use things like guardrails and safety nets, as well as Personal Fall Arrest Systems (PFAS) (U.S. Department of Labor, 2024). We also follow strict rules for setting up, checking, and using scaffolding, and we make sure ladders are used safely (WHO, 2021).
- **Equipment and Machinery Safety:** Using heavy machinery and power tools safely is very important. This means checking and maintaining equipment regularly, making sure operators are trained and certified, and having clear instructions for safe use, including lockout/tagout procedures during repairs. We also mark off dangerous areas and keep workers away from moving machines to protect them (Ranasinghe et al., 2023).
- **Housekeeping and Site Organization:** Slips, trips, and falls are frequent accidents in construction sites that are often caused by poor organization. Keeping clear paths for walking and exiting, storing tools and materials properly, and regularly cleaning up debris are all

important safety steps. Studies show that poor housekeeping on high-rise sites in Addis Ababa puts workers at serious risk, so thorough site management and strict safety rules are essential (Belachew, 2020).

- **Electrical Safety:** To avoid electrical dangers, we make sure equipment is properly grounded and insulated, identify and turn off live wires, and regularly check electrical tools and wiring. In Ethiopian projects, safety procedures focus on identifying risks, using proper gear, and following instructions. Good electrical safety practices help prevent shocks and fires by isolating live parts, keeping equipment in good condition, and teaching workers how to avoid risks (Kasahun Tsehay Jemaneh, 2022).
- **Hazardous Substances Control:** Handling harmful materials requires careful steps, including following correct procedures for use, storage, and disposal, clearly labeling and sharing safety information through Safety Data Sheets (SDS), and ensuring good ventilation in enclosed areas to prevent the buildup of dangerous fumes or dust (OSHA, 2023).

i. Protocols for Continuous Safety Improvement and Emerging Trends

After the initial setup, ongoing protocols help keep safety as a top priority, and new technologies are helping to make it even better.

- **Safety Training and Education:** Keeping workers trained is very important. This includes training new workers when they start, special training for dangerous tasks, and regular short meetings and talks to share safety info and discuss risks at the workplace (U.S. Department of Labor, 2024). Studies show that hands-on training methods are especially effective.
- **Incident and Near-Miss Reporting and Investigation:** It's important to report any accidents or near accidents right away so we can learn from them and stop similar things from happening again. These incidents are carefully looked into to find out what went wrong and fix the problems, which helps improve safety over time (Winge et al., 2023).
- **Regular Safety Inspections and Audits:** Safety checks are done often to find and fix possible dangers before they cause injuries. Both internal and external checks are carried out to make sure the safety management system is working well and that all rules are being followed. Using safety reports and data helps track how well we're doing and where we need to improve (BSG, 2025).

ii. Impact of Technology on Construction Safety

Recent literature highlights the transformative role of digital technologies in enhancing safety outcomes (Moholkar et al., 2024).

➤ Digital Technologies for Risk Prediction and Monitoring:

- **Artificial Intelligence (AI) and Machine Learning (ML):** AI-powered platforms are increasingly used for predictive risk assessment, identifying safety issues from historical data, and real-time monitoring. AI can analyze video feeds to detect if workers are wearing PPE correctly or are in restricted zones, enabling immediate alerts (Novade, 2024).
- **Wearable Technology and IoT (Internet of Things):** Smart PPE (helmets, vests, wristbands) equipped with sensors that monitor worker vital signs, fatigue, and exposure to environmental hazards. IoT sensors monitor air quality, structural integrity, and equipment performance, providing real-time data for proactive intervention (Ranasinghe et al., 2023; MDPI, 2025).
- **Drones (UAVs):** Drones are used for remote inspection of hazardous or hard-to-reach areas, reducing human exposure to risk and improving the accuracy and efficiency of site monitoring (Struxhub, 2024).

➤ Immersive Training and Visualization:

- **Building Information Modeling (BIM):** BIM facilitates the identification of safety issues early in the design phase, allowing for "safety by design" principles to be integrated, thereby preventing hazards before construction commences (MDPI, 2025).
- **Data-Driven Safety Management:** Mobile safety applications and cloud-based platforms streamline access to safety manuals, checklists, incident reporting, and compliance tracking. The "quest for data" drives the increased use and acceptance of these apps, enabling better analytics and AI model development for accident prevention (Novade, 2024).

iii. International Standards and Best Practices

While specific regulatory frameworks vary (e.g., OSHA in the US, HSE in the UK), global organizations promote harmonized safety standards.

- **International Labour Organization (ILO):** The ILO's revised Code of Practice on Safety and Health in Construction (ILO, 2022) provides comprehensive advice for governments,

employers, and workers. It emphasizes occupational safety and health (OSH) management systems, a preventative safety culture, and cooperation among stakeholders.

- **ISO Standards:** ISO 45001 (Occupational Health and Safety Management Systems) is increasingly adopted globally, providing a framework for organizations to manage OSH risks and improve performance.
- **Common Focus Areas:** International protocols consistently focus on PPE, risk management, safety training, emergency response, machinery safety, fall protection, hazardous materials handling, and structural integrity. There's also a growing emphasis on addressing mental health and well-being in construction (BSG, 2025).

2.3.9 Effectiveness of the safety measures in ensuring the health and well-being of construction workers.

The effectiveness of safety measures in ensuring the health and well-being of construction workers is a critical area of study, given the industry's high rates of injuries, fatalities, and occupational diseases. A review of the literature consistently demonstrates that well-implemented safety measures and protocols have a significant positive impact on worker health and overall well-being, moving beyond mere accident prevention to encompass holistic health outcomes, including mental health.

A. Reduction of Accidents and Injuries

The most direct and measurable impact of effective safety measures is the reduction in accident rates and the severity of injuries.

- **Comprehensive Safety Management Systems (SMS):** Studies show that companies implementing robust SMS, aligned with standards like ISO 45001:2018, experience significantly lower accident rates (Refocus Safety Ltd, 2023). These systems promote proactive hazard identification, risk assessment, and the implementation of controls, thereby preventing incidents before they occur.
- **Personal Protective Equipment (PPE):** While PPE is considered the last line of defense, its proper and consistent use is proven to reduce the occurrence and severity of injuries. Research indicates that PPE, including hard hats, safety glasses, and gloves, is essential in mitigating risks from falling objects, impacts, and exposure to harmful substances (U.S. Department of

Labor, 2024; ResearchGate, 2024). However, its effectiveness is contingent on proper usage, maintenance, and worker adherence (JournalsPub, 2024).

- **Fall Protection Systems:** Given that falls are a leading cause of fatalities, the implementation of fall protection measures (e.g., guardrails, safety nets, personal fall arrest systems) has a direct and profound impact on saving lives and preventing debilitating injuries (WHO, 2021).
- **Regular Inspections and Audits:** Frequent and systematic safety inspections and audits lead to the timely identification and rectification of hazards, contributing to a substantial reduction in workplace incidents (JournalsPub, 2024).

B. Prevention of Occupational Diseases and Long-term Health Issues

Beyond immediate injuries, effective safety measures are crucial in preventing chronic health problems that can arise from prolonged exposure to construction hazards.

- **Hazardous Substance Control:** Protocols for proper handling, storage, and disposal of hazardous materials, coupled with adequate ventilation and respiratory protection, directly reduce the incidence of respiratory diseases (e.g., silicosis, asbestosis), skin conditions, and other chemical-related illnesses (ILO, 1995).
- **Noise Control:** Implementation of noise control measures (e.g., quieter equipment, enclosures, hearing protection) effectively prevents noise-induced hearing loss, a prevalent occupational disease in construction (ILO, 1995).
- **Ergonomic Interventions:** Addressing ergonomic hazards through proper tool design, mechanical aids for lifting, and ergonomic training can significantly reduce musculoskeletal disorders (MSDs) such as back pain, carpal tunnel syndrome, and tendonitis, which are common among construction workers due to repetitive tasks and heavy lifting (Ethos Safety, 2023). The adoption of technologies like exoskeletons is an emerging measure to further reduce physical strain.

C. Enhancement of Mental Health and Well-being

In the past, construction safety mainly focused on physical dangers. But now, more recent studies show that safety practices and a good work environment have a big effect on the mental health and general happiness of construction workers.

