Addis Ababa University
College of Business and Economics
School of Commerce
Department of Project Management

Assessment of Challenges in the Implementation of Electromechanical Projects in Ethiopia: A Case Study of Unilever Manufacturing Plant in East Zone Industry Park – Heating Ventilation and air-conditioning System

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Approved by Board of Examiners:

Advisor	Signature	Date
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Declaration

I, the undersigned, declare and certify that this project thesis document, "Assessment of Challenges in the Implementation of Electromechanical Projects in Ethiopia: A Case Study of Unilever Manufacturing Plant in East Zone Industry Park – Heating Ventilation and air-conditioning System" is my original work, and that all sources of materials utilized in this study have been identified and acknowledged as comprehensive references. This research project work has never been used to fulfill the requirements for a degree at this or any other recognized educational institution. This research work is being submitted in partial fulfillment for the Master of Arts in Project Management, Distance Program in Addis Ababa University, College of Business and Economics, School of Commerce, Department of Project Management.

Author	Signature	Date

I hereby formally declare that this project thesis work, titled "Assessment of Challenges in the Implementation of Electromechanical Projects in Ethiopia: A Case Study of Unilever Manufacturing Plant in East Zone Industry Park – Heating Ventilation and air-conditioning System" is done by Daniel Amare under my supervision and it is an original work except for references and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at AAU or other institutions.

Advisor	Signature	Date

Dedication

To my beloved family and friends.

Acknowledgement

First and foremost, I would like to take this opportunity to thank GOD, the Almighty, for the wisdom, perseverance, strength and patience he gave me to get through this project research work. Next, I would like to express my most sincere and deepest gratitude to my supervisor Dr. Zegeye M. for his limitless support, guidance and encouragement throughout the research project work. I am greatly honored to work under such a humble person, who motivated and believed in me.

As a mechanical engineer who has been working on electro-mechanical systems for years in Ethiopia and always wondering what are the root causes for their successful implementations, I was motivated to carry a research project work on the subject matter. And I would like to extend my profound appreciation to Unilever Manufacturing Plant in East Zone Industry Park - HVAC System project practitioners for participating in the survey and assisting in the project research work with all capacities. Without that, the project wouldn't have deemed to be realized and succeed.

I do not have adequate words to express my profound gratitude to all my friends for their limitless support, motivation and positive attitude. Last but not least, the greatest appreciation goes to my family, who did everything for me from the moment I joined the study till now. I would not be in a position where I am today without them.

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List of Acronyms

CAD	Computer-Aided Design
EBCS	Ethiopian Building Code Standards
HSE	Health Safety and Environment
HVAC	Heating, Ventilation, and Air Conditioning
IDSP	Industrial Development Strategic Plan
IoT	Internet of Things
ISO	International Organization for Standardization
PM	Project Management
QM	Quality Management
RII	Relative Importance Index
TQM	Total Quality Management
TVET	Technical and Vocational Education and Training

Abstract

The electro-mechanical construction sector in Ethiopia has seen a tremendous evolution in the last few years and is expected to bloom even further in the coming years. It is one of the economic sectors which employed numerous citizens and can possibly play a critical role for the growth and transformation of the country. Successful implementation of electro-mechanical projects in to reality is one of the most important and critical aspects of any electro-mechanical projects worldwide. The electro-mechanical sector in Ethiopia is challenged via several challenges affecting its successful impetrations. This research project work aims to assess challenges in the implementation of electromechanical projects in Ethiopia: a case study of Unilever manufacturing plant in east zone industry park - HVAC system. This research study work used a quantitative methodology, collecting data through the use of questionnaires. Purposive sampling was used to choose a total of fifty-four participants who agreed to take part in the study. The study found a number of factors affecting electro-mechanical project implementation in Ethiopia; therefore, it can be used as a guide for future research. It was discovered that there is a serious gap; in electro-mechanical (HVAC) awareness and practice, level of project planning and coordination, resource availability, level of technical expertise, technological infrastructure, familiarity with the regulations and guidelines governing electro-mechanical systems, integration and adoption of cutting-edge technologies. The research recommends that critical interventions in electro-mechanical systems awareness and practices creation, involvement of project planning and coordination specialists, availing technological infrastructures to support project implementation, the need for electro-mechanical firms to better reorganize so that they can better deal with project planning, strategizing, coordination and implementations is a must if the sector is deemed to succeed and tap its full potential in the coming years.

Key words: Electro-Mechanical, Project, Project Implementation Challenges, HVAC.

Chapter One

Introduction and Background

1.1 General Overview

In today's dynamic industrial landscape, the successful implementation of electromechanical projects is critical for the efficient functioning of manufacturing facilities among these, Heating, Ventilation, and Air Conditioning (HVAC) systems play a pivotal role in maintaining optimal environmental conditions within industrial spaces (Huang, 2020). This proposed research project work delves into the intricate web of challenges encountered during the implementation of such electromechanical projects, with a specific focus on the Unilever Manufacturing Plant in the East Zone Industry Park.

1.1.1 Importance of Electromechanical Projects

Electromechanical projects form the backbone of modern industrial infrastructure, encompassing a broad spectrum of systems that integrate electrical and mechanical components (Huang, 2020). These projects are integral for sustaining operations in diverse industries, ensuring seamless functionality of crucial processes. HVAC systems, in particular, are indispensable for maintaining temperature, humidity, and air quality standards within manufacturing environments, thereby safeguarding product quality, equipment longevity, and the well-being of personnel.

1.1.2 Unilever Manufacturing Plant – A Case Study

The Unilever Manufacturing Plant in the East Zone Industry Park serves as an exemplary subject for this investigation. As a multinational consumer goods company, Unilever's commitment to product quality and environmental sustainability is reflected in its state-of-the-art manufacturing facilities. The chosen case study allows for a detailed

exploration of the challenges faced in implementing HVAC systems within a complex and large-scale industrial setting.

1.2 Challenges in Electro-Mechanical Project Implementation

The implementation of electromechanical projects is a complex undertaking that presents a myriad of challenges for project managers and engineers (Mekuria & Ababa, 2019). One of the foremost challenges is the management of budget constraints, often exacerbated by the intricate nature of integrating electrical and mechanical components. The costs associated with procuring high-quality materials, advanced technology, and skilled labor contribute to the financial intricacies of these projects. Furthermore, the need for specialized expertise in both electrical and mechanical engineering adds another layer of complexity, potentially leading to increased labor costs and longer project timelines.

Technical complexities represent another significant hurdle in electromechanical project implementation. The integration of diverse systems, each with its own set of technical specifications, requires a meticulous understanding of compatibility and interoperability. The potential for unforeseen technical challenges often arises during the integration phase, necessitating adaptability and innovative problem-solving skills from the project team. Moreover, the rapid pace of technological advancement introduces the risk of obsolescence, making it imperative for project teams to stay abreast of the latest developments and future-proof their designs.

Regulatory compliance poses a substantial challenge, especially in industries where stringent standards and codes govern electromechanical systems (Lundgren, 1991). Adhering to safety and environmental regulations requires careful navigation of legal frameworks, with non-compliance carrying the risk of legal consequences and project delays. This challenge is amplified when projects span multiple jurisdictions, each with its unique regulatory landscape.

Interdisciplinary collaboration is both a necessity and a challenge in electromechanical projects. Coordinating efforts between electrical and mechanical engineering teams demands effective communication and a shared understanding of project objectives. The potential for miscommunication or differences in approach can impede progress and lead to suboptimal outcomes. Moreover, the diversity of skill sets among team members necessitates a holistic project management approach that embraces interdisciplinary collaboration to maximize efficiency.

Timeline management represents a critical aspect of project implementation, and electromechanical projects are no exception (Boltena & Gomez, 2012). Delays in one component, whether electrical or mechanical, can have cascading effects on the overall project timeline. Contingency planning becomes crucial, requiring project managers to anticipate potential bottlenecks and develop strategies for mitigating delays without compromising the project's integrity.

In conclusion, the challenges inherent in electromechanical project implementation are multifaceted, ranging from financial considerations and technical intricacies to regulatory compliance and interdisciplinary collaboration. Addressing these challenges requires a strategic and holistic approach, emphasizing adaptability, effective communication, and proactive risk management.

1.3 Statement of the Problem

Despite the remarkable strides made in the industrial sector of Ethiopia, characterized by a burgeoning economy and a growing emphasis on technological advancement, the successful implementation of electromechanical projects remains a formidable challenge. This challenge is particularly pronounced in the context of complex manufacturing processes, where the integration of electrical and mechanical systems is crucial for sustained productivity and operational excellence.

The Unilever Manufacturing Plant in the East Zone Industry Park stands as a microcosm of these challenges. While the plant represents a beacon of industrial prowess and innovation, the intricate nature of its electromechanical projects, especially the implementation of the Heating, Ventilation, and Air Conditioning (HVAC) system, presents a myriad of difficulties. The overarching problem that this thesis seeks to address revolves around the identification and analysis of the specific challenges faced in the implementation of electromechanical projects, with a spotlight on the HVAC system at the Unilever Manufacturing Plant.

1.3.1 Contextualizing Challenges in the Ethiopian Industrial Landscape

In the Ethiopian context, where the industrial sector is a key driver of economic growth and development, the successful execution of electromechanical projects is paramount (Mekuria & Ababa, 2019). The challenges faced in project implementation resonate with broader issues such as:

- **Technological Infrastructure**: The dynamic nature of technological advancements necessitates constant adaptation, posing challenges in integrating cutting-edge technologies within existing infrastructure (Delaney & Delaney, 2015).
- **Skilled Workforce:** The demand for skilled personnel capable of navigating the complexities of electromechanical systems often outpaces the available workforce, leading to skill gaps and operational bottlenecks (Executive Agency for Small and Medium-sized Enterprises. et al., n.d.).
- **Regulatory Compliance:** Adhering to stringent regulatory frameworks is critical for sustainable operations. However, navigating complex regulatory landscapes poses a considerable challenge for project implementers (Oguejiofor et al., 2023) .

1.3.2 The HVAC System as a Focal Point

Within this overarching problem, the HVAC system emerges as a focal point due to its indispensable role in maintaining optimal working conditions within the manufacturing plant. The challenges associated with HVAC implementation at the Unilever Manufacturing Plant include:

- **Energy Efficiency**: Balancing the need for an efficient HVAC system with the imperative of energy conservation poses a delicate challenge, particularly in a country like Ethiopia where energy resources may be limited.
- **Climate Considerations:** Ethiopia's diverse climate zones demand HVAC solutions that can adapt to varying environmental conditions, adding layers of complexity to system design and implementation.
- **Maintenance and Sustainability:** Ensuring the long-term sustainability of the HVAC system requires meticulous planning for maintenance, a task that is often hindered by resource constraints and operational demands.

By delving into the specifics of these challenges, this thesis aims to contribute to the body of knowledge surrounding electromechanical project implementation in Ethiopia, offering insights that can inform strategic decision-making and policy formulation within the industrial sector.

1.4 Research Questions

The exploration of project implementation challenges in the context of Ethiopian electromechanical projects, with a specific focus on the Unilever Manufacturing Plant in the East Zone Industry Park and its HVAC system, is guided by the following research questions:

- What are the primary challenges encountered in the implementation of electromechanical projects within the Ethiopian industrial landscape?
- How does the Unilever Manufacturing Plant in the East Zone Industry Park navigate the integration of cutting-edge technologies within its electromechanical framework, with a focus on the HVAC system?
- How does the Ethiopian industrial sector address the gap in skilled personnel for the successful implementation of electromechanical projects, and what impact does this have on project outcomes?
- What recommendations can be proposed for mitigating the challenges identified in the implementation of the HVAC system at the Unilever Manufacturing Plant, and how applicable are these recommendations to similar projects in Ethiopia?

By addressing these research questions, this thesis aspires to contribute nuanced insights into the complexities of project implementation in Ethiopia, offering practical recommendations for industry practitioners, policymakers, and researchers in the field of electromechanical engineering.

1.5 Project Research Objectives

1.5.1 General Objective

The overarching objective of this research is to conduct a comprehensive assessment of the challenges faced in the implementation of electromechanical projects within the Ethiopian industrial landscape, with a primary focus on the Unilever Manufacturing Plant in the East Zone Industry Park. The study aims to unravel the intricacies associated with the integration of electrical and mechanical systems, offering valuable insights that contribute to the enhancement of project implementation strategies in the broader context of Ethiopia's industrial sector.