- A strong safety culture, where people can talk openly, feel safe to share their worries, and know their health is important, helps improve mental well-being (Winge et al., 2023; Onward Shift, 2024). When workers feel supported and valued, they experience less stress and anxiety.
- The tough nature of construction jobs, like long hours and changing schedules, can cause burnout, stress, and problems with sleep patterns (Frontiers in Built Environment, 2024). Safety rules that help manage tiredness, such as taking proper breaks and keeping work hours reasonable, are important for mental health. They also help workers maintain a good balance between their job and personal life.
- Giving workers access to mental health support, such as Employee Assistance Programs (EAPs), on-site counseling, workshops on stress management, and training to raise awareness about mental health, is very helpful. These efforts help workers and managers understand mental health better and reduce any feelings of shame about seeking help (Healthsource Solutions, 2024; Onward Shift, 2024). Helping workers deal with substance abuse, which is often connected to mental health problems, is also an important part of improving their well-being.
- Fewer accidents mean less stress and less psychological harm from seeing or being in dangerous situations. So, when safety measures are effective, they not only protect people physically but also improve their mental health and overall happiness.

D. Impact of Training and Education

The effectiveness of safety measures is highly dependent on comprehensive training and education.

- **Improved Knowledge and Behavior:** Studies consistently demonstrate that well-structured and contextually tailored safety training programs significantly enhance workers' safety knowledge, improve adherence to safety protocols, and lead to a reduction in workplace accidents (Civil Engineering Journals, n.d.). Training in behavioral modeling and hands-on practice are particularly effective methods for knowledge acquisition and transfer of safe behaviors to the work setting (PMC, 2020).
- **Proactive Safety Culture:** Training also plays a vital role in fostering a proactive safety culture, empowering workers to identify hazards, use PPE correctly, and communicate safety concerns,

thereby enhancing their personal sense of control and well-being (Civil Engineering Journals, n.d.).

E. Role of Technology in Enhancing Effectiveness

Emerging technologies are increasingly proving their effectiveness in augmenting traditional safety measures and enhancing worker health and well-being.

- **Real-time Monitoring and Alert Systems:** Wearable technology and IoT sensors that monitor vital signs, fatigue levels, environmental hazards (e.g., gas leaks, heat stress), and worker location provide real-time data and alerts, enabling immediate intervention and preventing accidents or exposure-related illnesses (RIB Software, 2024; JournalsPub, 2024).
- **AI-driven Predictive Analytics:** AI and machine learning are being used to analyze vast datasets of incident reports and site conditions to predict potential hazards, allowing for proactive mitigation strategies that directly contribute to a safer and healthier work environment (Novade, 2024).
- **Immersive Training (VR/AR):** Virtual Reality (VR) and Augmented Reality (AR) simulations provide immersive and safe environments for workers to experience and practice responses to hazardous scenarios, improving their preparedness and reducing real-world risks (MDPI, 2025). This enhanced preparedness can also reduce anxiety and stress on the job.

The construction industry is characterized by high-risk environments, making the health and well-being of construction workers a critical concern. Safety measures play a pivotal role in mitigating risks and enhancing worker health outcomes. This literature review synthesizes existing research findings on the effectiveness of safety measures in the construction sector, focusing on various aspects such as technological integration, psychological factors, and comprehensive health initiatives.

Safety Measures and Health Risks Associated with Manufactured Nanomaterials

Recent studies have highlighted the introduction of manufactured nanomaterials (MNMs) in construction as a potential health risk for workers. Lee et al. (2010) emphasizes the need for guidelines to regulate the use and disposal of MNMs to mitigate their toxicological effects. This underscores the importance of assessing current safety measures in the context of emerging materials that could compromise worker health. As construction practices evolve, there is a pressing need for research that

evaluates the effectiveness of safety protocols specifically tailored to address the unique challenges presented by MNMs.

Total Worker Health Initiatives

The Total Worker Health (TWH) initiative integrates occupational safety and health with wellness programs, demonstrating significant benefits for construction workers. Anger et al. (2015) report that TWH interventions effectively improve risk factors for injuries and chronic illnesses, suggesting that holistic approaches yield better outcomes than isolated safety programs. This finding prompts further exploration into how construction firms can implement TWH strategies more broadly, particularly in high-risk environments.

Moreover, Schwatka et al. (2016) affirm that integrated safety and health efforts can lead to enhanced worker well-being, indicating a shift towards comprehensive safety measures in the industry. Future research should investigate specific TWH interventions that can be adapted for various construction sub-sectors, as well as their long-term impacts on worker health.

Safety Climate and Worker Behavior

A strong safety climate is crucial for promoting positive safety behaviors among construction workers. Lyu et al. (2018) found that a positive safety climate correlates with improved safety outcomes, particularly among ethnic minority workers. This highlights the necessity of tailoring safety measures to meet the needs of diverse worker groups, suggesting an area for further investigation into how cultural factors influence safety climate and worker compliance.

Lorente et al. (2014) also discuss the role of personal resources in enhancing work engagement and safety behaviors among construction workers. This indicates that psychological factors, such as self-efficacy, are integral to effective safety measures. Future research should focus on developing training programs that foster these personal resources, thereby enhancing overall safety performance.

Technological Innovations in Safety Management

The advent of advanced technologies, such as Building Information Modeling (BIM) and Unmanned Aerial Vehicles (UAVs), has transformed safety management in construction. Alizadehsalehi et al. (2018) propose a 4D BIM/UAV-enabled safety management model that enhances hazard identification and risk mitigation on construction sites. This technological integration could lead to significant

reductions in accidents and injuries, reinforcing the need for ongoing research into the application of such innovations in real-world settings.

Psychological Capital and Safety Compliance

The role of Psychological Capital (PsyCap) in enhancing safety compliance has garnered attention in recent research. Diugwu et al. (2012) suggest that fostering positive psychological attributes among workers can lead to improved safety behaviors. This highlights the importance of integrating psychological factors into safety training programs, emphasizing a comprehensive approach to worker health and safety. Future studies should explore the effectiveness of PsyCap interventions in diverse construction environments, assessing their impact on overall safety performance.

Challenges in Implementing Safety Measures

Despite the advancements in safety measures, challenges remain in their implementation. Chung et al. (2020) identified issues with inadequate protective equipment and compliance during the COVID-19 pandemic as significant barriers to ensuring worker safety. This finding emphasizes the need for construction stakeholders to develop strategies that can enhance compliance with safety protocols, particularly in crises. Future research should investigate the effectiveness of real-time monitoring systems, such as IoT-based applications, in promoting adherence to safety measures.

2.3.10 Challenges faced in the effective implementation of safety practices in the construction project.

The effective implementation of safety practices in construction projects faces numerous challenges and barriers, often leading to persistent accident rates despite the existence of comprehensive safety regulations and technologies. These obstacles are multifaceted, stemming from organizational, economic, human, and regulatory factors (AIP Publishing, n.d.; MDPI, 2025).

i. Organizational and Management-Related Barriers

These challenges relate to how safety is prioritized, managed, and integrated within the organizational structure of construction companies.

- **Lack of Top Management Commitment and Leadership:** Research consistently identifies a lack of genuine commitment from top management as a primary barrier (Frontiers, 2024; DergiPark, n.d.). When safety is not seen as a core value but merely a compliance issue, it often receives insufficient resources, attention, and enforcement. This translates into inadequate safety policies, poor supervision, and a reactive rather than proactive approach to safety (AIP Publishing, n.d.).
- **Poor Safety Culture:** A weak or negative safety culture, where safety is not internalized by all personnel, hinders effective implementation. This includes attitudes of complacency, overconfidence, negligence, and a belief that safety is solely the responsibility of safety officers (DergiPark, n.d.; Scholars Middle East Publishers, n.d.). Workers may prioritize speed and productivity over safety, especially under pressure (CORE, n.d.).
- **Inadequate Safety Management Systems (SMS) and Planning:** While SMS are crucial, their ineffective operation can be a barrier. This includes a lack of proper safety planning, insufficient risk assessments, and poorly defined roles and responsibilities within the project team (MDPI, 2023). Some projects may lack dedicated safety inspectors or comprehensive job safety analyses (Scholars Middle East Publishers, n.d.).
- **Subcontracting Practices and Fragmented Responsibility:** The widespread use of subcontractors, often with varying safety standards and management systems, creates challenges in ensuring consistent safety practices across a project. Unclear lines of responsibility and communication between main contractors and subcontractors can lead to safety gaps and a lack of accountability (AIP Publishing, n.d.).
- **Poor Communication and Coordination:** Ineffective communication channels between management, supervisors, and workers at different levels can impede the dissemination of safety information, hazard alerts, and best practices. Language barriers, especially in multicultural workforces, further exacerbate this challenge (AIP Publishing, n.d.; ResearchGate, n.d.).

ii. Economic and Resource-Related Barriers

Financial constraints and resource allocation frequently pose significant obstacles to safety implementation.

- **Cost of Safety Implementation:** Construction firms, particularly small and medium-sized enterprises (SMEs) which often act as subcontractors, may view safety investments as a cost rather than an investment, leading to reluctance in allocating sufficient funds for training, PPE, safety equipment, and advanced safety technologies (AIP Publishing, n.d.; ResearchGate, n.d. - "Case Studies on the Safety Management at Construction Site"). This cost-cutting mentality can be particularly prevalent in competitive bidding environments.
- **Tight Project Deadlines and Budget Pressures:** Intense pressure to complete projects within strict timeframes and budgets often leads to safety compromises. Project managers and workers may cut corners, rush tasks, and neglect safety procedures to meet deadlines, increasing the risk of accidents (AIP Publishing, n.d.; MDPI, 2023).
- **Insufficient Resources (Human and Material):** This includes a lack of qualified safety personnel, inadequate provision of necessary safety equipment and PPE, and a general scarcity of resources dedicated to safety management within the organization (AIP Publishing, n.d.; ResearchGate, n.d. - "An Overview of Safety and Health Management Challenges").

iii. Human and Worker-Related Barriers

Individual worker characteristics, attitudes, and behaviors can significantly influence safety outcomes.

- **Lack of Safety Knowledge and Awareness:** Many workers, especially those with limited education or new to the industry, may lack a fundamental understanding of workplace hazards, safe work procedures, and the importance of using PPE (DergiPark, n.d.; Scholars Middle East Publishers, n.d.).
- **Unsafe Behavior and Attitudes:** Overconfidence, negligence, complacency, and a "macho" culture that discourages reporting unsafe conditions or near misses can lead to unsafe acts (CORE, n.d.; DergiPark, n.d.). Workers may intentionally bypass safety procedures to save time or effort.
- **Inadequate Training:** Insufficient or ineffective safety training, particularly for high-risk tasks, leaves workers unprepared to handle hazards safely. Training may be perceived as time-consuming and often lacks practical relevance (AIP Publishing, n.d.; UTS ePress, 2024). High labor turnover in the industry can also make consistent training challenging (ResearchGate, n.d. - "An Overview of Safety and Health Management Challenges").

- **Worker Fatigue and Stress:** Long working hours, demanding physical tasks, and high-pressure environments can lead to worker fatigue and stress, impairing judgment, reducing alertness, and increasing the likelihood of accidents (Scholars Middle East Publishers, n.d.).

iv. Regulatory and External Barriers

Factors beyond the immediate control of a project or company can also impede safety.

- **Weak or Inadequate Regulatory Frameworks:** In some regions, especially developing countries, safety regulations may be fragmented, outdated, or lack dedicated enforcement mechanisms. This can lead to poor compliance and a lack of accountability among construction stakeholders (UTS ePress, 2024; MDPI, 2023).
- **Insufficient Government Audits and Inspections:** A lack of regular and thorough government safety audits and inspections can reduce the incentive for companies to comply with safety standards, especially if the likelihood of detection and penalties is low (ResearchGate, n.d. - "An Overview of Safety and Health Management Challenges").
- **Technological Adoption Challenges:** While new technologies offer immense potential for safety improvement, their adoption faces barriers such as high upfront investment, the need for extensive training, issues with data sharing and ownership, and resistance to change from traditional work cultures (ASCE Library, n.d.; Vilnius Tech Journals, 2022; Emerald Insight, n.d.).

The construction industry is characterized by its complexity and inherent risks, leading to a high frequency of accidents and injuries. Despite the existence of safety regulations and protocols, many construction projects still face significant challenges in implementing effective safety practices. This literature review synthesizes key findings from various studies to explore the barriers to safety practices in construction, particularly focusing on teamwork dynamics, management commitment, resource constraints, and the impact of external factors such as health crises.

➤ Teamwork Dynamics and Safety Performance

Effective teamwork is critical in enhancing safety practices within construction projects. Kheni et al. (2010) highlighted that teamwork plays a vital role in systematic error management, which is essential for accident prevention. However, the study also identified cognitive, affective, and behavioral components of teamwork that can hinder safety performance. This suggests that barriers to the

effective implementation of safety practices may stem from inadequate teamwork dynamics. As emphasized by Mitropoulos and Memarian (2012), construction supervisors must actively foster teamwork processes to improve safety outcomes, indicating a need for targeted training on teamwork in safety contexts

➤ Management Commitment and Coordination

The importance of management commitment to health and safety cannot be overstated. Awwad et al. (2016) found that a lack of coordination among contractors, clients, and the workforce significantly hampers safety practices in the construction industry, particularly in developing countries. The high incidence of accidents, despite existing safety regulations, suggests that mere compliance is insufficient. This concern is echoed in the findings of Khalid et al. (2021), who argue that small construction firms face immense challenges due to financial constraints, limiting their ability to adopt advanced technologies that could improve safety management. These studies emphasize the need for comprehensive safety training and awareness programs that are supported by strong managerial commitment.

➤ Resource Constraints and Technological Barriers

Resource limitations are a prevalent barrier to implementing safety practices, particularly in small and medium-sized enterprises (SMEs). Khalid et al. (2021) noted that limited resources hinder the adoption of advanced safety technologies such as the Internet of Things (IoT), which could enhance safety protocols. This lack of access to modern safety management tools reflects a broader issue in the construction sector, where financial constraints prevent firms from implementing comprehensive safety measures (Li et al., 2018). Moreover, the challenges posed by inadequate technological infrastructure in developing countries further exacerbate these issues, as noted in the research by Li et al. (2018).

➤ Impact of Health Crises

The COVID-19 pandemic has introduced additional barriers to effective safety practices in construction. Kanchana et al. (2015) and Amoah & Simpeh (2020) identified that ignorance of COVID-19 protocols, inadequate personal protective equipment, and compliance difficulties have become significant challenges. The findings emphasize that these barriers not only jeopardize worker

safety but also contribute to broader public health concerns. This underscores the necessity for construction firms to develop robust strategies to adapt to evolving health threats and ensure the safety of their workforce.

2.3.11 Interventions and Techniques to Enhance Safety Management Systems in Large-Scale Construction Projects

Large-scale construction projects are often marked by complexity, tight deadlines, high budgets, multiple stakeholders, and hazardous work environments. These conditions make the establishment and continuous enhancement of an effective Safety Management System (SMS) not only necessary but critical. A forward-looking approach to SMS incorporates technology, human behavior, policy, and organizational culture to reduce accident rates and improve overall project efficiency. This literature review explores evidence-based interventions and innovative techniques that can enhance SMS in future large-scale construction projects.

The Role and Structure of Safety Management Systems (SMS)

An SMS is defined by the International Labour Organization (ILO, 2001) and ISO 45001:2018 as a coordinated system of processes and procedures designed to manage safety risks systematically. Core components include:

- Safety policy and objectives
- Hazard identification and risk assessment
- Training and awareness
- Incident reporting and investigation
- Monitoring and continuous improvement

According to Fang et al. (2006), the effectiveness of an SMS is heavily influenced by the complexity and size of the project, making scalability and flexibility critical design features for large-scale developments.

Challenges in Safety Management for Large-Scale Projects

Numerous studies identify unique challenges in large-scale construction projects:

- Multilevel subcontracting and fragmentation lead to inconsistent safety protocols across the site (Lingard & Rowlinson, 2005).
- A Multicultural and multilingual workforce results in communication breakdowns, which are major contributors to accidents (Loosemore & Malouf, 2010).
- Dynamic work environments cause continuous changes in risks, requiring real-time updates to safety protocols (Zhou et al., 2015).
- Time and cost pressures often result in safety being deprioritized during critical project phases (Tam et al., 2004).

These factors contribute to a growing need for modern, adaptive, and proactive safety management solutions.

Forward Interventions and Techniques

➤ Building Information Modeling (BIM)

BIM supports 3D and 4D modeling, enabling visualization of safety-critical areas and planning for risk mitigation before physical work begins. Zhang et al. (2015) found that BIM-based safety planning reduces incidents by improving spatial awareness and facilitating safety communication.

Key applications:

- Visualization of high-risk areas
- Safety training simulations
- Integration with scheduling (4D BIM)

Internet of Things (IoT) and Wearable Technologies

IoT technologies enhance real-time monitoring by collecting data from sensors and wearable devices. Li et al. (2019) report that IoT-based safety systems can detect abnormal environmental conditions (e.g., temperature, gas exposure) and monitor worker fatigue or motion to preempt accidents.

Common implementations:

- Smart helmets with fatigue sensors
- Proximity alert systems

- GPS-enabled tracking for site evacuation

Artificial Intelligence (AI) and Predictive Analytics

AI models process large datasets to detect patterns and predict future safety risks. Azar et al. (2021) demonstrated that machine learning can identify high-risk conditions days before incidents occur, allowing preemptive measures to be taken.