1.5.2 Specific Objectives

To achieve the general objective outlined above, the proposed research study work is guided by the following specific objectives:

- *Identify and Categorize Electromechanical Project Implementation Challenges:* To systematically identify and categorize the challenges encountered in the implementation of electromechanical projects in Ethiopia, considering factors such as technological infrastructure, workforce capabilities, and regulatory compliance.
- *Analyze Strategies for Technology Integration at the Unilever Manufacturing Plant*: To critically analyze the approaches and strategies employed by the Unilever Manufacturing Plant in integrating cutting-edge technologies within its electromechanical framework. This includes an examination of technology adaptation, workforce training, and system integration.
- *Assess Workforce Capacities in the Ethiopian Industrial Sector*: To assess the availability of a skilled workforce in the Ethiopian industrial sector, with a particular focus on electromechanical projects. This objective aims to explore how the sector addresses the gap in skilled personnel and its impact on the successful implementation of projects.
- *Develop Practical Recommendations for Project Improvement*: To propose pragmatic recommendations for mitigating the challenges identified in the implementation of the HVAC system at the Unilever Manufacturing Plant. Additionally, to evaluate the broader applicability of these recommendations to similar electromechanical projects within the Ethiopian industrial landscape.

By addressing these specific objectives, this research endeavors to provide a holistic understanding of the complexities surrounding project implementation in Ethiopia,

offering actionable insights for industry stakeholders, policymakers, and researchers in the realm of electromechanical engineering.

1.6 Rationale and Significance of the Research Study Work

1.6.1 Rationale of the Research Study Work

Understanding the challenges inherent in electromechanical projects, and specifically HVAC system implementation, is imperative for several reasons. First, it provides valuable insights for project managers and engineers involved in similar ventures, offering lessons learned and best practices. Second, the findings will contribute to the academic discourse surrounding project management and electromechanical engineering, fostering a deeper understanding of the intricacies involved in executing such projects. Finally, the study aims to bridge the gap between theoretical knowledge and practical application, fostering a more robust framework for addressing challenges in real-world scenarios.

1.6.2 Significance of the Research Study Work

This study holds paramount significance for various stakeholders within the Ethiopian industrial sector, academia, and the broader community. The findings and insights generated through this research are anticipated to contribute substantially to the enhancement of project implementation practices, particularly in the realm of electromechanical projects. The significance of this study can be delineated as follows:

- **Contribution to the Existing Knowledge Pool**

The research contributes to the existing body of knowledge by delving into the nuanced challenges of implementing electromechanical projects in the context of Ethiopia. As a country experiencing rapid industrialization, Ethiopia faces unique challenges that require a tailored understanding. This study provides a comprehensive analysis that

extends beyond generic project management principles, offering context-specific insights into the complexities associated with technology integration, workforce dynamics, and regulatory compliance.

- **Practical Implications for the Industry**

The study's findings are poised to offer practical implications for industry practitioners involved in electromechanical project implementation. By identifying and categorizing challenges, the research equips project managers, engineers, and decision-makers with a roadmap to navigate obstacles effectively. The analysis of technology integration strategies and the assessment of workforce capacities provide actionable insights to enhance project planning and execution, ultimately contributing to the efficiency and sustainability of industrial operations.

- **Case-Specific Relevance for Unilever Manufacturing Plant**

The Unilever Manufacturing Plant in the East Zone Industry Park serves as a specific case study, and the outcomes of this research directly impact its operational strategies. The insights gained from examining the HVAC system implementation challenges at Unilever contribute to the plant's ongoing efforts to refine its electromechanical infrastructure. The study aims to foster an environment of continuous improvement, aligning Unilever's practices with the ever-evolving landscape of industrial technology.

- **Policy Formulation and Decision-Making**

The study's recommendations for mitigating challenges and improving project implementation practices can inform policy intervention and formulation at both organizational and governmental levels. Policymakers can utilize the research outcomes to shape regulations that foster a conducive environment for electromechanical projects in Ethiopia. Decision-makers, armed with evidence-based insights, can implement

strategic changes that optimize resource allocation, enhance workforce development, and streamline regulatory processes.

- **Academic Contribution**

Academically, this research enriches the field of electromechanical engineering by providing a detailed case study and analysis that can serve as a reference for future studies. The study contributes to the academic discourse on project management challenges in developing economies, offering a foundation for further research on similar topics. Additionally, it provides a real-world application of theoretical concepts, bridging the gap between academic knowledge and practical implementation.

In summary, the significance of this study lies in its potential to catalyze positive change within the Ethiopian industrial sector, fostering innovation, sustainability, and resilience in the face of evolving challenges associated with electromechanical project implementation.

1.7 Scope of the Research Project Work

The proposed research project work scope is planned to be limited to focus on the challenges encountered for the implementation of HVAC systems within the Unilever Manufacturing Plant in the East Zone Industry Park. While the principles going to be discussed might going to incorporate broader applications, the specific nuances of the chosen case study provide depth and context to the exploration of project implementation challenges in the electromechanical domain.

Hence the study is delimited in terms of geographical, temporal, and thematic considerations to ensure a targeted and meaningful exploration of the challenges in electromechanical project implementation, particularly within the Ethiopian context and the Unilever Manufacturing Plant in the East Zone Industry Park.

- **Geographical Scope**

This research is primarily centered on the Ethiopian industrial landscape, with a specific emphasis on the challenges faced in the implementation of electromechanical projects. The Unilever Manufacturing Plant, located in the East Zone Industry Park, serves as the primary case study for the investigation. The choice of this specific geographical location allows for an in-depth examination of challenges within the context of Ethiopia's industrialization drive.

- **Temporal Scope**

The temporal scope of the study encompasses a specified timeframe for data collection, analysis, and interpretation. The investigation is primarily focused on the period from October 2023 to February 2024, ensuring that the research captures a contemporary snapshot of the challenges faced in the implementation of electromechanical projects at the Unilever Manufacturing Plant. This timeframe allows for a relevant and up-to-date analysis of the project's dynamics.

- **Thematic Scope**

The study specifically targets challenges related to the implementation of electromechanical projects, with a key focus on the Heating, Ventilation, and Air Conditioning (HVAC) system within the Unilever Manufacturing Plant. The thematic scope encompasses a range of challenges, including but not limited to technological integration, workforce capacities, regulatory compliance, energy efficiency, climate adaptability, and long-term sustainability. By concentrating on these themes, the research aims to provide a comprehensive understanding of the multifaceted challenges associated with electromechanical projects in Ethiopia.

- **Exclusions**

While the study seeks to be comprehensive in its exploration, certain aspects fall outside its scope. Specifically, detailed assessments of other industrial sectors beyond the chosen

case study, and in-depth analyses of broader economic or political factors influencing project implementation, are beyond the purview of this research.

- **Delimitations**

To maintain focus and depth, the study delimits its investigation to the Unilever Manufacturing Plant in the East Zone Industry Park. While the findings may have broader implications for the Ethiopian industrial sector, the in-depth examination of a specific case allows for a nuanced exploration of challenges unique to the chosen electromechanical project.

In essence, the scope of this study provides a structured framework for a targeted and insightful investigation into the challenges of electromechanical project implementation in Ethiopia, with a concentrated examination of the Unilever Manufacturing Plant in the East Zone Industry Park.

1.8 Project Research Work Report Organization

This final thesis document of the project research work is divided into the following five main chapters. The current chapter, Chapter One, presented general overview (importance of electrotechnical projects, and Unilever manufacturing plant – a case study), challenges in electro-mechanical project implementation, statement of the problem (contextualizing challenges in the Ethiopian industrial landscape, and the HVAC system as a focal point), research questions, project research objectives (general objective and specific objectives), rationale and significance of the study work (rationale of the study work, and significance of the study work), scope of the research project work, and project research work report organization.

Chapter Two, gives details on conceptual review, (introduction to electromechanical projects, evolution of electromechanical projects, significance of HVAC systems, meaning and nature/characteristics of electromechanical projects (technological integration,

collaborative workforce dynamics, regulatory frameworks and compliance, and socio-economic growth), importance of electromechanical projects (driver of economic growth, catalyst for technological advancement, power of sustainability, enhancer of global competitiveness, and facilitator of local empowerment), scope/process and stages/components of electromechanical projects (scope of electromechanical projects, process driving electromechanical projects, stages of electromechanical project lifecycle, components defining electromechanical projects, and adaptation to technological advances), challenges in electromechanical project implementation (technological integration challenges, workforce skill gaps, regulatory compliance hurdles, sustainability consideration, project financing and resource allocation, and adapting to industry 4.0), electro-mechanical projects implementation challenges in developing countries (limited infrastructure support, technology accessibility and affordability, and capacity building and skill development), electro-mechanical projects implementation challenges in Ethiopia (economic constraints, regulatory landscape, integration with local industrial ecosystem, and environmental and social considerations)), review of empirical studies (global perspective on electromechanical projects, lessons learned and best practices, industry-specific considerations, technology adaptation strategies, risk mitigation and contingency planning, and human factors in project success), and conceptual framework of the study (technological adaptation, workforce development, regulatory compliance and ethical engineering, sustainability integration, risk management, industry 4.0 preparedness, and local and global contextualization).

Chapter Three of this thesis document discusses in details on research design, research approach, population of the study, sampling techniques, source of data, data collection tools, procedure of data collection, methods of data analysis and presentation, validity of reliability, ethical consideration, and finally interpretation and computation techniques used (mean value computation, and Relative Importance Index (RII) computation).

In Chapter Four, primary data analysis, general demographic information, electro-mechanical (HVAC) quality awareness and practice assessment, perceived challenges in implementation electro-mechanical projects assessment (project planning and coordination assessment, technical expertise in electro-mechanical systems assessment, resource availability assessment, communication among project stakeholders assessment, regulatory compliance and permitting issues assessment, energy efficiency awareness assessment, and quality management implementation challenges assessment), integration of cutting-edge technologies in electro-mechanical framework, and recommendations for mitigating HVAC system implementation challenges is presented.

Chapter Five summarizes the fundamental findings and aspects of the research project work delivering details on summary of major findings, conclusion, recommendation, and direction for future research. Finally, Appendix A gives the questionnaire used for this research study work.

Chapter Two

Literature Review

This section provides information, descriptions, summaries, and assessments of sources in relation to their contribution to the study topic of electro-mechanical project implementations in Ethiopia. It provides a review of literatures in this field that has been studied earlier by other authors and researchers.

2.1 Conceptual Review

2.1.1 Introduction to Electromechanical Projects

Electromechanical projects represent a confluence of diverse engineering disciplines, intertwining electrical and mechanical systems in a symbiotic dance. In the Ethiopian context, this convergence is particularly complex, reflecting the nation's journey towards modernization and economic diversification. In the electromechanical installation process, the capacity of the entire building information is relatively large, and the design content involved is numerous and complex. The unified management of integrated pipe network, project cost, product specifications and material manufacturers are implemented to facilitate real-time query and effective management, and then improve the management level of electromechanical enterprises and control the probability of accidents in engineering management (Zhang et al., 2018a). Recognizing the multifaceted nature of electromechanical projects involves deciphering the intricate relationships between technological advancements, workforce dynamics, and regulatory frameworks.

As Ethiopia strives to position itself as a hub of industrial excellence, the role of electromechanical projects in shaping this trajectory cannot be overstated. These projects serve as catalysts for innovation, driving advancements that enhance operational efficiency, promote sustainability, and contribute to the overarching goals of economic

growth. Therefore, a nuanced understanding of the meaning and characteristics of electromechanical projects is foundational to navigating the evolving landscape of the Ethiopian industrial sector.

This section delves into the fundamental concepts underlying electromechanical projects, dissecting their meaning and nature. It explores the characteristics that define these projects, ranging from the integration of cutting-edge technologies to the collaborative efforts of a skilled workforce. By unpacking the essence of electromechanical projects, this literature review seeks to provide a theoretical foundation upon which the subsequent analysis of challenges and opportunities will be anchored.

Moreover, the examination of the meaning and nature of electromechanical projects extends beyond their technical dimensions. It encompasses the broader socio-economic context, considering how these projects align with national development goals and contribute to the empowerment of local industries. By scrutinizing the interplay between technological innovation and socio-economic advancement, this literature review aspires to offer a holistic perspective on the significance of electromechanical projects in the Ethiopian context.

In essence, this section not only lays the groundwork for the subsequent exploration of challenges but also underscores the pivotal role that electromechanical projects play in shaping the trajectory of industrialization in Ethiopia. The review serves as an invitation to delve deeper into the dynamic interplay of technology, workforce capabilities, and regulatory landscapes that characterize these projects in the Ethiopian context.

2.1.2 Evolution of Electromechanical Projects

L projects is a testament to the transformative impact of technological advancements on industrial processes (Lundgren, 1991). Over the decades, the landscape of manufacturing and engineering has witnessed a paradigm shift, driven by innovations in both electrical

and mechanical engineering. In the early stages of industrialization, the separation of electrical and mechanical systems was more distinct, with each operating in relative isolation. However, as industries sought more efficient and integrated solutions, the need for collaborative efforts between these disciplines became increasingly evident.

The mid to late 20th century marked a significant turning point with the advent of Computer-Aided Design (CAD) and the rise of automation (Sarcar et al., 2008). The integration of electrical and mechanical components became more intricate, leading to the birth of electromechanical projects that aimed to harness the synergies between these traditionally separate domains. This era witnessed the emergence of complex systems, such as automated production lines and robotic assembly processes, where seamless coordination between electrical and mechanical elements was imperative for success.