Applications

- Predictive injury models
- Automated hazard identification
- Decision support systems

Drones and Robotics

Drones provide aerial surveillance, helping identify potential hazards in inaccessible areas. Robots can also be deployed for repetitive, high-risk tasks. Bock and Linner (2015) note that integrating autonomous systems reduces exposure to dangerous environments.

➤ Human and Behavioral Interventions

Behavior-Based Safety (BBS)

BBS focuses on influencing worker behavior by reinforcing safe practices and reducing unsafe actions. According to Cooper (2009), successful BBS programs use real-time feedback, peer observations, and behavior reinforcement to reduce accident rates.

Key practices:

- Observation checklists
- Real-time feedback systems
- Incentive-based behavior modification

Safety Culture and Leadership

Leadership plays a fundamental role in embedding a strong safety culture. Zohar (2010) emphasizes that transformational safety leadership—where leaders visibly prioritize safety, engage workers, and lead by example can significantly reduce workplace accidents.

Essential actions:

- Regular site walkarounds by senior leaders
- Open-door safety reporting policies
- Recognition of safety excellence

Safety Training and Virtual Reality (VR)

Advanced training methods using VR and AR technologies offer immersive learning environments for workers. Guo et al. (2012) found that VR-based safety training increases hazard recognition and retention, especially in complex and high-risk tasks.

- Organizational and Policy-Level Techniques

Safety Standardization (ISO 45001)

The implementation of ISO 45001:2018, an international standard for occupational health and safety management systems, ensures consistent safety practices across all contractors. Fang & Wu (2013) argue that aligning project safety practices with international standards reduces variability and enhances accountability.

Contractor Prequalification and Alignment

A significant source of safety breakdowns is subcontractor inconsistency. Toole (2002) recommends implementing rigorous safety prequalification criteria that include historical performance, training protocols, and on-site SMS compliance.

Integration of Safety into Design (DfS)

Design for Safety (DfS) incorporates safety considerations into the early design stage of a project. Research by Behm (2005) suggests that DfS can eliminate up to 22% of construction risks before they reach the site.

Strategies include:

- Modifying the design to reduce working at height
- Prefabrication to reduce on-site assembly risks
- Material selection for safer handling

Case Studies of Best Practices

- London Crossrail Project (UK)
 - Integrated BIM and predictive analytics to preemptively identify hazards.
 - Achieved one of the lowest accident rates among UK megaprojects.
- Hong Kong-Zhuhai-Macau Bridge (China)
 - Deployed IoT sensors and multilingual safety dashboards.
 - Conducted real-time safety monitoring across three jurisdictions.
- Dubai Expo 2020
 - Used wearable technology and multilingual VR training.
 - Recorded fewer incidents despite a multinational, high-density workforce.

2.4 Empirical Review

According to Mr. Lingard (2020), safety induction programs are foundational to building construction safety management. These programs introduce workers to site-specific hazards, safety rules, and emergency procedures before they begin work. Lingard's research shows that projects implementing thorough inductions experienced a 35% reduction in accidents during workers' first week on site, highlighting the importance of early risk awareness. Mr. Zhou (2020) found that frequent toolbox talks short safety briefings held before daily tasks effectively remind workers about specific hazards related to their activities. Zhou reported a 25% decrease in unsafe work behaviors on sites where toolbox talks were consistently conducted, especially when led by supervisors who encouraged two-way communication. This protocol helps maintain safety awareness in the face of changing daily conditions.

Mr. Hinze (2020) emphasizes the critical role of PPE, including helmets, gloves, boots, and fall arrest gear, in mitigating injury severity. His field research demonstrated that strict enforcement and correct use of PPE reduced injury severity rates by over 50%, especially in high-risk tasks such as electrical work and demolition. PPE remains a vital last line of defense when other controls are insufficient.

Mr. Sawhney (2020) stresses the importance of emergency protocols such as fire drills and evacuation planning, especially in high-rise construction. His study showed a 30% improvement in evacuation times and reduced panic during emergencies after regular drill implementation. Visible signage and clear communication channels are also crucial components of these protocols.

According to Mr. Lingard (2020), well-structured safety measures, such as comprehensive safety training and site-specific hazard communication, significantly improve workers' health outcomes. His study found that workers receiving regular safety training reported a 40% decrease in work-related injuries and illnesses, demonstrating that knowledge empowerment directly impacts physical well-being.

According to Mr. Lingard (2020), one significant challenge is the lack of adequate safety training and education, especially for subcontractors and temporary workers. Lingard found that insufficient training contributes to poor hazard recognition and unsafe behaviors, resulting in a higher accident rate by up to 40% among untrained workers on large projects.

According to Mr. John Peterson (2018), safety compliance in the United States is largely driven by stringent OSHA regulations, which mandate regular inspections, hazard communication protocols, and mandatory safety training. His study found that firms adhering to OSHA standards reported a 30% decrease in workplace injuries over a five-year period.

In contrast, Mr. Hiroshi Tanaka (2019) examined safety practices in Japan, emphasizing the role of behavioral safety and continuous improvement (Kaizen) in minimizing risks. His empirical data revealed that proactive safety culture where workers are encouraged to report near-misses and participate in safety committees led to a measurable improvement in site safety performance.

Meanwhile, Mr. Ahmed Al-Mansoori (2020) explored safety management systems in the UAE's construction industry, noting that multinational firms often implement hybrid safety models combining international standards (e.g., ISO 45001) with local regulatory requirements. His findings suggest that leadership commitment and cross-cultural training are essential for effective safety outcomes in diverse labor environments.

According to a local study in Addis Ababa City, construction projects. According to Mr. Alemu (2020), emergency preparedness protocols, such as fire extinguishers, first aid kits, and emergency exits, are

mandatory on selected large construction sites in urban areas. However, their implementation is inconsistent across the country. Alemu's survey found that only 40% of sampled sites had functioning emergency preparedness systems, but where present, these protocols improved emergency response time significantly.

According to Mr. Desta (2020), the use of basic PPE (Personal Protective Equipment), such as hard hats and boots, has been effective in reducing minor injuries on Ethiopian construction sites. His study, conducted in Addis Ababa, showed that sites enforcing PPE usage experienced a 40% decrease in laceration and crush injuries, improving physical well-being. However, many workers still lack proper training in PPE use.

According to Mr. Ayele (2020), effective safety management begins with comprehensive risk assessments and the consistent enforcement of site-specific safety protocols. His study emphasizes the importance of regular safety audits and worker training programs as foundational elements of a resilient safety culture.

Similarly, Dr. Tesfaye (2019) highlights that the integration of technology such as wearable safety devices and real-time monitoring systems has significantly improved hazard detection and response times on construction sites. Empirical evidence from his research shows a 25% reduction in incident rates following the adoption of digital safety tools.

Moreover, Ms. Mekdes (2021) argues that leadership commitment and employee engagement are equally vital. Her findings suggest that projects with strong managerial oversight and participatory safety planning experience higher compliance and lower injury rates. These insights collectively underscore the multifaceted nature of safety practices, where procedural rigor, technological innovation, and human factors converge to shape effective safety management systems.

The above-mentioned literatures describe the knowledge field of safety management to aid the researcher in addressing the research topic. The researcher's analysis of many safety management literatures yielded the following conclusions: construction building safety regulations, construction dangers and injuries, empirical findings on the use of basic PPE (personal perspective equipment), emergency preparedness protocols, and lack of adequate safety training and education.

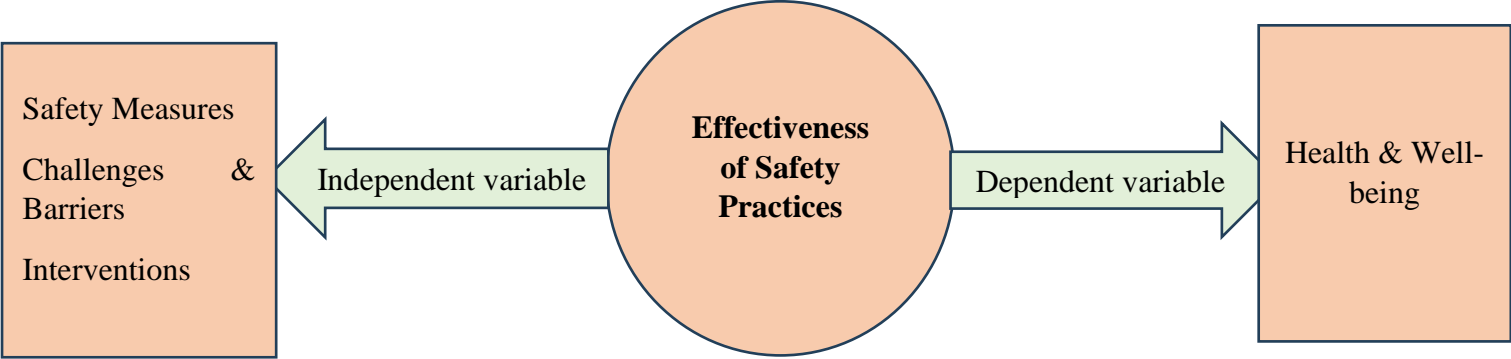
2.5 Research gap

Despite the advancements in safety protocols and technologies, several knowledge gaps remain. For instance, there is a need to explore the long-term effectiveness of technology-driven safety measures in diverse construction contexts. Additionally, while many studies emphasize risk management, there is limited research on the specific barriers to implementing effective safety protocols in developing countries, as highlighted by Nawaz et al. (2019).