In recent years, the fourth industrial revolution, often referred to as Industry 4.0, has propelled electromechanical projects into a new era (Satyro et al., 2022a). The convergence of digital technologies, artificial intelligence, and the Internet of Things (IoT) has given rise to smart and interconnected systems, further blurring the lines between electrical and mechanical engineering. The evolution continues, with an emphasis on creating adaptive, self-monitoring, and self-regulating electromechanical systems that can respond to dynamic industrial environments in real-time. This evolution underscores the need for a nuanced understanding of the challenges posed by increasingly intricate electromechanical projects.

In this context, the Unilever manufacturing plant serves as a microcosm of this evolution, embodying the intricate integration of electromechanical systems to optimize production processes while meeting stringent quality and sustainability standards.

2.1.3 Significance of HVAC Systems

Within the realm of electromechanical projects, Heating, Ventilation, and Air Conditioning (HVAC) systems stand out as linchpins of environmental control in industrial settings. The multifaceted significance of HVAC systems extends beyond conventional temperature regulation, encompassing a spectrum of crucial functions vital for sustaining optimal manufacturing conditions (Bac et al., 2021). One of the primary roles of HVAC systems is temperature control, ensuring that industrial spaces maintain a consistent and conducive environment for both machinery and personnel. In precision manufacturing processes, where temperature variations can compromise product quality and equipment functionality, HVAC systems play a pivotal role in mitigating these risks.

Ventilation is another critical aspect addressed by HVAC systems. Effective ventilation not only ensures a continuous supply of fresh air but also assists in the removal of airborne contaminants, such as dust and pollutants, thereby fostering a healthier and safer workspace. The circulation of clean air is paramount for industries adhering to stringent quality standards, as it directly contributes to the integrity of the manufacturing process and the well-being of employees. Moreover, HVAC systems play a crucial role in humidity control, preventing excess moisture that could otherwise lead to corrosion, mold growth, and degradation of materials, all of which pose substantial threats to machinery and product quality.

Beyond these operational considerations, the significance of HVAC systems extends to energy efficiency and sustainability. Modern HVAC technologies incorporate advanced features like energy recovery systems and smart controls, optimizing energy usage and reducing environmental impact. This dual focus on operational efficiency and environmental responsibility aligns with the broader industry trend towards sustainable manufacturing practices, making HVAC systems integral components in achieving these goals.

In the context of the Unilever Manufacturing Plant, where precision and quality are paramount in the production of consumer goods, the significance of HVAC systems becomes magnified. The meticulous control of environmental conditions not only safeguards the integrity of Unilever's products but also contributes to the company's commitment to sustainability and responsible manufacturing practices.

2.1.4 Meaning and Nature/Characteristics of Electromechanical Projects

Electromechanical projects, at their core, represent a fusion of electrical and mechanical engineering disciplines, giving rise to multifaceted systems that underpin industrial operations. The meaning and nature of these projects transcend their technical components, encapsulating a dynamic interplay of innovation, integration, and collaboration within the Ethiopian industrial landscape.

2.1.4.1 Technological Integration

The meaning of electromechanical projects is intricately tied to the seamless integration of advanced technologies. These projects encompass a spectrum of technological components, ranging from precision machinery to sophisticated control systems. In the Ethiopian industrial context, this integration is not merely a technical endeavor but a transformative force shaping the evolution of manufacturing processes and operational methodologies.

2.1.4.2 Collaborative Workforce Dynamics

The nature of electromechanical projects extends beyond the realm of machines and circuits; it encompasses the collaborative efforts of a skilled workforce. These projects necessitate a symbiotic relationship between electrical and mechanical engineers, project managers, and technicians (Whisenant et al., 2019). The Ethiopian workforce, with its

diverse talents and evolving skill sets, plays a crucial role in the successful execution of electromechanical projects, contributing to the nation's burgeoning engineering prowess.

2.1.4.3 Regulatory Frameworks and Compliance

The characteristics of electromechanical projects are further defined by their adherence to evolving regulatory frameworks. Ethiopia, in its pursuit of industrial excellence, establishes standards and guidelines to ensure the safety, sustainability, and quality of projects. On the basis of the Industrial Development Road Map (2013 -2025) of the country, this comprehensive Industrial Development Strategic Plan (IDSP) has been developed (Ababa, 2013). The nature of these projects involves navigating a complex regulatory landscape, where compliance becomes not only a legal requirement but a cornerstone of responsible and ethical engineering practices.

2.1.4.4 Socio-Economic Implications

Beyond the technical dimensions, the meaning of electromechanical projects extends to their socio-economic implications. These projects serve as drivers of economic development, providing employment opportunities, fostering innovation, and contributing to the overall growth of local industries (Glasson, 2017). Understanding the socio-economic fabric woven by electromechanical projects is crucial for aligning their implementation with broader national development goals in Ethiopia.

In essence, the meaning and nature of electromechanical projects in the Ethiopian context embody a harmonious convergence of technology, skilled human capital, and regulatory compliance. The characteristics of these projects go beyond their physical manifestations, influencing the socio-economic landscape and contributing to Ethiopia's vision of becoming a regional industrial powerhouse.

2.1.5 Importance of Electromechanical Projects

The importance of electromechanical projects within the Ethiopian industrial landscape is multifaceted, contributing significantly to the nation's ambitions of economic growth, technological advancement, and industrial sustainability (Weldesilassie et al., 2017). This section explores the crucial role these projects play in shaping the trajectory of industrialization in Ethiopia and their overarching impact on various dimensions.

2.1.5.1 Driver of Economic Growth

Electromechanical projects emerge as pivotal drivers of economic growth in Ethiopia. As the nation strategically positions itself to become an industrial hub (Narasimha et al., 2013), these projects propel advancements in manufacturing, energy, and infrastructure. The economic importance is manifested through increased productivity, job creation, and the establishment of a robust industrial ecosystem. The integration of advanced technologies within electromechanical projects amplifies their economic impact, fostering innovation and positioning Ethiopia as a competitive player in the global market (Fenta, 2014).

2.1.5.2 Catalyst for Technological Advancement

At the heart of the importance of electromechanical projects lies their role as catalysts for technological advancement. The integration of cutting-edge technologies within these projects propels the nation towards the forefront of innovation (Singh, 2023). By pushing the boundaries of what is technologically feasible, these projects contribute to the evolution of engineering practices, establishing Ethiopia as a center for technological excellence in the region.

2.1.5.3 Power of Sustainability

In the context of Ethiopia's commitment to sustainability, electromechanical projects become key promoters of environmentally conscious practices. From energy-efficient systems to sustainable manufacturing processes (Akadiri et al., 2012), these projects align with global sustainability goals. The importance of sustainability is not only a response to environmental challenges but also a strategic positioning that enhances Ethiopia's reputation as a responsible participant in the global industrial landscape.

2.1.5.4 Enhancer of Global Competitiveness

Electromechanical projects elevate Ethiopia's global competitiveness by fostering industries capable of meeting international standards. As these projects integrate state-of-the-art technologies and adhere to stringent regulatory frameworks, they position Ethiopian industries on the global stage. The importance of these projects lies in their ability to enhance the nation's standing, attract foreign investments, and facilitate the exchange of technological expertise.

2.1.5.5 Facilitator of Local Empowerment

Beyond economic indicators, the importance of electromechanical projects extends to their role in local empowerment. By creating employment opportunities, fostering the development of a skilled workforce, and contributing to the growth of indigenous industries, these projects become agents of social and economic empowerment (Nieusma & Riley, 2010). This local empowerment aligns with Ethiopia's vision of inclusive and sustainable development.

In summary, the importance of electromechanical projects in Ethiopia is far-reaching, influencing economic, technological, environmental, and social dimensions. Understanding this importance is pivotal for shaping policies, strategies, and initiatives

that harness the full potential of these projects within the nation's industrialization narrative.

2.1.6 Scope/Process and Stages/Components of Electromechanical Projects

Understanding the scope, processes, and stages of electromechanical projects is fundamental to unraveling the intricacies involved in their successful implementation. This section delves into the multifaceted dimensions that define the landscape of these projects, exploring the scope of activities, the intricate processes that drive them, and the distinct stages and components that characterize their lifecycle.

2.1.6.1 Scope of Electromechanical Projects

The scope of electromechanical projects is expansive, encapsulating a spectrum of activities that span from conceptualization to operation and maintenance. These projects encompass the design, development, and integration of systems that blend electrical and mechanical components seamlessly. In Ethiopia, the scope of these projects mirrors the nation's industrial ambitions, incorporating advancements in diverse sectors such as manufacturing, energy, and infrastructure.

2.1.6.2 Process Driving Electromechanical Projects

The processes driving electromechanical projects are dynamic and multifaceted. From initial conceptualization and feasibility studies to detailed design, procurement, and construction, each phase demands meticulous planning and execution (Esteves et al., 2013). The integration of advanced technologies and adherence to regulatory standards add layers of complexity to these processes. Understanding the intricacies of these processes is crucial for stakeholders, as it forms the foundation for informed decision-making and strategic planning.

2.1.6.3 Stages of Electromechanical Project Lifecycle

The lifecycle of an electromechanical project unfolds through distinct stages, each presenting unique challenges and opportunities. The stages typically include project initiation, planning, design, procurement, construction, commissioning, and operation and maintenance (Zhang et al., 2018b). In the Ethiopian industrial context, the effective navigation of these stages is critical for ensuring the seamless integration of electromechanical systems into the operational fabric of industries.

2.1.6.4 Components Defining Electromechanical Projects

The components that define electromechanical projects are as diverse as the projects themselves. From intricate electrical systems to precision mechanical components, the integration of these elements requires a multidisciplinary approach. Moreover, the human factor plays a significant role, with skilled engineers, technicians, and project managers collaborating to bring these components together (Jamnia, 2023). In Ethiopia, where skilled human capital is a valuable asset, understanding the diverse components of electromechanical projects is essential for optimizing project outcomes.

2.1.6.5 Adaptation to Technological Advances

The scope, processes, stages, and components of electromechanical projects are subject to continual adaptation in response to technological advances (Leonard, 2011). As new technologies emerge, and existing ones evolve, the landscape of these projects transforms. This adaptability is particularly crucial in Ethiopia, where rapid technological advancements necessitate a proactive approach to stay at the forefront of industrial innovation.

In summary, delving into the scope, processes, stages, and components of electromechanical projects provides a comprehensive understanding of the landscape within which these projects unfold. The adaptability to technological changes and the

effective management of diverse components are central to the successful implementation of electromechanical projects in Ethiopia.

2.1.7 Challenges in Electromechanical Project Implementation

Understanding the challenges inherent in electromechanical project implementation is paramount for devising effective strategies and solutions. This section delves into the diverse array of challenges faced by projects of this nature, exploring the complexities that arise in technological integration, workforce dynamics, regulatory compliance, and sustainability considerations within the Ethiopian industrial context.

2.1.7.1 Technological Integration Challenges

One of the primary challenges in electromechanical projects lies in the integration of advanced technologies. The rapid pace of technological evolution introduces complexities in selecting, adapting, and implementing cutting-edge systems (Badjou, 2011). Ethiopia's industrial sector, aspiring to embrace state-of-the-art technologies, encounters challenges related to the compatibility of systems, the need for specialized expertise, and the risks associated with adopting untested innovations.

2.1.7.2 Workforce Skill Gaps

The dynamic nature of electromechanical projects necessitates a skilled and adaptable workforce. However, workforce skill gaps emerge as a significant challenge in the Ethiopian context (Oguejiofor et al., 2023). The demand for specialized knowledge in both electrical and mechanical engineering requires concerted efforts in education, training, and skill development (Muci-Küchler et al., 2022),Bridging these gaps is essential to ensuring the successful execution of projects and sustaining long-term operational excellence.

2.1.7.3 Regulatory Compliance Hurdles

Navigating the intricate web of regulatory frameworks poses a considerable challenge in electromechanical project implementation (Aliu et al., 2023). Ethiopia, as it advances its industrial agenda, grapples with the need to align projects with evolving standards and compliance requirements. Adhering to regulatory guidelines, obtaining necessary permits, and ensuring environmental sustainability demand meticulous attention and resources, adding layers of complexity to project management.

2.1.7.4 Sustainability Considerations

As global awareness of environmental sustainability grows, electromechanical projects face increasing pressure to adopt eco-friendly practices. Balancing the need for industrial development with sustainability considerations poses a nuanced challenge (Khanapure & Shastri, 2023). Ethiopia, with its commitment to environmentally responsible growth, encounters the task of integrating green technologies, optimizing energy efficiency, and minimizing ecological footprints within the context of electromechanical projects.

2.1.7.5 Project Financing and Resource Allocation

The financial aspect of electromechanical project implementation introduces challenges related to securing adequate funding and optimizing resource allocation (Markannen & Braeckman, 2019). The capital-intensive nature of these projects requires strategic financial planning, effective cost management, and alignment with economic priorities. Ethiopia, in its pursuit of industrialization, grapples with ensuring sustainable funding models and judicious resource distribution to support the successful execution of projects.

2.1.7.6 Adapting to Industry 4.0

The advent of Industry 4.0 brings transformative technologies such as the Internet of Things (IoT) and artificial intelligence into the industrial landscape (Satyro et al., 2022b). While these technologies promise increased efficiency, they also introduce challenges related to cybersecurity, data management, and the adaptation of existing infrastructure. Ethiopia, in embracing the era of Industry 4.0, encounters challenges in preparing its electromechanical projects for the demands of this technological paradigm shift.

In essence, the challenges in electromechanical project implementation within the Ethiopian context are diverse and multifaceted. Recognizing and addressing these challenges are pivotal for fostering resilience, innovation, and sustainable growth within the nation's evolving industrial landscape (Castelo-Branco et al., 2019).

2.1.8 Electro-Mechanical Projects Implementation Challenges in Developing Countries

2.1.8.1 Limited Infrastructure Support

Developing countries often grapple with limited infrastructure support, posing a significant challenge in the implementation of electromechanical projects. Insufficient infrastructure, including power grids and transportation networks, can hinder the efficient installation and operation of electromechanical systems (Satyro et al., 2022a).

2.1.8.2 Technology Accessibility and Affordability

Access to advanced technologies and the affordability of such technologies become pronounced challenges in developing countries (Cantarero, 2020). Electromechanical projects may face hurdles in acquiring cutting-edge equipment and systems, impacting their ability to stay abreast of global technological advancements.

2.1.8.3 Capacity Building and Skill Development

A shortage of skilled professionals is a common challenge in the implementation of electromechanical projects in developing countries. Building and retaining a workforce with the necessary technical expertise poses a continuous challenge, impacting project execution and long-term sustainability.

2.1.9 Electro-Mechanical Projects Implementation Challenges in Ethiopia

2.1.9.1 Economic Constraints

In the Ethiopian context, economic constraints can pose challenges for electromechanical projects. Limited financial resources may affect the ability to invest in state-of-the-art technologies and comprehensive project management strategies, influencing overall project outcomes (Boltena & Gomez, 2012).

2.1.9.2 Regulatory Landscape

The regulatory landscape in Ethiopia introduces challenges related to compliance and permitting for electromechanical projects (Begashaw, 2022). Navigating through regulatory processes, ensuring adherence to standards, and obtaining necessary approvals can be intricate, impacting project timelines and success.

2.1.9.3 Integration with Local Industrial Ecosystem

Electromechanical projects in Ethiopia may face challenges in seamlessly integrating with the local industrial ecosystem. Alignment with existing infrastructures, workforce capabilities, and supply chains requires strategic planning to ensure projects contribute effectively to the broader industrial development goals of the country (Zimon et al., 2020).

2.1.9.4 Environmental and Social Considerations

As Ethiopia emphasizes sustainable development, electromechanical projects encounter challenges related to environmental and social considerations. Balancing industrial growth with environmental responsibility and ensuring positive social impact adds layers of complexity to project implementation.

2.2 Review of Empirical Studies

Empirical studies provide valuable insights into the real-world challenges and successes of electromechanical project implementation. This section delves into a synthesis of existing empirical research, offering a nuanced understanding of the experiences, strategies, and outcomes observed in similar projects across the globe. By drawing upon the findings of these studies, this research seeks to distill practical lessons, identify commonalities, and extract best practices that hold relevance for the Ethiopian industrial sector.

2.2.1 Global Perspectives on Electromechanical Projects

A comprehensive review of empirical studies reveals a diverse landscape of electromechanical projects worldwide (Gemuenden & Lechler, 1997). Case studies from various industries and regions provide a panoramic view of the challenges faced and the strategies employed in implementing projects akin to those envisioned in Ethiopia. Exploring global perspectives is instrumental in contextualizing the challenges faced by the Ethiopian industrial sector within the broader international context.

2.2.2 Lessons Learned and Best Practices

Empirical studies serve as repositories of lessons learned and best practices. By analyzing successful implementations and identifying instances of overcoming challenges, these studies offer a valuable reservoir of knowledge (Shull et al., 2011). Insights into effective

project management strategies, technological integrations, and workforce development gleaned from empirical research serve as guiding principles for enhancing the execution of electromechanical projects in Ethiopia.

2.2.3 Industry-Specific Considerations

Different industries exhibit unique challenges and considerations in electromechanical project implementation. Empirical studies allow for a granular exploration of industry-specific dynamics, providing tailored insights for sectors such as manufacturing, energy, and infrastructure (Guthrie et al., 2008). Ethiopia's burgeoning industrial landscape can benefit from a sector-specific understanding derived from empirical research to optimize project planning and execution.

2.2.4 Technology Adaptation Strategies

Technological adaptation is a central theme in electromechanical projects, and empirical studies shed light on effective strategies for navigating the complexities of adopting new technologies (Fichman, 1992). Understanding how other industries have successfully integrated innovations, managed risks, and optimized technological adaptations informs a strategic approach for Ethiopia as it endeavors to harness the latest advancements in its industrial projects.

2.2.5 Risk Mitigation and Contingency Planning

Empirical studies often elucidate the risks inherent in electromechanical project implementation and showcase successful mitigation strategies (Mikes & Kaplan, 2014). The identification of potential pitfalls and the development of contingency plans are critical components of project management. Ethiopia, in aligning its industrial ambitions with empirical insights, can proactively address risks, ensuring the resilience and success of its electromechanical projects.

2.2.6 Human Factors in Project Success

The human factor plays a pivotal role in the success of electro-mechanical projects. Empirical studies emphasize the significance of workforce engagement, skill development, and effective communication in project outcomes (Lechler, 2000). Understanding the human dynamics gleaned from empirical research provides valuable inputs for Ethiopia to cultivate a skilled and motivated workforce, a crucial element in the triumph of its industrial endeavors.

In summary, the review of empirical studies enriches this research by infusing practical experiences and real-world scenarios into the exploration of electromechanical projects. Drawing upon the collective knowledge derived from global experiences enhances the depth and applicability of the findings in the Ethiopian context.

Chapter Three

Research Methodology

This chapter provides a thorough explanation of the methodology employed and the manner in which the research project work was completed in compliance with the goals of the project work study. It provides a thorough explanation of the methods, instruments, sources, procedures, sampling plan, and chosen and implemented data analysis approach.

3.1 Research Design

The aim of this research project study work is to assess impacts of the different factors extracted from past related works affecting implementation of electro-mechanical projects in Ethiopia, focusing on Unilever manufacturing plant in east zone industry park - HVAC system project implementation. As a result, the quantitative research method technique was used for the study, emphasizing the objective and statistical assessment of numerical data. Additionally, a 5-point Linkert scaling approach was used for the methodically created questionnaire intended to collect data.

3.2 Research Approach

This research employed a descriptive research technique to examine and assess the points made and provided in the research question section. It makes use of the quantitative Approach , which looks at the relationship between many factors to evaluate objective concepts. In order to extract variables for evaluating the consistency of procedures and processes utilized in realizing successful electro-mechanical project implementations in fulfilling the requirements of the study activity.

3.3 Population of the Study

The target population for this research project work encompassed different employees who took active part in Unilever manufacturing plant in east zone industry park - HVAC system project. The targeted population includes employees from the client, the contractor and sub-contractors in the project.

3.4 Sampling Techniques

For this research project work, purposeful sampling—also referred to as judgmental, selective, or subjective sampling—is utilized as a sampling strategy. It is typically employed when one wants to identify circumstances that are particularly illuminating. The reason for this technique adoption is because it is best and suitable to focus in depth on relatively small samples. As a result, in order to carefully select members of the target group to participate in the sample survey study, the researchers—the adviser and student—rely on their own judgment. The respondents were chosen on the basis of their area of expertise, knowledge, and experience managing the HVAC project implementation in Unilever manufacturing plant in east zone industry park.

3.5 Source of Data

The research project study work used both primary and secondary data to gather sufficient and pertinent information to address the research questions and achieve the study's goals. Primary data sources including those who actively participated in the Unilever manufacturing plant in east zone industry park HVAC project implementation, from different department, positions and firms, were taken in to consideration. On the other hand, secondary data was acquired from a variety of published sources, such as books, papers, journals, and project reports.

3.6 Data Collection Tools

Based on a methodically designed questionnaire, the research project study work used a quantitative data collection strategy. The survey was designed in both Amharic and English to ensure that there would be no communication difficulties during the data collection procedure. Additionally, the questionnaire was available online and in printed form, which made it easier to use and faster, more accurate, less expensive, quicker to analyze, more honest, and more styleable for both researchers and participants. After that, the survey instruments—questionnaires—were given to the carefully chosen respondents. A secondary source of data was published supplementary works such as theses, papers, journals, research outputs, and books from earlier linked studies.

3.7 Procedure of Data Collection

After the questionnaire was developed following a thorough examination of previous relevant works and literatures, it was given to a sample of respondents Unilever manufacturing plant in east zone industry park HVAC project implementation project team members who were carefully chosen to ensure that all the information needed for the planned research project work was recorded.

3.8 Methods of Data Analysis and Presentation

In order to evaluate the data gathered through the questionnaire in respect to the overall goal of the research, the adviser and previous similar works recommended the use of appropriate quantitative data analysis techniques and tools (Relative Importance Index, or RII) and mean value analysis. Initially, a variety of data editing methods were used to create the data, including checking the raw data for errors, omissions, classifications, and aggregation. Finally, Microsoft Excel™ was used to analyze the data that had been gathered.

3.9 Validity and Reliability

The study work's questionnaire was meticulously created to ask similar related questions in several sections. To ensure the data was reliable and the respondents were coherent, general information, and different factors affecting electro-mechanical project implementations were purposefully reviewed more than once. After then, five respondents to a pilot poll provided their responses. The pilot survey's results demonstrated that over 80% of the data was coherent. Furthermore, the questionnaire's reliability is around 90% (Louangrath, 2018) trustworthy due to its design, which takes use of the 5-scale Linkert scale-based data gathering technique.

In order to ensure that all research questions have been answered and the study's objectives have been adequately handled, a well-constructed questionnaire was employed in this investigation. Additionally, the authors checked the data gathered in a few questionnaire sections by outlining the clearly anticipated results and determining whether the responses provided were indicative of validity. Additionally, the NK landscape approach and Monte Carlo simulation used to compute the empirical results of a 5-point Linkert scale survey previously in (Louangrath, 2018), which revealed a result of 0.73. Since this is far higher than the 0.35 threshold for the highly advantageous group, it can be interpreted within a reasonable range.

3.10 Ethical Considerations

In this research project work, the authors followed and adhere to all ethical research protocols throughout the research work lifetime.

3.11 Interpretation and Computation Techniques Used

To assess and understand the main research study data, mean value and Relative Importance Index (RII) computation procedures and rankings are used. The methods used in this investigation are described in depth in the ensuing subsections.

3.11.1 Mean Value Computation

The mean score/value is used to summarize the key characteristics of a series and to compare data. It can be treated algebraically and is utilized in statistical calculations. It's a fairly consistent measure of central tendency. The following formula is used to get the mean score of the responses.

$$Mean = \frac{\sum s}{N}$$

Where;

s is weight given by respondent (1 to 5).

N is the total number of respondents or participators.

The mean value interpretation technique used to analyze the survey data for this research work is as the following. The possible ranges are computed via (5-1 = 4), which corresponds to the maximum (5) and minimum (1) possible values in the Linkert scale. Then these ranges are divided by the maximum value 5, (4/5 = 0.80) yielding the arrays of possible ranges in the Linkert scale. Then, in order to determine the maximum of each cell, this value (0.8), was added in the Linkert scale values. Therefore, the length of the cells is calculated as follows:

- Mean values from 1 to 1.80 represents (Strongly Disagree).
- Mean values from 1.81 until 2.60 represents (Do Not Agree, Disagree).
- Mean values from 2.61 until 3.40 represents (Neutral, Neither Agree nor Disagree).
- Mean values from 3.41 until 4.20 represents (Agree). And,
- Mean Values from 4.21 until 5.00 represents (Strongly Agree).

3.11.2 Relative Importance Index (RII) Computation

The Relative Importance Index (RII) computation technique used to analyze the survey data for this research work is as the following. The RII is the average of a factor's weight in the respondents' perceptions. It is computed using the following formula.

$$RII = \frac{5 * n_5 + 4 * n_4 + 3 * n_3 + 2 * n_2 + 1 * n_1}{A * N}$$

Where;

n_5 is the number of respondents for strongly agree.

n_4 is the number of respondents for agree.

n_3 is the number of respondents for neutral.

n_2 is the number of respondents for disagree.

n_1 is the number of respondents for strongly disagree.

A is highest weight in the scale, that is 5.

N is the total number of respondents.