"A review of existing literature reveals that prior research has not comprehensively examined the safety measures and protocols implemented on construction sites." This means that when researchers looked at all the studies and publications already out there about construction safety, they found that none of them had thoroughly investigated all the different safety rules, procedures, and equipment put in place on construction sites. It suggests that the existing research might be fragmented or incomplete in its coverage of safety measures. "Moreover, studies conducted in the context of Addis Ababa have largely overlooked evaluating the effectiveness of these measures in safeguarding the health and well-being of construction workers." This part narrows the focus to Addis Ababa. It's saying that even the research that has been done in Addis Ababa hasn't really looked at whether the safety measures that are supposedly in place actually work. Are they making a real difference in protecting workers from injuries, illnesses, and other harm? This aspect has been largely ignored.

2.6 Conceptual Framework

Figure 1:- Conceptual framework



Source: own development, 2025

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter describes the methodology to be used in the study. The adopted methodology to accomplish this study consists of: review of literature related to safety, information about the study design, study location, study population, questionnaire design, and statistical data analysis.

3.2 Research Design

In this research, a descriptive design is used to present the findings of the collected data. The data from the research sample is described using descriptive statistics. In addition to the questionnaire survey, site observation is used as a source of primary data, which helps the researcher to know beyond the reviewed literature.

3.2.1 Research Approach

This research adopts a mixed-methods approach, integrating both quantitative and qualitative data. Data will be collected through questionnaires administered to respondents and site observation. The primary purpose of the site observation is to gain first-hand, authentic data and to complement and triangulate the information gathered via the questionnaire, addressing any potential gaps or providing richer contextual understanding.

3.3 Population and Sampling

3.3.1 Target Population

Hair et al. (2010) states the target population as a specified group of people or objects for which questions can be asked or observed to collect required data structures and information. The target population for this research would be construction workers working Bole International Airport Terminal Expansion Project, constructed by China Communication Construction Company (CCCC) in Addis Ababa, Ethiopia. So, Project Managers, Site Engineers, Mechanical Engineers, Architectural

Engineers, Foreman, Daily labor workers, and Structural managers total of 67 people, are the target population for the research.

3.4 Sampling technique and Sample size

A non-probability convenience sampling technique will be used for the research, in which samples from the target population will be selected based on their proximity to the researcher. Non-probability sampling refers to a sampling strategy where not every member of the population has an equal chance of taking part in the study.

The sample size is determined using the Taro Yamane technique, which was developed by Taro Yamane in 1967 to calculate the sample size from a given population.

$$n = \frac{N}{1 + N(e)^2}$$

n= the sample size is indicated by the letter. N= denotes the research population.

e= denotes the margin error = (0.05)

N = 67(total personnel of the firm in the four projects)

$n = 67 / (1 + 67(0.05)^2) = 57$ in this scenario (confidence level of 95 percent), but in this scenario, the population is small, so I took 67

3.5 Source of Data

This study employed a mixed-methods approach, using both primary and secondary data sources to address the research problem. Primary data were collected through questionnaires and self-observation with various stakeholders involved in the construction projects, such as daily laborers, skilled workers, foremen, engineers, and project managers. Site visits and observations were also conducted to gain a deeper understanding of the project context and challenges. Secondary data were obtained from published and unpublished literature related to the topic, such as books, journals, and reports.

3.6 Data collection methods

Based on the tools and processes for acquiring data, a questionnaire with closed-ended questions will be used. In order to formulate the questions, the research questions will be employed. The information is then spread and gathered. The main research information will come from employees and will be gathered through closed-ended questionnaires. A Likert scale will be used in the questionnaire (1=strongly disagree, 2=disagree, 3= undecided, 4=agree, and 5=strongly agree). Documents related to the topic will be gathered as well.

3.7 Data analysis

Data analysis is a systematic process of extracting meaningful insights from the data collected for a specific study. The data analysis should be aligned with the research objectives and questions. In this study, the researcher employed both quantitative and qualitative data analysis methods to examine the data obtained from the questionnaire. The quantitative data from the closed-ended questions were analyzed using descriptive statistics (SPSS) to calculate the mean scores of the variables. The data collected using observation were analyzed using qualitative data analysis techniques together with the results of the descriptive statistics in order to supplement one by each other.

Descriptive methods were used to analyze the questionnaires that were gathered from the company's various construction-skilled professionals. The outcomes of the analysis of the descriptive data will be presented as percentages, frequencies, means, and standard deviation. As a result, the data will be displayed in a table. Based on how respondents responded to the questionnaire's questions, the Relative Important Index (RII) technique was used in Excel to rank the significant safety Measure practices.

$$\text{Relative important index (RII)} = \frac{5 N5 + 4 N4 + 3N3 + 2N2 + 1 N1}{A}$$

A

N5= number of respondents for strongly agree

N4= number of respondents for agree;

N3= number of respondents for neutral;

N2= number of respondents for disagree

N1= number of respondents for strongly disagree

A=Highest weight; and

N=Total number of respondents

3.8 Validity and Reliability

To ensure the validity and reliability of the data collected from official sources, they will be verified with other secondary sources. The data will also be updated to reflect the current situation. The purpose of verification is to remove any errors or inconsistencies from the data and to increase the confidence level of the data. This will help to produce a more accurate and trustworthy result. The internal reliability of the questionnaire will be measured by Cronbach's alpha test, which will use SPSS software and the formula to calculate the alpha value.

$$\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N - 1) \cdot \bar{c}}$$

N=stands for the number of items

\bar{c} = stands for covariance between items

\bar{v} = stands for average variance.

Table 3- Cronbach Alpha Results

No	Variables	Cronbach Alpha Value	Number of Questions
1	key safety measures and protocols implemented	0.745	8
2	Implemented safety measures in ensuring the health and well-being of construction workers	0.820	8
3	challenges and barriers faced in the effective implementation of safety practices	0.947	11
4	Recommendations can be provided to enhance the safety management system for similar large-scale construction projects	0.790	9

Source: own survey, 2025(SPSS output)

Individual variables have a value range of 0.745 to 0.947, according to the Cronbach's Alpha values in the above table, indicating that they have internal consistency and are reliable for further investigation.

3.9 Ethical Consideration

This research followed the ethical principles that guide scientific inquiry and respect human dignity. The researcher obtained informed consent from all the participants, who were free to withdraw at any time. The researcher also protected the privacy and confidentiality of the participants. The researcher minimized the potential for harm by ensuring that the research procedures were safe and comfortable for the participants. The researcher also ensured fairness and equity by selecting a diverse and representative sample of participants and avoiding any bias or discrimination. The researcher disclosed the methods and objectives of the research clearly and honestly. The researcher also acknowledged the sources of information and assistance that contributed to the research, and respected the intellectual property rights of others.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS, AND INTERPRETATION

4.1 Introduction

This chapter covers the analysis of the data gathered by questionnaires. It entails data analysis and interpretation in order to form a conclusion and provide suggestions for high-rise building safety measures practices. This chapter also includes descriptive statistics which contain broad demographic traits and educational background, and the respondent's response is analyzed and presented. Quantitative research approaches were used to accomplish the stated objectives. In order to acquire the essential data and information in order to answer the study questions, questionnaires were used as a data collection instrument. SPSS is used for statistical testing and interpretation of the findings.

4.2 Data Analysis

The data that has been collected using the above-mentioned data collection instruments was analyzed by using SPSS (Statistical Package for Social Sciences) software (Version 27).

Descriptive statistics such as mean, standard deviation, frequency, and percentage were used to summarize the data, and results are presented in tables and figure form.

4.3 Response Rate

Out of the total desired 67 respondents, all 67 are filling out and returning the questionnaires. Where the remaining 3 respondents are not filled properly. So, the data analysis was conducted with 67 respondents.

Table 4- Respondent's response rate

Sample Size	67
Completed and returned questionnaires	67
Response rate	100%

Source: own survey, 2025(SPSS output)

4.4 General Information of the Respondents

4.4.1 Profile of Demographics

The background information of respondents who completed the questionnaire, such as gender, age, job position and educational qualification, work experience, and employment status in the project, is shown in the figure below.