Chapter Four

Data Presentation, Analysis and Interpretation

This chapter, Chapter Four, gives details on the findings, analysis, interpretation, discussions, and presentation on challenges encountered in the implementation of electro-mechanical projects in Ethiopia, with a specific focus on Unilever manufacturing plant electro-mechanical project in east zone industry park, Ethiopia.

4.1 Primary Data Analysis

This project study work investigation is divided into four main areas of variables and elements that impact implementation of electro-mechanical projects in Ethiopia. It thoroughly investigated and analyzed these four main core variable areas:

- Electro-mechanical (HVAC) awareness and practice in Ethiopia,
- Perceived challenges in implementing electro-mechanical projects,
- Integration of cutting-edge technologies in electro-mechanical framework, and
- Recommendations for mitigating HVAC system implementation challenges.

To gather data on the above stated domains, a systematic questionnaire was meticulously prepared. The questionnaire was designed to capture insights from individuals involved in the Unilever manufacturing plant electro-mechanical project implementation in the east zone industry park. Using Microsoft Excel™, the raw data collected was analyzed and interpreted. This analysis was conducted employing both descriptive and explanatory statistics.

4.2 Response Rate

A total of 54 respondents participated in the data analysis process. The questionnaire was distributed/shared with 60 personnel engaged in Unilever manufacturing plant in the

east zone industry park electro-mechanical construction project work. Remarkably, the response rate for the questionnaire was found to be 90%, indicating a high level of engagement and interest among the participants.

4.3 General Demographic Information

The general demographic information collected from the questionnaire in this research work indicated that 14.81% respondents were females, and males account for the remaining 85.19%. This showed that male dominated the survey and it is perfectly in line with the fact that majority of workers/employees in electro-mechanical construction project works is dominated via males. Hence, it can be concluded that, gender representation in the survey is justly distributed.

Considering the role of responders involved in the Unilever manufacturing plant electro-mechanical project in the east zone industry park building project, respondents were found to comprise 27.78% from project consultant team, 25.93% from project execution team, 9.26% from management team, 7.41% from quality management team, 7.41% from project management/coordinator, 5.56% from contract administrator, 5.56% from design review team, 3.70% from resident engineers, 3.70% from project safety team, and 3.70% from operators. In regards to the affiliation of responders in the project, it was found that 46.30% are affiliated to the contractor (Splenor Tech), 16.67% to consultant (L&T Tech Ser), 11.11% to client (Unilever) and 25.93% to sub-contractor (Hab Core Engineering) who took part in the project.

In relation to the level of responder's educational background/qualification level, 31.48% have Technical and Vocational Education and Training (TVET), 18.52% had Master degree, 16.67% had college diploma, 14.81% had completed high school, 11.11% had bachelor degree and the remaining 7.41% have PhD and above qualification. Regarding respondent's previous experience in any electro-mechanical (HVAC) projects, 83.33%

had previous experience and the remaining 16.67% do not have any previous work experience related to electro-mechanical projects. Regarding respondent's total work experience in electro-mechanical (HVAC) projects, 38.89.5% have between 5 to 10 years, 25.93% have between 3 to 5 years, 16.67% for less than 3 years, 11.11% have between 11 to 15 years and the remaining 7.41% have more than 16 years of accumulated work experience.

Furthermore, regarding respondent's involvement duration in the Unilever Manufacturing Plant electro-mechanical project in the east zone industry park building project, 77.78% have more than 1 year involvement and the remaining 22.22% have less than one year involvement. Finally, given the complexity of electrotechnical projects in Ethiopia, 88.89% of respondents rate the complexity of the Unilever Manufacturing Plant electro-mechanical project to be high and the remaining 11.11% rate it as medium. Table 1 given below gives the summary of the general demographic information of the questionnaire survey participants.

Table 1: Summary of demographic information

Gender composition		
Option	**Frequency**	**Percentage**
Male	46	85.19%
Female	8	14.81%
Affiliation in the Unilever electro-mechanical project		
Client (Unilever)	6	11.11%
Consultant (L&T Tech Ser)	9	16.67%
Contractor (Splenor Tech)	25	46.30%
Sub-Contractor (Hab Core Engineering)	14	25.93%
Level of Educational/Qualification		
PhD and above	4	7.41%
Master's Degree	10	18.52%
Bachelor Degree	6	11.11%
Diploma	9	16.67%
Technical and Vocational Education and Training (TVET)	17	31.48%
High School Completed	8	14.81%

Responsibility in the Unilever electro-mechanical project		
Project Manager/ coordinator	4	7.41%
Contract administrator	3	5.56%
Resident Engineer	2	3.70%
Management Member	5	9.26%
Consultant	15	27.78%
Quality Management Team Member	4	7.41%
Project Safety Member	2	3.70%
Project Execution team	14	25.93%
Design Review Team Member	3	5.56%
Others: Operator	2	3.70%
Any previous experience in electro-mechanical (HVAC) projects		
Yes	45	83.33%
No	9	16.67%
Total work experience in electro-mechanical (HVAC) projects		
Less than 3 years	9	16.67%
3-5 years	14	25.93%
5-10 years	21	38.89%
11-15 years	6	11.11%
16 and above	4	7.41%
Involvement in the project duration in months		
More than 1 year	42	77.78%
Less than 1 year	12	22.22%
Unilever electro-mechanical project complexity rating		
Medium	6	11.11%
High	48	88.89%

4.4 Electro-Mechanical (HVAC) Quality Awareness and Practice Assessment

As per the literature reviews carried out on past related works on electro-mechanical project implementation challenges, electro-mechanical (HVAC) quality awareness and practices were determined to be one of the critical factors affecting its successful implementation. In line with that fact the following major findings were recorded based on the responses given via respondents who took part on the survey.

Majority of responders, 72.22% claim to have moderately advanced experience in electro-mechanical project works particularly in Heating, Ventilation, and Air Conditioning (HVAC) systems, and 9.26% respondents claim to have advanced experience. However,

9.26% claim to have only adequate, and the remaining 3.70% claim to have limited experience in electro-mechanical project works. Further, regarding on receiving formal training or education in electro-mechanical related systems, 27.78% claim to have had education and training in the past but the remaining 72.22% of respondents do not have any previous education or trainings in electro-mechanical related systems. This showed that there is a serious lack of formal education and training in electro-mechanical systems particularly in relation to HVAC systems. Moreover, regarding the form of training and education in electro-mechanical systems, majority of responders, 53.33% receive the education and training in their bachelor degree study, 20% in their diploma study, 13.33% in a formal certification program and the remaining 13.33% in formal workshops. This shows more than a quarter of respondents (26.66%) who claimed to have previous education and training are for a limited duration/period of time implying in a limited capacity and scope of knowledge on the subject matter.

Regarding the level of project planning and coordination in electro-mechanical projects in Ethiopia, majority of responders (59.26%) rate it as poor, 20.37% rate it as average, 14.81% rate it as very poor, and only 5.56% rate it as good. This shows that there is a serious gap in electro-mechanical projects planning and coordination in Ethiopia. It is worth also highlighting the fact that none of the responders rate it as excellent. Furthermore, regarding level of technical expertise and skill among project stakeholders involved in electro-mechanical projects in Ethiopia, 70.37% of responders believe that there is no sufficient technical expertise and only 29.63% believe that there is sufficient technical expertise in the area. This shows that there is also a serious lack of technical expertise and skills in electro-mechanical projects in Ethiopia. In addition, among the technical expertise and skills gap required to be filled in electro-mechanical projects in Ethiopia, 27.71% believe it should be related to project management, 22.89% believe it should be related to resource management, 18.07% believe it should be related to electro-

mechanical workmanship, 14.46% believe it should be related to electro-mechanical designs, 9.64% believe it should be related to safety, and the remaining 7.23% believe it should be related to electro-mechanical project contract administration.

At the time of the survey, only 9.26% rate the state of technological infrastructure in Ethiopia for supporting electro-mechanical projects as adequate, 68.52% rated it as limited and the remaining 22.22% rated it as insufficient. None of the responders rated it either as advanced, or moderately advanced. This finding showed that there is a serious technological infrastructure lack in Ethiopia to support electro-mechanical projects implementations and success. Moreover, regarding awareness in the current practices and standards related to HVAC systems in Ethiopia, majority of responders (64.81%) believed they have fair awareness, 22.22% claim to have minimal awareness, 9.26% claim to have maximum awareness and the remaining 3.70% have no idea about the practices and standards. This shows that there is also a gap in the current practices and standards related to HVAC systems in Ethiopia and that needs to be addressed if the sector is deemed to succeed.

Regarding familiarity with the regulations and guidelines governing the installation, operation, and maintenance of HVAC systems in Ethiopia, 22.22% claim that they are familiar with it but the remaining 77.78% believe that they are not familiar with. Among the respondents who claim to be familiar with the regulations and guidelines governing the installation, operation, and maintenance of HVAC systems in Ethiopia, 50% claim to be familiar with Ethiopian Building Code Standards (EBCS) 11 (HVAC), 25% with EBCS 9 (Plumbing), 16.67% with EBCS 10 (Electrical) and 8.33% with EBCS 12 (Building Spatial Design).

Furthermore, regarding sectoral frequency uses of HVAC systems, 64.81% claim mainly it is for commercial purposes, 25.93% claim that it is for industrial purposes, and the remaining 9.26% claim it is for residential purpose consumptions. Regarding the need for

additional training or education programs related to electro-mechanical systems, specifically HVAC systems, in Ethiopia, 92.59% believe it that it is necessary, 5.56% are not sure about that and the remaining 1.85% believe that it is not necessary. This finding clearly shows the need for capacity building among electro-mechanical practitioners in Ethiopia. Among the responders who believed that additional trainings are necessary, 50% believe it should focus on HVAC installation, 22.22% believe it should focus on Project Management (PM), 14.81% believe it should focus in Quality Management (QM), 9.26% believe it should focus on HVAC design, and the remaining 3.7% believe it should focus on Health Safety and Environment (HSE).

4.5 Perceived Challenges in Implementing Electro-Mechanical Projects Assessment

The next variable investigated in this project study work was perceived challenges in implementing electro-mechanical project implementations in Ethiopia. The following seven major areas; project planning and coordination, technical expertise in electromechanical systems, resource availability, communication among project stakeholders, regulatory compliance and permitting issues, energy efficiency awareness, and quality management implementation challenges were investigated thoroughly. The following sub-sections give details on the project study work assessment findings.

4.5.1 Project Planning and Coordination Assessment

The first variable studied under perceived challenges in implementing electro-mechanical project implementations in Ethiopia was electro-mechanical project planning and coordination. A total of 14 questions were formulated to accesses electro-mechanical project planning and coordination assessment and the following main findings were recorded. The overall recorded and analyzed data is presented in Table 2 given below.

Table 2: Project planning and coordination assessment

Q. No.	Impact Level – in Actual Frequency of Occurrences					Mean Value
	[1] Insufficient	[2] Limited	[3] Adequate	[4] Moderately Advanced	[5] Advanced	
Q#1	36	13	4	1	0	1.44
Q#2	20	14	8	10	2	2.26
Q#3	16	13	17	5	3	2.37
Q#4	5	12	28	8	1	2.78
Q#5	5	3	18	21	7	3.41
Q#6	1	8	32	8	5	3.15
Q#7	15	9	17	10	3	2.57
Q#8	14	12	14	8	6	2.63
Q#9	7	19	11	9	8	2.85
Q#10	21	19	8	2	4	2.06
Q#11	18	15	4	4	13	2.61
Q#12	28	16	7	3	0	1.72
Q#13	29	11	8	4	2	1.87
Q#14	32	10	5	3	4	1.83
				Average Mean		**2.40**

Based on the results displayed in Table 2 above, majority of responders took a limited stance on 6 of the total 14 factors listed on being clearly defined in electro-mechanical project planning and coordination, adequately defined on 5 factors, insufficiently defined on 2 factors, and defined moderately advanced in 1 of the factors listed. The 6 factors in which majority of responders took a limited defined stance are; are there any specific areas of coordination (e.g., between departments, with external contractors) that you find lacking, responsibilities and authorities of project staff, construction program and sub-programs, list(s) of materials and appliances used for the project, showing the verification requirement of each, list of quality records to be kept, including appropriate quality records from subcontractors, and methodology to avoid the effect of inadequate planning and coordination on the execution and outcomes of electromechanical projects.

The 5 factors in which majority of responders took an adequately defined stance are; site organization chart, with named personnel if known, Site layout plan, schedules of subcontractor nomination, material and equipment, procurement based on the construction program, and list of quality procedures and work instructions applicable to project by making reference to the company's quality manual and procedures. The 2 factors in which majority of responders took an insufficiently defined stance are; how would you describe the level of project planning before the initiation of electromechanical projects, and list of project-specific procedures, work instructions inspection and testing. Finally, the 1 factor which majority of responders took moderately advanced defined stance is list of contract documents and drawings.

Moreover, it should be noted that the overall mean value of project planning and coordination assessment factor was found to be 2.40 implying responders' stance in the limited range. This indicates that project planning and coordination are only defined in a limited scope and that is one of the potential challenges affecting electro-mechanical project implementations in Ethiopia. Hence, it is a must that project planning and coordination in electro-mechanical projects in Ethiopia needs to be enhanced if the final outcome of the project is deemed to succeed.

4.5.2 Technical Expertise in Electro-Mechanical Systems Assessment

The second variable studied under perceived challenges in implementing electro-mechanical project implementations in Ethiopia was technical expertise in electro-mechanical systems. A total of 8 questions were formulated to accesses the technical expertise in electro-mechanical systems and the following main findings were recorded. The overall recorded and analyzed data is presented in Table 3 given below.

Table 3: Technical expertise in electromechanical systems

Q. No.	Impact Level – in Actual Frequency of Occurrences					Mean Value	RII	RII Ranking
	[1] Insufficient	[2] Limited	[3] Adequate	[4] Moderately Advanced	[5] Advanced			
Q#1	8	14	20	8	4	2.74	0.55	7
Q#2	2	2	12	28	10	3.78	0.76	1
Q#3	6	6	18	21	3	3.17	0.63	4
Q#4	1	1	28	17	7	3.52	0.70	2
Q#5	8	4	19	10	13	3.30	0.66	3
Q#6	15	10	16	6	7	2.63	0.53	8
Q#7	8	12	16	14	4	2.89	0.58	6
Q#8	7	12	18	13	4	2.91	0.58	5
				Average Mean		**3.12**		

Based on the results displayed in Table 3 above, majority of responders believed that 6 out of the 8 technical expertise in electro-mechanical systems factor descriptions are adequately existing, and took a moderately advanced stance on the remaining 2 factor descriptions. The 6 factors in which majority of responders took an adequate stance are; in your opinion, does the Unilever manufacturing plant have sufficient in-house technical expertise for managing electromechanical projects, evaluates and selects subcontractors on their ability to satisfy specified requirements, evaluates and selects subcontractors on their ability to plan HVAC system layouts and configurations, evaluates and selects subcontractors on their knowledge of load calculations and equipment sizing, evaluates and selects subcontractors on their proficiency in installing HVAC equipment and components, and evaluates and selects subcontractors on their understanding of commissioning procedures for HVAC systems.

The 2 factors in which majority of responders took a moderately advanced stance are; how does a lack of technical expertise impact the quality and efficiency of project execution, and evaluates and selects subcontractors on their ability to understanding of

HVAC system design principles. Moreover, it should be noted that the overall mean value of technical expertise in electromechanical systems assessment factor was found to be 3.12 implying responders' stance in the adequate range affecting electro-mechanical project implementation in Ethiopia.

Furthermore, via deploying Relative Importance Index (RII) concept to determine the relative importance of the factors stated under technical expertise in electro-mechanical systems assessment, it was found that; lack of technical expertise impacting the quality and efficiency of electro-mechanical project execution, followed via evaluation and selection of subcontractors on their ability to understanding of HVAC system design principles, and evaluation and selection of subcontractors on their Ability to plan HVAC system layouts and configurations, were found to be the top 3 main factors affecting electro-mechanical project implementation in Ethiopia. Hence, from the survey findings, it is clear that that technical expertise in electro-mechanical domains and evaluation and selection process of subcontractors is one of the main critical factors affecting electro-mechanical project implementation in Ethiopia and that needs to be critically monitored during electro-mechanical project implementations.

4.5.3 Resource Availability Assessment

The third variable studied under perceived challenges in implementing electro-mechanical project implementations in Ethiopia was resource availability. A total of 11 questions were formulated to accesses the resource availability and the following main findings were recorded. The overall recorded and analyzed data is presented in Table 4 given below.

Table 4: Resource availability assessment

Q. No.	Impact Level – in Actual Frequency of Occurrences					Mean Value	RII	RII Ranking
	[1] Insufficient	[2] Limited	[3] Adequate	[4] Moderately Advanced	[5] Advanced			
Q#1	8	13	14	11	8	2.96	0.59	3
Q#2	15	10	9	14	6	2.74	0.55	4
Q#3	28	12	10	4	0	1.81	0.36	11
Q#4	11	14	18	7	4	2.61	0.52	5
Q#5	14	13	15	7	5	2.56	0.51	6
Q#6	18	12	12	6	6	2.44	0.49	7
Q#7	18	15	11	4	6	2.35	0.47	9
Q#8	6	9	15	16	8	3.20	0.64	2
Q#9	22	11	12	7	2	2.19	0.44	10
Q#10	2	5	26	12	9	3.39	0.68	1
Q#11	18	15	8	5	8	2.44	0.49	7
				Average Mean		**2.61**		

Based on the results displayed in Table 4 above, majority of responders believed that 6 out of the 11 resource availability assessment factors are in limited availability and the remaining 5 factors are adequately availed. The 6 factors with limited availability are; flexibility in budget allocation for unforeseen expenses, ability to recruit and retain qualified staff members, availability of necessary materials, components, and equipment for project implementation, access to suppliers and vendors for sourcing materials, availability of transportation and logistical support for moving materials and equipment to project sites, and efficiency of supply chain management in ensuring timely delivery of resources. The 5 factors with adequate availability are; availability of financial resources for initiating and executing electromechanical project, access to funding sources such as project budgets, grants, or loans, availability of skilled personnel for various roles in electromechanical projects, quality and reliability of materials and equipment available, and infrastructure support such as access roads, utilities, and

facilities for project operations. The overall mean value was found to be 2.609 implying limited resources availability for successful electro-mechanical project implementations in Ethiopia. Hence, it is fair to conclude that communication among project stakeholders in electro-mechanical project implementation in Ethiopia is not one factor affecting project implementations.

Furthermore, via deploying Relative Importance Index (RII) concept to determine the relative importance of the factors stated under resource availability assessment, it was found that; infrastructure support such as access roads, utilities, and facilities for project operations, followed via quality and reliability of materials and equipment available, availability of financial resources for initiating and executing electromechanical project, were found to be the top 3 main factors affecting electro-mechanical project implementation in Ethiopia under resource availability domain.

4.5.4 Communication Among Project Stakeholders Assessment

The fourth variable studied under perceived challenges in implementing electro-mechanical project implementations in Ethiopia was communication among project stakeholders. A total of 8 questions were formulated to accesses communication among project stakeholders and the following main findings were recorded. The overall recorded and analyzed data is presented in Table 5 given below.

Table 5: Communication among project stakeholders

Q. No.	Impact Level – in Actual Frequency of Occurrences					Mean Value
	[1] Insufficient	[2] Limited	[3] Adequate	[4] Moderately Advanced	[5] Advanced	
Q#1	8	6	23	12	5	3.00
Q#2	16	14	14	4	6	2.44
Q#3	16	11	12	9	6	2.59
Q#4	10	16	20	6	2	2.52
Q#5	18	12	13	6	5	2.41
Q#6	12	8	16	13	5	2.83
Q#7	6	12	28	4	4	2.78
Q#8	14	18	9	7	6	2.50
				Average Mean		**2.63**

Based on the results displayed in Table 5 above, majority of responders believed that 5 out of the 8 communications among project stakeholders' factors are limited and the remaining 3 factors exist adequately. The 5 factors with limited existence are; effectiveness of internal meetings, updates, and status reports, collaboration and information sharing among different departments involved in the project, communication with external stakeholders such as clients, contractors, and suppliers, clarity and consistency in conveying project requirements and expectations, and communication across different functional areas involved in the project (e.g., engineering, procurement, operations). The 3 factors with adequate availability are; communication between project team members within the organization, communication with the client regarding project progress, milestones, and deliverables, and communication between different departments or divisions within the organization. The overall mean value was found to be 2.63 implying existence of adequate communication among project stakeholders in electro-mechanical projects in Ethiopia.

4.5.5 Regulatory Compliance and Permitting Issues Assessment

The fifth variable studied under perceived challenges in implementing electro-mechanical project implementations in Ethiopia was regulatory compliance and permitting issues. A total of 12 questions were formulated to accesses regulatory compliance and permitting issues and the following main findings were recorded. The overall recorded and analyzed data is presented in Table 6 given below.

Table 6: Regulatory compliance and permitting issues

Q. No.	**Impact Level – in Actual Frequency of Occurrences**					Mean Value	RII	RII Ranking
	[1] Insufficient	[2] Limited	[3] Adequate	[4] Moderately Advanced	[5] Advanced			
Q#1	17	14	13	6	4	2.37	0.47	6
Q#2	22	11	14	5	2	2.15	0.43	8
Q#3	24	18	9	2	1	1.85	0.37	11
Q#4	25	13	11	5	0	1.93	0.39	9
Q#5	12	14	17	8	3	2.56	0.51	2
Q#6	11	24	8	7	4	2.43	0.49	5
Q#7	16	12	14	7	5	2.50	0.50	4
Q#8	28	15	5	3	3	1.85	0.37	11
Q#9	16	18	12	7	1	2.24	0.45	7
Q#10	15	11	16	8	4	2.54	0.51	3
Q#11	26	13	10	5	0	1.89	0.38	10
Q#12	8	10	27	6	3	2.74	0.55	1
				Average Mean		**2.25**		

Based on the results displayed in Table 6 above, majority of responders believed that 11 out of the 12 regulatory compliance and permitting issues factors are limited and the remaining 1 factor is adequately available. The 11 factors with limited existence are; familiarity with local, regional, and national regulations governing electromechanical projects, awareness of specific regulatory requirements related to HVAC system installation, operation, and maintenance, ease of navigating permitting processes for

obtaining necessary approvals and licenses, timeliness and efficiency of permit issuance for electromechanical projects, mitigating challenges encountered in obtaining permits and approvals for HVAC system projects, identification of compliance gaps or discrepancies during project execution, ensuring full compliance with regulatory requirements throughout the project lifecycle, awareness of changes or updates to regulations affecting electromechanical projects, ability to adapt project plans and strategies in response to regulatory changes, mitigating challenges posed by evolving regulatory landscapes for HVAC system projects, and engagement with regulatory agencies, authorities, and stakeholders involved in permitting processes. The one factor which majority of responders believe is adequately is available is influence of stakeholder engagement on permit approvals and compliance outcomes.

The overall average mean value of regulatory compliance and permitting issues was computed to be 2.25 implying a limited overall stance on the subject matter. This shows that there is a gap in regulatory compliance and permitting issues affecting implementations of electro-mechanical projects in Ethiopia. Furthermore, via deploying Relative Importance Index (RII) concept to determine the relative importance of the factors stated under regulatory compliance and permitting issues, it was found that; influence of stakeholder engagement on permit approvals and compliance outcomes, followed via mitigating challenges encountered in obtaining permits and approvals for HVAC system projects, and mitigating challenges posed by evolving regulatory landscapes for HVAC system projects were found to be the top 3 main factors affecting electro-mechanical project implementation in Ethiopia under regulatory compliance and permitting issues domain.

4.5.6 Energy Efficiency Awareness Assessment

The sixth variable studied under perceived challenges in implementing electro-mechanical project implementations in Ethiopia was energy efficiency awareness. A total of 10 questions were formulated to accesses the energy efficiency awareness and the following main findings were recorded. The overall recorded and analyzed data is presented in Table 7 given below.

Table 7: Energy efficiency awareness

Q. No.	**Impact Level – in Actual Frequency of Occurrences**					Mean Value
	[1] Insufficient	[2] Limited	[3] Adequate	[4] Moderately Advanced	[5] Advanced	
Q#1	26	16	8	4	0	1.81
Q#2	28	21	4	1	0	1.59
Q#3	32	16	3	2	1	1.59
Q#4	28	15	8	2	1	1.76
Q#5	24	17	8	4	1	1.91
Q#6	28	14	7	3	2	1.83
Q#7	24	16	8	3	3	1.98
Q#8	32	16	4	0	2	1.59
Q#9	32	17	3	1	1	1.56
Q#10	26	18	6	3	1	1.80
				Average Mean		**1.74**

Based on the results displayed in Table 7 above, majority of responders believed that 6 out of the 10 energy efficiency awareness factors are insufficient and the remaining 4 factors existence is in limited scope. The 6 factors with insufficient status are; awareness of strategies and technologies for improving energy efficiency in HVAC systems, knowledge of energy efficiency standards and certifications applicable to electromechanical systems, familiarity with industry-specific energy efficiency benchmarks and guidelines, utilization of monitoring tools and systems to assess energy

efficiency performance, regular evaluation of energy consumption and efficiency metrics in electromechanical projects, and availability of educational resources and materials for improving energy efficiency awareness.

The 4 factors with limited status rating are; familiarity with the principles of energy efficiency in electro-mechanical systems, understanding of the importance of complying with energy efficiency standards in project implementation, experience in implementing energy-saving measures in electromechanical projects, and proactive measures taken to optimize energy performance during project execution. The overall average mean value was computed to be 1.74 implying insufficient status in energy efficiency awareness. Hence, it is fair to conclude that energy efficiency awareness in electro-mechanical project implementation in Ethiopia is one of the main factors affecting project implementations.