Table 5-Profile of Demographics

		Frequency	Percent	Valid Percent	Cumulative Percent
Genders of Respondents	Male	51	76.1	76.1	76.1
	Female	16	23.9	23.9	100.0
	Total	67	100.0	100.0	
Age of Respondents	20-30	19	28.4	28.4	28.4
	31-40	44	65.7	65.7	94.0
	>41	4	6.0	6.0	100.0
	Total	67	100.0	100.0	
Job Position of Respondents	Foreman	16	23.9	23.9	23.9
	Site Engineer	19	28.4	28.4	52.2
	Structural Engineer	5	7.5	7.5	59.7
	Project Manager	7	10.4	10.4	70.1
	Residential Engineer Consultant	9	13.4	13.4	83.6
	Safety Engineer	11	16.4	16.4	100.0
	Total	67	100.0	100.0	
Education	Diploma	16	23.9	23.9	23.9
	Bachelor's Degree	30	44.8	44.8	68.7

	Master's Degree	21	31.3	31.3	100.0
	Total	67	100.0	100.0	
Employment status	Permanent	45	67.2	67.2	67.2
	Temporary/Contract	22	32.8	32.8	100.0
	Total	67	100.0	100.0	
work experiences	6-10	34	50.7	50.7	50.7
	11-15	30	44.8	44.8	95.5
	16-20	3	4.5	4.5	100.0
	Total	67	100.0	100.0	

Source; own survey 2025 (SPSS output)

According to the demographics of the respondents, 51 (76.1 percent) are male and 16 (23.9 percent) are female. This implies that gender proportion inequity in the construction sector, as the number of females engaged in the construction sector are small as compared to the number of male employees working in the construction sector.

19(28.4%) of the respondents were within the age group of (20-30), 44(65.7%) of the respondents were within the age group of (31-40), and 4(6) of the respondents were above 41 years old. This indicates that the majority of responders were young.

Out of all respondents, 23.9% (16) were foreman, 28.4% (19) were site engineer, 7.5% (5) were structural engineer, 10.4% (7) were project manager, 13.4% (9) were residential engineer consultant, 16.4% (11) were safety engineer, from this, we can analyze that, the majority of the respondents were site engineers. The researcher feels that health and safety are the responsibility of all professions involved in the study in some manner, and has attempted to engage as many as feasible.

As shown in the table above, 44.8% of the respondents were Bachelor's Degree holders, 23.9% were Diploma holders, and 31.3% were Master's Degree holders. It can be seen that the construction industry has space for every educational level.

From the above table, we can understand that 67.2% of our respondents were permanent workers and 32.8% were contract workers. From this, we can analyze that the majority of our respondents were permanent employees.

The figure above shows the work experience of the respondents. 6-10 years of experience, which is 50.7%, there were also respondents with 11-15 years, which is 44.8% and there were also respondents with 16-20 years of experience, which is only 4.5%. From this, we can analyze that the majority of our respondents have 6-10 years of experience.

4.5 Descriptive Statistics of the Independent Variable

On a five-point Likert Scale ranging from 1 to 5, respondents were given a series of questions about safety measure practices. (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree). The following assumption underpins the mean score analysis.

If the mean statistical value falls between 0 and 1.5, the respondents strongly disagreed.

If the mean statistical value is between 1.5 and 2.5, the respondents disagreed.

If the mean statistical value falls between 2.5 and 3.5, the respondents are undecided.

If the mean statistical value is in the range of 3.5 to 4.5, the respondents agreed.

If the mean statistical value is more than 4.5, the respondents strongly agreed.\

4.5.1 Key safety measures and protocols implemented

Table 6- Descriptive Analysis of key safety measures and protocols implemented

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
A formal safety management system is in place on the project site.	67	1	5	3.67	1.021
A dedicated safety officer or team is present on-site at all times.	67	1	5	3.67	1.079
All workers are provided with appropriate PPE (helmets, gloves, vests, boots, etc.).	67	1	5	3.58	1.089
Workers are trained on the proper use of PPE.	67	1	5	3.66	1.023
First aid stations are available and well-equipped.	67	2	5	3.61	1.014
Safety signs and instructions are clearly displayed and easy to understand.	67	1	5	3.70	1.030
Work areas are kept clean and free from unnecessary hazards.	67	2	5	3.58	1.032
All workers follow safe work practices aligned with national and international standards.	67	1	5	3.66	1.052
Valid N (listwise)	67				

Source: own survey, 2025(SPSS output)

Table 6 above in descriptive statistics on key safety measures and protocols implemented shows that A formal safety management system is in place on the project site, has a mean value of 3.67, which indicates that the respondent agrees that there is A formal safety management system in place on the project site. Regarding A dedicated safety officer or team being present on-site at all times, the mean value score is 3.67, which indicates that the majority of the respondents agreed that A formal safety management system is in place on the project site. Regarding All workers are provided with appropriate PPE (helmets, gloves, vests, boots, etc.), the mean score is 3.58, which indicates that the majority of the respondents agreed that All workers are provided with

appropriate PPE (helmets, gloves, vests, boots, etc.). Regarding whether Workers are trained on the proper use of PPE, the mean score is 3.66, which indicates that the majority of the respondents agree that Workers are trained on the proper use of PPE. Regarding First aid stations are available and well-equipped, the mean score is 3.61, which indicates that the majority of the respondents agree that First aid stations are available and well-equipped. Regarding Safety signs and instructions are clearly displayed and easy to understand, the mean score is 3.70, which indicates that the majority of the respondents agree that Safety signs and instructions are clearly displayed and easy to understand. Regarding Work areas being kept clean and free from unnecessary hazards, the mean score is 3.58, which indicates that the majority of the respondents agree that Work areas are kept clean and free from unnecessary hazards. Regarding All workers follow safe work practices aligned with national and international standards, the mean score is 3.66, which indicates that the majority of the respondents agree that All workers follow safe work practices aligned with national and international standards.

From the above data, we can analyze the following related to key safety measures and protocols implemented

- We can analyze from the above data, the highest mean value is 3.70, and the lowest mean value is 3.58. This means that people generally believe key safety measures and protocols are implemented on the project site. However, since the score is not very close to 5, it also implies that: Some respondents may be uncertain or less confident. The system might be partially implemented, not fully understood, or not consistently applied.

4.5.2 Effectiveness of the safety measures in ensuring the health & well-being of construction workers

Table 7- Descriptive Analysis of implemented safety measures in ensuring the health and well-being of construction workers

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
I understand what to do in case of an emergency.	67	1	5	3.67	1.093
I feel safer when using the PPE provided on-site.	67	1	5	3.66	1.122
Adequate rest breaks are provided to avoid fatigue.	67	1	5	3.58	1.103

Clean drinking water and sanitation facilities are available on-site.	67	1	5	3.67	1.093
I feel my physical health is protected by the current safety measures.	67	1	5	3.84	1.024
I feel comfortable reporting unsafe conditions to my supervisor.	67	1	5	3.67	1.093
Safety compliance is consistently enforced for all workers.	67	1	5	3.67	1.093
Overall, I believe the implemented safety measures are effective in protecting workers' health and well-being.	67	1	5	3.67	1.093
Valid N (listwise)	67				

Source: own survey, 2025(SPSS output)

Table 7 above in descriptive statistics on Implemented safety measures in ensuring the health and well-being of construction workers shows that understanding what to do in case of an emergency has a mean value of 3.67, which indicates that the respondent agrees that they understand what to do in case of an emergency situation. Regarding, I feel safer when using the PPE provided on-site, the mean score is 3.66, which indicates that the respondents agree that they feel safer when they use the PPE provided on-site. Regarding Adequate rest breaks being provided to avoid fatigue, the mean score is 3.58, which indicates that the respondents agree that Adequate rest breaks are provided to avoid fatigue. Regarding Clean drinking water and sanitation facilities being available on-site, the mean value is 3.67, which indicates that the respondents agree that clean drinking water and sanitation facilities are available on-site. Regarding, I feel my physical health is protected by current safety measures, the highest mean score is 3.84, this indicates that the responded agrees that they feel physical health is protected by current safety measures in the site. Regarding I feel comfortable reporting unsafe conditions to my supervisor, the mean value is 3.67, which indicates that the respondents agree that they feel comfortable reporting unsafe conditions on-site. Regarding Safety compliance is consistently enforced for all workers, the mean score is 3.67, which indicates that the respondents agree that Safety compliance is consistently enforced for all workers. Overall, I believe the implemented safety measures are

effective in protecting workers' health and well-being. The mean score is 3.67, which indicates that the respondents agree that overall, they believe the implemented safety measures are effective in protecting workers' health and well-being.