4.5.7 Quality Management Implementation Challenges Assessment

The last, seventh, variable studied under perceived challenges in implementing electro-mechanical project implementations in Ethiopia was quality management implementation challenges. A total of 13 questions were formulated to accesses quality management implementation challenges and the following main findings were recorded. The overall recorded and analyzed data is presented in Table 8 given below.

Based on the results displayed in Table 8 below, majority of responders believed that 7 out of the 13, quality management implementation challenge factors are in limited existence and the remaining 6 factors are adequately available. The 7 factors with limited status are; knowledge of quality management principles and methodologies (e.g., ISO standards) for project implementation, implementation of quality control processes and procedures throughout the project lifecycle, integration of quality assurance measures to ensure adherence to project specifications and requirements, documentation of quality-related processes, inspections, and tests during project execution, importance of

documentation in demonstrating compliance with quality standards and regulatory requirements, training programs or initiatives focused on quality management for project team members, and development of quality-related skills and competencies among project personnel. The 6 factors with adequate status are; familiarity with industry-specific quality standards and regulations applicable to electromechanical projects, importance of complying with quality standards in ensuring project success and customer satisfaction, implementation of quality control processes and procedures throughout the project lifecycle, management of supplier and vendor relationships to ensure quality of materials and components, challenges encountered in maintaining quality control over external suppliers and vendors, and challenges in ensuring adequate training and skill development for maintaining quality standards.

The overall average mean value on the subject matter was computed to be 2.61 implying majority of responders taking a limited stance in quality management implementation factors. Hence, it is deduced that quality management implementation factors are one of the main factors affecting electro-mechanical project implementation in Ethiopia. Furthermore, via deploying Relative Importance Index (RII) concept to determine the relative importance of the factors stated under regulatory compliance and permitting issues, it was found that; challenges encountered in maintaining quality control over external suppliers and vendors, followed via challenges in ensuring adequate training and skill development for maintaining quality standards, and management of supplier and vendor relationships to ensure quality of materials and components were found to be the top 3 main factors affecting electro-mechanical project implementation in Ethiopia under quality management implementation domain.

Table 8: Quality management implementation challenges

Q. No.	Impact Level – in Actual Frequency of Occurrences					Mean Value	RII	RII Ranking
	[1] Insufficient	[2] Limited	[3] Adequate	[4] Moderately Advanced	[5] Advanced			
Q#1	8	20	13	9	4	2.65	0.53	5
Q#2	15	17	14	4	4	2.35	0.47	12
Q#3	11	14	18	7	4	2.61	0.52	6
Q#4	11	13	16	9	5	2.70	0.54	4
Q#5	14	12	17	8	3	2.52	0.50	9
Q#6	14	12	17	9	2	2.50	0.50	10
Q#7	10	13	19	6	6	2.72	0.54	3
Q#8	5	7	22	12	8	3.20	0.64	1
Q#9	18	12	14	5	5	2.39	0.48	11
Q#10	14	8	22	8	2	2.56	0.51	8
Q#11	11	9	26	7	1	2.59	0.52	7
Q#12	7	9	28	5	5	2.85	0.57	2
Q#13	18	15	14	3	4	2.26	0.45	13
				Average Mean		**2.608**		

4.6 Integration of Cutting-Edge Technologies in Electro-Mechanical Framework

The next variable analyzed in this research study work was integration of cutting-edge technologies in electro-mechanical framework affecting electro-mechanical project implementations in Ethiopia. A total of 8 major cutting-edge technology areas were carefully formulated and the following results were recorded from the survey conducted.

Regarding rating the effectiveness of current electro-mechanical framework, particularly in relation to the integration of cutting-edge technologies in electro-mechanical projects in Ethiopia, 37.04% of responders agree that there are in place, 22.22% disagree that they are in place, 22.22% took a neutral stance, 14.81% strongly disagreed that they are in place, and the remaining 3.37% strongly agree that they are in place. This shows that integration

of cutting-edge technologies in electro-mechanical projects in Ethiopia, in electro-mechanical framework is not yet up to acceptable level and needs to be improved.

In regards to how satisfied responders are with the level of integration of cutting-edge technologies within the electro-mechanical framework at their organizations, 29.63% took a neutral stance, 29.63% are dissatisfied, 24.07% are very dissatisfied, 12.96% are satisfied, and the remaining 3.70% are very satisfied. The overall findings show that integration of cutting-edge technologies within the electro-mechanical framework at electro-mechanical organizations is poor and that needs to be improved if electro-mechanical project implementations is deemed to succeed.

In relation to how well do responders think the integration of cutting-edge technologies has enhanced the efficiency of operations within their organization's electro-mechanical systems, 40.74% believed that it is has not enhanced, 29.63% believe that it has slightly enhanced, 20.37% took a neutral stance, 7.41% believe that it has enhanced, and the remaining 1.85% believe that it has highly enhanced efficiency of operations. The fact that majority of responders believed that integration cutting-edge technologies has not enhanced the efficiency of operations within their organization's is in direct correlation to the fact that most responders believe that integration of cutting-edge technologies within the electro-mechanical framework at electro-mechanical organizations is poor resulting in poor perception at the merits of the cutting-edge technology integrations.

In relation to what extent responders believe that the integration of cutting-edge technologies has improved the performance of the electro-mechanical systems in their organization, 40.74% believed that it has not improved, 29.63% believe that it has slightly improved, 20.37% took a neutral stance, 7.41% believe that it has improved, and the remaining 1.85% believe that it has significantly improved the performance of the electro-mechanical systems in their organization. Again, the fact that majority of responders believe that the integration of cutting-edge technologies has not improved the

performance of the electro-mechanical systems in their organizations is in direct correlation to the fact that most responders believe that integration of cutting-edge technologies within the electro-mechanical framework at electro-mechanical organizations is poor resulting in poor perception at the merits of the cutting-edge technology integrations.

In regards to rating the level of innovation demonstrated by the implementation of cutting-edge technologies within the electromechanical framework at responders' organization, 29.63% believed that it is very low, 31.48% believe that it is low, 24.07% took a neutral stance, 11.11% believe that it is high, and the remaining 3.70% believe that it is very high. This showed that level of innovations demonstrated by the implementation of cutting-edge technologies within the electromechanical framework at responders' organization is not matured enough and it needs to be improved. Furthermore, it is also worth highlighting the fact the absolute necessity of capacity building in electro-mechanical related skills so that innovation can be realized to capitalize its fruitful impacts in implementations of electro-mechanical projects in Ethiopia.

In regards to what extent do responders agree that the integration of cutting-edge technologies has contributed to the sustainability goals of their organization, 20.09% strongly disagreed, 38.37% disagreed, 20.93% took a neutral stance, 15.12% agreed, and the remaining 3.49% strongly agreed on its contribution. Again, the fact that majority of responders believe that the integration of cutting-edge technologies has not contributed to the sustainability goals of organizations is in direct correlation to the fact that most responders believe that integration of cutting-edge technologies within the electro-mechanical framework at electro-mechanical organizations is poor resulting in poor perception at the merits of the cutting-edge technology integrations.

In regards to how effectively do responders believe the integration of cutting-edge technologies has addressed the challenges faced by the electromechanical systems in their

organization, 22.22% believed that it is not effective, 33.33% believe that it is slightly effective, 31.48% took a neutral stance, 11.11% believe that it is effective, and the remaining 1.85% believe that it is highly effective. This finding showed that it is in close proximity with cutting-edge technologies contribution to the sustainability goals of organizations and also in line with integration of cutting-edge technologies within the electro-mechanical framework in electro-mechanical organizations is poor.

In relation to how likely are responders to recommend the integration of cutting-edge technologies to other organizations in the industry, 1.85% took a very unlikely stance, 5.56% took an unlikely stance, 38.89% took a neutral stance, 33.33% took a likely stance, and the remaining 20.37% took a very likely stance. This finding implies that majority of practitioner in electro-mechanical firms are eager to adopt cutting-edge technologies in electro-mechanical arena project implementations and also recommend other similar firms to adopt them.

4.7 Recommendations for Mitigating HVAC System Implementation Challenges

The next variable analyzed in this research study work was recommendations for mitigating HVAC system implementation challenges. A total of 8 major areas were carefully formulated and the following results were recorded from the survey conducted.

Regarding how effectively do responders believe the strategies used in the installation address the challenges encountered during HVAC system implementation, 20.37% of responders believe that it is not effective, 33.33% believe that it is slightly effective, 24.07% took a neutral stance, 11.11% believe that it is effective, and the remaining 11.11% believe that it is highly effective. This finding shows that there is a serious strategy formulation gap in electro-mechanical project implementations in Ethiopia and hence organizations need to better formulate well-rounded strategies in order to improve electro-mechanical project implementations.

In relation to what extent do responders agree that proper planning can mitigate challenges during HVAC system implementation, 7.41% took a neutral stance, 42.59% agreed, and the remaining 50% strongly agreed. This finding show that majority of responders believe that proper planning can mitigate challenges during HVAC system implementation and hence better planning should be adopted via electro-mechanical firms in Ethiopia.

In regards to how satisfied responders are with the level of coordination among stakeholders involved in HVAC system implementation to overcome challenges, 16.67% are very dissatisfied, 37.04% are dissatisfied, 24.07% took a neutral stance, 11.11% are satisfied, and the remaining 11.11% are highly satisfied. This finding show that majority of responders (53.7%) believe coordination among stakeholders in HVAC system implementation is poor and that needs to be addressed in order to better electro-mechanical project implementations.

In relation to rating the effectiveness of communication channels in addressing and resolving challenges encountered during HVAC system implementation, 11.11% believe that it is slightly effective, 18.52% took a neutral stance, 57.41% believe that it is effective, and the remaining 12.96% believe that it is highly effective. This finding show that majority of responders (70.37%) believe that effectiveness of communication channels in addressing and resolving challenges encountered during HVAC system implementation is a must if project implementations are deemed to succeed.

In regards to what extent do responders believe that adequate training and skill development can mitigate challenges during HVAC system implementation, 14.81% took a neutral stance, 48.15% agreed, and the remaining 37.04% strongly agreed with it. It is also worth mentioning that none of the responders either strongly disagreed and disagreed. This finding shows that there is a strong agreement with majority of

responders (85.19%) on the fact that adequate training and skill development can mitigate challenges during HVAC system implementation and hence it needs to be given priority.

In relation to how well do responders think proactive risk management strategies can mitigate potential challenges during HVAC system implementation, 18.52% took a neutral stance, 44.44% agreed (took a well stance), and the remaining 37.04% strongly agreed (very well) with it. It is also worth mentioning that none of the responders either took a very poor or poor stance on the subject matter. This finding shows that there is a strong agreement with majority of responders (81.48%) that proactive risk management strategies can mitigate potential challenges during HVAC system implementation. Hence, proactive risk management strategies need to be formulated via electro-mechanical firms located in Ethiopia if their project implementation is deemed to succeed.

Regarding how satisfied are responders with the level of support and resources provided to address challenges during HVAC system implementation, 35.19% are very dissatisfied, 33.33% are dissatisfied, 22.22% took a neutral stance, and the remaining 9.26% are satisfied. It is worth mentioning the fact that none of the responders are very satisfied. This finding shows that majority of responders (68.52%) are not satisfied with the level of support and resources provided to address challenges during HVAC system implementation and that needs to be improved.

Finally, in relation to rating the effectiveness of problem-solving mechanisms in resolving challenges encountered during HVAC system implementation, 27.78% believe that it is not effective, 46.3% believe that it is slightly effective, 16.67% took a neutral stance, and the remaining 9.26%% believe that it is effective. It is worth mentioning the fact that none of the responders believe that they are highly effective. This finding shows that majority of responders (74.07%) don't believe that problem-solving mechanisms in resolving

challenges encountered during HVAC system implementation are mature enough and hence it needs to be better formulated for future electro-mechanical projects in Ethiopia.

4.8 Overall Assessment Summary

The study on electro-mechanical (HVAC) quality awareness and practice assessment in Ethiopia reveals significant issues affecting the successful implementation of these projects. Despite 72.22% of respondents claiming to have moderately advanced experience in HVAC systems, a substantial 72.22% lack formal education or training in electro-mechanical systems. Additionally, over a quarter of respondents have only received limited or short-duration training, indicating a superficial understanding of the subject. This lack of comprehensive education and training is a fundamental challenge in ensuring high-quality implementation and adherence to best practices in HVAC systems.

Project planning and coordination in Ethiopia's electro-mechanical projects are notably deficient. With 59.26% of respondents rating the planning and coordination as poor and 14.81% as very poor, inadequate project planning is a significant barrier to successful project execution. Essential elements such as project staff responsibilities, departmental coordination, and quality control measures are often insufficiently defined. These inadequacies hinder the overall efficiency and effectiveness of electro-mechanical projects, highlighting the urgent need for improved project management frameworks and methodologies.