From the above data, we can analyze the following related to the implemented safety measures in ensuring the health and well-being of construction workers

- Based on the analyzed data, the mean values range from 3.58 to 3.84, indicating a generally positive perception of the implemented safety measures in ensuring the health and well-being on the project site. The relatively high scores suggest that respondents acknowledge the presence of key safety practices.
- However, since the values are not approaching the maximum score of 5, this may reflect some level of uncertainty or lack of full confidence among participants. It could imply that the implemented safety measures in ensuring the health and well-being on the project site are either partially implemented, not thoroughly understood, or inconsistently enforced across the site.

4.5.3 Challenges faced in the effective implementation of safety practices

Table 8- Descriptive Analysis of challenges faced in the effective implementation of safety practices

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
There is insufficient visible commitment from top management to safety practices.	67	1	4	1.99	.788
Management does not consistently enforce safety rules and procedures.	67	1	4	2.00	.778
Employees lack understanding of the importance and benefits of safety practices.	67	1	4	1.99	.788
New employees do not receive adequate safety induction training.	67	1	4	2.00	.778
Communication regarding safety practices is unclear or inconsistent.	67	1	4	1.99	.788

The necessary personal protective equipment (PPE) is not always readily available or suitable.	67	1	4	2.00	.778
Equipment and machinery are not regularly maintained, leading to safety risks.	67	1	4	1.99	.788
Working conditions (e.g., weather, space constraints) hinder safe practices.	67	1	4	2.00	.778
Safety signs and signals are not always visible or properly maintained.	67	1	4	1.99	.788
There are significant challenges that limit the full implementation of safety practices.	67	1	4	2.00	.778
Findings from safety investigations are not consistently acted upon.	67	1	4	1.99	.788
Valid N (listwise)	67				

Source: own survey, 2025(SPSS output)

Table 8- above in descriptive statistics on challenges faced in the effective implementation of safety practices shows that there is insufficient visible commitment from top management to safety practices, has a mean value is 1.99, which indicates that the respondent disagrees that there is insufficient visible commitment from top management to safety practices on the site. Regarding Management does not consistently enforce safety rules and procedures, the mean value is 2.00, which indicates that the respondent disagrees that Management does not consistently enforce safety rules and procedures on the site. Regarding Employees' lack of understanding of the importance and benefits of safety practices, the mean value is 1.99, which indicates that the respondent disagrees that Employees lack understanding of the importance and benefits of safety practices on the site. Regarding New employees not receiving adequate safety induction training, the mean value is 2.00; this indicates that the respondent disagrees that new employees do not receive adequate safety induction

training on the site. Regarding Communication regarding safety practices is unclear or inconsistent, the mean value is 1.99, which indicates that the respondent disagrees that communication regarding safety practices is unclear or inconsistent on the site. Regarding the necessary personal protective equipment (PPE) is not always readily available or suitable, the mean value is 2.00; this indicates that the respondent disagrees that the necessary personal protective equipment (PPE) is not always readily available or suitable on the site. Regarding equipment and machinery that are not regularly maintained, leading to safety risks, the mean value is 1.99. This indicates that the respondent disagrees that the equipment and machinery are not regularly maintained, leading to safety risks on the site. Regarding Working conditions (e.g., weather, space constraints) hindering safe practices, the mean value is 2.00; this indicates that the respondent disagrees that the Working conditions (e.g., weather, space constraints) hinder safe practices on the site. Regarding Safety signs and signals that are not always visible or properly maintained, the mean value is 1.99; this indicates that the respondent disagrees that the safety signs and signals are not always visible or properly maintained on the site. Regarding, there are significant challenges that limit the full implementation of safety practices, the mean value is 2.00, which indicates that the respondent disagrees that there are significant challenges that limit the full implementation of safety practices on site. Regarding Findings from safety investigations that are not consistently acted upon, the mean value is 1.99, which indicates that the respondent disagrees that the Findings from safety investigations are not consistently acted upon on-site.

From the above data, we can analyze the following related to Challenges faced in the effective implementation of safety practices

- The analyzed data show that the mean values range narrowly between 1.99 and 2.00, which suggests that respondents generally do not perceive significant challenges to the effective implementation of safety practices on the project site. Given that lower scores on the scale typically indicate disagreement, these results imply that most participants do not strongly associate the site with major safety-related obstacles, reflecting a positive outlook on the current safety management environment.

4.5.4 Interventions and techniques to enhance the safety management system in large-scale construction projects

Table 9- Descriptive Analysis of Recommendations can be provided to enhance the safety management system for similar large-scale construction projects

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Future projects should allocate a dedicated budget for safety management and training.	67	1	5	3.81	1.158
Regular third-party safety audits should be conducted throughout the project lifecycle.	67	1	5	3.82	1.127
Continuous refresher training should be provided to all workers during the project.	67	1	5	3.81	1.158
Safety training materials should be provided in multiple languages as needed.	67	1	5	3.81	1.158
Safety feedback from workers should be actively encouraged and acted upon.	67	1	5	3.81	1.158
Regular safety meetings involving all levels of workers and management should be held.	67	1	5	3.82	1.127
Real-time data collection should be used to track and respond to safety risks.	67	1	5	3.81	1.158
All workers should be empowered to stop unsafe work without fear of retaliation.	67	1	5	3.82	1.127
Cross-site learning from past project safety outcomes should be documented and shared.	67	1	5	3.81	1.158
Valid N (listwise)	67				

Source: own survey, 2025(SPSS output)

Table 9: - above in descriptive statistics on Recommendations can be provided to enhance the safety management system for similar large-scale construction projects shows that Future projects should allocate a dedicated budget for safety management and training, has a mean value is 3.81, which indicates that the respondent agrees that Future projects should allocate a dedicated budget for safety management and training. Regarding Regular third-party safety audits should be conducted throughout the project lifecycle, the mean value is 3.82, which indicates that the respondent agrees that Regular third-party safety audits should be conducted throughout the project lifecycle on site. Regarding Continuous refresher training should be provided to all workers during the project, the mean value is 3.81, which indicates that the respondent agrees that Continuous refresher training should be provided to all workers during the project on-site. Regarding Safety training materials should be provided in multiple languages as needed. The mean value is 3.81, which indicates that the respondent agrees that Safety training materials should be provided in multiple languages as needed on-site. Regarding Safety feedback from workers should be actively encouraged and acted upon, the mean value is 3.81, which indicates that the respondent agrees that Safety feedback from workers should be actively encouraged and acted upon on the site. Regarding Regular safety meetings involving all levels of workers and management should be held, the mean value is 3.82, this indicates that the respondent agrees that Regular safety meetings involving all levels of workers and management should be held on the site, Regarding Real-time data collection should be used to track and respond to safety risks, the mean value is 3.81, this indicates that the respondent agrees that Real-time data collection should be used to track and respond to safety risks on the site. Regarding All workers should be empowered to stop unsafe work without fear of retaliation, the mean value is 3.82, which indicates that the respondent agrees that All workers should be empowered to stop unsafe work without fear of retaliation on the site. Regarding Cross-site learning from past project safety outcomes should be documented and shared, the mean value is 3.81, this indicates that the respondent agrees that Cross-site learning from past project safety outcomes should be documented and shared on site.

From the above data, we can analyze the following related to Recommendations can be provided to enhance the safety management system for similar large-scale construction projects.

- The evaluation results indicate that the minimum score assigned to the proposed recommendations for enhancing the safety management system in similar large-scale construction projects falls within the

range of 3.81 to 3.82 on a 5-point Likert scale. This narrow range suggests a consistently high level of agreement among respondents regarding the relevance and potential effectiveness of the recommendations.

- Such uniformity in scoring reflects a strong consensus that the proposed measures are valuable and applicable across comparable project contexts. Although the variation is minimal, it may also imply that all recommendations are perceived as similarly impactful, warranting further analysis to identify those with the greatest potential for implementation and improvement

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

5.1 Summary of major findings

This last chapter of the study presents the summary of the findings obtained from the responses to the research questionnaire. The conclusions drawn from the findings and site observations, in relation to the research question, along with recommendations for existing safety measures, are listed, along with suggestions for future studies.

5.2 Conclusions

The construction sector has long been regarded as one of the most dangerous. According to empirical studies, the industry has a dismal safety record compared to other industries worldwide. The following is a summary of the study's main findings.

- The study found that most of the Chania Communications Construction Company workers in these projects are male with age 31-40, and have between 6 and 10 years of experience.
- Based on the study's findings, which indicate agreement among respondents regarding the implementation of key safety measures, including formal safety systems, PPE provision, training, and clear signage.
- The study indicates strong agreement among respondents regarding the effectiveness of implemented safety measures in promoting health and well-being, such as emergency preparedness, PPE usage, rest breaks, sanitation, and open communication.
- The study reveals that respondents generally disagree with the presence of major challenges and barriers to effective safety implementation, such as a lack of management commitment, poor communication, inadequate training, and insufficient PPE, indicating that safety practices are well-supported.

- The study highlights strong consensus among respondents on key recommendations to enhance safety management in large-scale construction projects dedicated safety budgets, regular audits, refresher training, inclusive communication, and worker empowerment.
- According to the observation checklist conducted during the Bole International Airport Terminal Expansion Project, it was noted that work areas were not consistently kept clean and free from unnecessary hazards. Additionally, materials and tools were not properly stored, stacked, or secured, increasing the risk of collapse, tripping, and other preventable accidents.
- According to Site observations reveal that workers from China Communications Construction Company do not consistently adhere to PPE requirements, often wearing protective gear only when safety engineers or top management are visibly present. This behavior suggests a lack of ingrained safety culture and personal accountability among the workforce, potentially increasing the risk of workplace injuries and undermining the effectiveness of established safety protocols.

5.3 Recommendations

- Given the scale, complexity, and strategic importance of the Bole International Airport terminal expansion, reinforcing the Safety Management System (SMS) is critical to safeguarding workers, passengers, and infrastructure throughout the construction phase. A proactive and integrated safety approach will ensure that the project meets international standards while minimizing risks and disruptions.
- In a high-stakes construction environment like Bole International Airport, where aviation operations, passenger safety, and infrastructure integrity converge, maintaining a continuous on-site presence of qualified safety personnel is essential. This measure ensures real-time hazard identification, immediate response to incidents, and consistent enforcement of safety protocols.
- With the scale and complexity of construction activities at Bole International Airport, proper use of Personal Protective Equipment (PPE) is a frontline defense against injuries and accidents. Enhancing PPE training programs ensures that all personnel, from laborers to supervisors, understand not only the importance of PPE but also how to use it correctly and consistently.

- To foster a proactive and inclusive safety culture within the Bole International Airport terminal expansion project, it is essential to institutionalize regular safety meetings that engage personnel across all organizational levels. These meetings serve as a platform for communication, collaboration, and continuous improvement, ensuring that safety remains a shared responsibility throughout the project lifecycle.
- It is recommended that work areas be consistently maintained in a clean and orderly condition, with prompt removal of debris and unused materials, proper storage and stacking of tools and construction materials in accordance with safety guidelines, and the establishment of clearly marked designated storage zones to ensure separation from active workspaces.
- Based on these findings, it is evident that core safety measures are effectively implemented on-site. However, to further enhance safety compliance and understanding, especially among a diverse workforce, it is recommended that safety training materials and instructions be provided in multiple languages as needed. This will ensure inclusivity and improve comprehension of safety protocols across all worker groups.
- it is recommended that the company implement continuous safety awareness programs, reinforce PPE compliance through regular supervision and peer accountability, and cultivate a culture where safety is viewed as a personal responsibility rather than a managerial directive. Additionally, incorporating incentive-based safety initiatives and disciplinary measures for non-compliance may further enhance adherence to PPE standards.

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APPENDEX-I

Questionnaire

I am a graduate student at Addis College undertaking a degree of Master Project Management. I am conducting research on the Assessment on safety measure practices in building construction projects, in the case of the Bole International Airport terminal expansion Project. This questionnaire is designed to collect data on the mentioned topic for academic purposes. Therefore, I kindly ask you to give me a few minutes of your time to answer the questions. The information you will provide will be treated with utmost confidentiality and will only be used for academic purposes. Thank you in advance for your cooperation.

General Instructions

- You do not need to write your name
- Use tick mark (✓) to answer the questions on the space provided

Part One: Information about the respondent, company direction. Please indicate your response by checking [✓], filling in the box, or leaving a remark, as applicable.

Part 1 Personal Information of Respondents

Gender Male Female

Age 20-30 31-40 >41

Job position Foreman, Site Engineer, Structural Engineer
Project Manager, Daily labor worker Residential
Engineer Consultant Safety Engineer

Education background Diploma Bachelor's Degree Master's
Degree Below Diploma Other

Work Experience 0- 5 years 6-10 years 11-15 years
16-20 years >21

Employment status Permanent Temporary/ Contract

Part Two: Information about the Research issue Please indicate your response by checking [√], filling in the blanks under agreement level Strongly disagree (1), Disagree (2), Undecided (3), Agree (4), and strongly agree (5).

key safety measures and protocols implemented, related questions

Items	Strongly disagree (1)	Disagree (2)	Undecided (3)	Agreed (4)	Strongly agree (5)
A formal safety management system is in place on the project site.					
A dedicated safety officer or team is present on-site at all times.					
All workers are provided with appropriate PPE (helmets, gloves, vests, boots, etc.).					
Workers are trained on the proper use of PPE.					
First aid stations are available and well-equipped.					
Safety signs and instructions are clearly displayed and easy to understand.					
Work areas are kept clean and free from unnecessary hazards.					
All workers follow safe work practices aligned with national and international standards.					

Implemented safety measures in ensuring the health and well-being of construction workers related to questions

Items	Strongly disagree (1)	Disagree (2)	Undecided (3)	Agreed (4)	Strongly agree (5)
I understand what to do in case of an emergency situation.					
I feel safer when using the PPE provided on-site.					
Adequate rest breaks are provided to avoid fatigue.					
Clean drinking water and sanitation facilities are available on-site.					
I feel my physical health is protected by the current safety measures.					
I feel comfortable reporting unsafe conditions to my supervisor.					
Safety compliance is consistently enforced for all workers.					
Overall, I believe the implemented safety measures are effective in protecting workers' health and well-being.					

Challenges faced in the effective implementation of safety practices related to questions

Items	Strongly disagree (1)	Disagree (2)	Undecided (3)	Agreed (4)	Strongly agree (5)
There is insufficient visible commitment from top management to safety practices.					
Management does not consistently enforce safety rules and procedures.					
Employees lack understanding of the importance and benefits of safety practices.					
New employees do not receive adequate safety induction training.					
Communication regarding safety practices is unclear or inconsistent.					
The necessary personal protective equipment (PPE) is not always readily available or suitable.					
Equipment and machinery are not regularly maintained, leading to safety risks.					
Working conditions (e.g., weather, space constraints) hinder safe practices.					
Safety signs and signals are not always visible or properly maintained.					
There are significant challenges that limit the full implementation of safety practices.					
Findings from safety investigations are not consistently acted upon.					

**Recommendations can be provided to enhance the safety management system
for similar large-scale construction projects in the future**

Items	Strongly disagree (1)	Disagree (2)	Undecided (3)	Agreed (4)	Strongly agree (5)
Future projects should allocate a dedicated budget for safety management and training.					
Regular third-party safety audits should be conducted throughout the project lifecycle.					
Continuous refresher training should be provided to all workers during the project.					
Safety training materials should be provided in multiple languages as needed.					
Safety feedback from workers should be actively encouraged and acted upon.					
Regular safety meetings involving all levels of workers and management should be held.					
Real-time data collection should be used to track and respond to safety risks.					
All workers should be empowered to stop unsafe work without fear of retaliation.					
Cross-site learning from past project safety outcomes should be documented and shared.					

APPENDEIX-II
Site Observation Check-list

Items	√	×
Are safety signs (e.g., "Danger," "Hard Hat Area," "No Entry") clearly visible and appropriately placed at entry points and hazardous zones?		
Are all new workers and visitors receiving a site-specific safety induction before commencing work or entering hazardous areas?		
Are materials and tools properly stored, stacked, and secured to prevent collapse or tripping hazards?		
Are fire extinguishers, first-aid kits, and other emergency equipment readily accessible and regularly inspected?		
Are safety supervisors present and visible on site?		
Are all workers wearing mandatory PPE (hard hats, safety boots, high-visibility vests) at all times on site?		
Are safety signs clearly visible and understood? Are instructions given by supervisors clear and acted upon? Do workers know where to report issues?		
Are clean, well-maintained, and easily accessible drinking water, sanitation facilities (toilets, handwashing stations), and designated rest/shelter areas available?		
Workers appear unaware of obvious hazards (e.g., walking under suspended loads, approaching live electrical panels without caution). Difficulty in verbally explaining basic safety rules when asked.		
Workers frequently remove or improperly wear PPE without immediate cause (e.g., hard hat off in a designated area, safety glasses on forehead). Visible signs of discomfort with PPE.		
Non-verbal cues of confusion or misunderstanding when safety instructions are given (e.g., blank stares, incorrect actions following		

instructions). Different languages are spoken by workers and supervisors.		
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