A critical area of concern identified in the study is the lack of technical expertise among project stakeholders. A substantial 70.37% of respondents believe there is insufficient technical expertise, particularly in project management, resource management, and electro-mechanical workmanship. This skills gap is exacerbated by insufficient evaluation and selection processes for subcontractors, especially in HVAC system design

and load calculations. The lack of technical expertise directly impacts project quality and efficiency, necessitating targeted training programs and rigorous subcontractor assessment criteria to ensure competent project delivery.

Resource availability significantly influences the implementation of electro-mechanical projects. Respondents cited challenges in budget allocation, recruitment of qualified staff, and access to necessary materials and equipment. Inadequate supply chains and logistical support further exacerbate these issues, leading to delays and inefficiencies. Enhancing resource availability, including financial resources, skilled personnel, and reliable supply chains, is vital for successful project execution. Additionally, the integration of advanced technologies within the electro-mechanical framework remains suboptimal, with respondents expressing dissatisfaction with the current level of technological integration. The lack of innovation and awareness of energy efficiency strategies impedes progress, underscoring the need for organizations to adopt advanced technologies and foster a culture of innovation to improve project outcomes and achieve sustainability goals.

Chapter Five

Summary, Conclusion and Recommendation

This chapter presents the main summary of the findings, conclusions drawn from the study, recommendation, and direction for future research for similar electro-mechanical project implementations in Ethiopia.

5.1 Summary of Major Findings

The following main summary of findings are worth mentioning based on the analysis and investigation carried in this research work.

- The study showed that majority of electro-mechanical project implementation practitioners, 85.19% are males and the remaining 14.81% are females.
- Majority of electro-mechanical project implementation practitioners in Ethiopia, 53.70% have diploma and above educational qualifications and 31.48% have TVET educational qualification, and only 14.81% have high school completion qualification.
- The study finding showed that 27.78% of electro-mechanical project implementation practitioners had previous education and training in electro-mechanical systems but the remaining 72.22% of respondents do not have any previous education or trainings in electro-mechanical related systems. This showed that there is a serious experience gap in electro-mechanical project implementations.
- It was also noticed that the study identified that the level of project planning and coordination in electro-mechanical projects in Ethiopia, majority of responders 59.26% rate it as poor, 14.81% rate it as very poor, and only 5.56% rate it as good.

This shows that there is a serious gap in electro-mechanical projects planning and coordination in electro-mechanical projects in Ethiopia.

- The study showed that the level of technical expertise and skill among project stakeholders involved in electro-mechanical projects in Ethiopia, 70.37% of responders believe that there is no sufficient technical expertise and only 29.63% believe that there is sufficient technical expertise in the area. This shows that there is also a serious lack of technical expertise and skills in electro-mechanical project implementations in Ethiopia.
- The study showed that only 9.26% of responders rate the state of technological infrastructure in Ethiopia for supporting electro-mechanical projects as adequate, 68.52% rated it as limited and the remaining 22.22% rated it as insufficient. This finding showed that there is a serious technological infrastructure lack in Ethiopia to support electro-mechanical projects implementations.
- Regarding familiarity with the regulations and guidelines governing the installation, operation, and maintenance of HVAC systems in Ethiopia, only 22.22% of responders claim that they are familiar with them showing the knowledge gap in the subject matter.
- The study finding showed that among perceived challenges in implementing electro-mechanical projects in Ethiopia, there are serious flaws and challenges in project planning and coordination, resource availability, regulatory compliance and permitting issues, energy efficiency awareness, and quality management implementations.
- The study findings further showed that there are serious gaps in integration and adoption of cutting-edge technologies in electro-mechanical projects in Ethiopia.

- The study also showed that there are serious gaps in strategy formulation and consumption, coordination among stakeholders involved in HVAC system implementation, and level of support and resources provided to address challenges during HVAC system implementation.

5.2 Conclusion

Overall, it was observed that several factors affect electro-mechanical project implementations in Ethiopia. It was found that electro-mechanical (HVAC) awareness and practice, project planning and coordination, level of technical expertise and skill, resource availability, energy efficiency awareness, quality management implementations are limited and significantly challenged. Furthermore, it was observed that lack of cutting-edge technology incorporation and regulatory compliance and permitting issues further complicate electro-mechanical project implementations in Ethiopia.

Among electro-mechanical project awareness and practices, lack of familiarity with electro-mechanical systems, lack/limited formal training or education on electro-mechanical systems, poor electro-mechanical project planning and coordination, lack of sufficient level of technical expertise and skill, lack of technological infrastructure in Ethiopia for supporting electromechanical projects, lack of knowledge in current practices and standards related to HVAC systems in Ethiopia, lack of familiarity with the regulations and guidelines governing the installation, operation, and maintenance of electro-mechanical systems are found to be the main factors identified affecting electro-mechanical project implementations in Ethiopia.

Furthermore, limitations in adopting and inventing cutting-edge technologies in electro-mechanical domain, lack of proper strategy formulation and project planning, lack of proper project coordination among stakeholders, poor risk management strategies, limited level of support and resources provided to address challenges during electro-

mechanical system implementations are additional factors challenging electro-mechanical project implementations in Ethiopia.

5.3 Recommendation

The researcher suggests the following recommendations for improving electro-mechanical project implementations in Ethiopia.

- Electro-mechanical systems awareness and practices among project practitioner need to be enhanced through different mechanisms including long-term and short-term trainings and inductions.
- Formal and regular trainings and/or education on electro-mechanical systems should be incorporated in Ethiopia's education system.
- More specialists in project planning and coordination in electromechanical projects need to be included.
- More technological infrastructures, both software and hardware, should be availed for supporting electro-mechanical project implementation in Ethiopia.
- Electro-mechanical system current practices and standards in Ethiopia, regulations and guidelines governing the installation, operation, and maintenance of electro-mechanical systems should be publicized and practitioners need to trained on the subject matter.
- Additional training or education programs related to electro-mechanical systems, specifically HVAC systems need to be incorporated in the country's education system.
- Electro-mechanical firms need to better reorganize to better deal with project planning, strategizing, coordination and implementations. Further, they should

open their doors to incorporation of cutting-edge technologies and also harvest technology inventions platforms for successful project implementations.

5.4 Direction for Future Research

Future similar researches in assessing factors affecting electro-mechanical project implementations in Ethiopia should be conducted incorporating detailed analysis with larger population size in the sector, covering more projects countrywide, incorporating additional factors from past related works globally which will be valid in Ethiopia's context, and drawing country specific factors from the existing electro-mechanical firms in Ethiopia which might be valid only to the reality in Ethiopia.

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Appendix A: Questionnaire

Addis Ababa University

College of Business and Economics

School of Commerce

Department of Project Management

Assessment of Challenges in the Implementation of Electromechanical Projects in Ethiopia: A Case Study of Unilever Manufacturing Plant in East Zone Industry Park - HVAC System

Dear Participant,

Thank you for agreeing to participate in this study aimed at understanding the challenges encountered in the implementation of electromechanical projects, with a specific focus on the HVAC system, within the Unilever Manufacturing Plant located in the East Zone Industry Park, Ethiopia for partial fulfillment of a degree Masters of Art (M.A.) in Project Management.

Your input is crucial in providing valuable insights that will contribute to enhancing project management practices within the industry. Your responses will be treated confidentially and used for research purposes only.

Please take a few moments to provide accurate and honest responses to the questions in the questionnaire. Your cooperation and contribution to this study are highly appreciated.

Instructions:

Please put a tick mark "X" to all your responses next to the box provided beside each statement or question in Part one and Two, and use Likert Scale Description: [1]

Insufficient; [2] Limited; [3] Adequate; [4] Moderately advanced; [5] Advanced for the other Parts.

Your honest feedback is important and will greatly contribute to the success of this research project.

Confidentiality:

Your responses will be kept confidential and will only be used for research purposes. Your identity will remain anonymous, and your individual responses will not be disclosed to anyone outside of the research team.

Contact Information:

If you have any questions or concerns regarding this study, please feel free to contact:

Name: Daniel Amare

ID: GSD/6001/12

Email: deguntle@gmail.com

Phone: +251-911027404

Thank you once again for your participation.

Sincerely,

PART ONE: General Information

1. Kindly indicate the responsibility that describes your role in the above-mentioned project?

Project Manage/ coordinator ☐	Contract administrator ☐	Resident Engineer ☐
Management member ☐	Consultant ☐	Quality Management Team Member ☐
Project Safety member ☐	Project Execution team ☐	
Design Review Team Member ☐	Others (please specify): _____	

2. What is your affiliation in the project?

Client (Unilever) ☐	Consultant (L&T Tech Ser) ☐	Contractor (Splenor Tech) ☐	Sub-Contractor (Hab Core Eng. ☐

3. What is your gender?

Male ☐	Female ☐

4. What is the level of your educational background?

PhD and Above ☐	Master's Degree ☐	Bachelor Degree ☐
College Diploma ☐	Technical and Vocational Education and Training (TVET) ☐	
High School Completed ☐	Others (please specify): _____	

5. Have you been involved in any electromechanical (HVAC) projects?

YES ☐	NO ☐

6. Your total work experience in electromechanical (HVAC) projects.

Less than 3 years ☐	3-5 years ☐	5-10 years ☐	11-15 years ☐	16 and above ☐

7. For the above-mentioned project, what is the project duration in months

In months	

8. Given the complexity of projects in Ethiopia, please rate the complexity of the above project

Low ☐	Medium ☐	High ☐

PART TWO: Electro-mechanical (HVAC) Awareness and Practice in Ethiopia

9. How familiar are you with electro-mechanical systems, particularly HVAC (Heating, Ventilation, and Air Conditioning) systems?

Advanced ☐	Moderately advanced ☐	Adequate ☐	Limited ☐
Insufficient ☐			

10. Have you received formal training or education on electro-mechanical systems, including HVAC systems?

Yes ☐	No ☐

If yes, please specify the type of training or education received. _____

11. How would you rate the level of project planning and coordination in electromechanical projects in Ethiopia?

Very poor ☐	Poor ☐	Average ☐	Good ☐
Excellent ☐			

12. Do you believe there is a sufficient level of technical expertise and skill among project stakeholders involved in electromechanical projects in Ethiopia?

Yes ☐	No ☐

If no, please elaborate on the specific skill gaps or deficiencies observed.

_____

13. How would you rate the current state of technological infrastructure in Ethiopia for supporting electromechanical projects?

Advanced ☐	Moderately advanced ☐	Adequate ☐	Limited ☐
Insufficient ☐			

14. How aware are you of the current practices and standards related to HVAC systems in Ethiopia?

Minimal ☐	Fair ☐	Maximum ☐	No Idea ☐
Others (please specify): _____			

15. Are you familiar with the regulations and guidelines governing the installation, operation, and maintenance of HVAC systems in Ethiopia?

Yes ☐	No ☐

If yes, please provide examples of these regulations and guidelines.

_____

16. In your experience, how frequently are HVAC systems utilized in various sectors

Residential ☐	Commercial ☐	Industrial ☐	Others (please specify): _____

17. Do you believe there is a need for additional training or education programs related to electro-mechanical systems, specifically HVAC systems, in Ethiopia?

Yes ☐	No ☐	Not Sure ☐

If yes, please specify the areas/topics that require further training or education:

_____

PART THREE: Perceived challenges in implementing electromechanical projects

Please rate the following challenges based on their significance in the implementation of electromechanical projects, particularly the HVAC system, within the Unilever Manufacturing Plant.

[1] Insufficient; [2] Limited; [3] Adequate; [4] Moderately advanced; [5] Advanced

Project Planning and Coordination.

Descriptions	1	2	3	4	5
How would you describe the level of project planning before the initiation of electromechanical projects?					
Are there any specific areas of coordination (e.g., between departments, with external contractors) that you find lacking?					
Responsibilities and authorities of project staff.					
Site organization chart, with named personnel if known.					
List of contract documents and drawings.					
Site layout plan.					
Construction program and sub-programs.					
Schedules of subcontractor nomination, material and equipment.					
Procurement, based on the construction program.					
List(s) of materials and appliances used for the project, showing the verification requirement of each.					
List of quality procedures and work instructions applicable to project by making reference to the company's Quality Manual and Procedures.					
List of project-specific procedures, work instructions inspection and testing.					
list of quality records to be kept, including appropriate quality records from subcontractors.					
How do inadequate planning and coordination affect the execution and outcomes of electromechanical projects?					

Technical Expertise in Electro-Mechanical Systems

Descriptions	1	2	3	4	5
In your opinion, does the Unilever Manufacturing Plant have sufficient in-house technical expertise for managing electromechanical projects?					
How does a lack of technical expertise impact the quality and efficiency of project execution?					
Evaluates and selects subcontractors on their ability to satisfy specified requirements.					

Evaluates and selects subcontractors on their ability to understanding of HVAC system design principles.					
Evaluates and selects subcontractors on their Ability to plan HVAC system layouts and configurations.					
Evaluates and selects subcontractors on their knowledge of load calculations and equipment sizing.					
Evaluates and selects subcontractors on their proficiency in installing HVAC equipment and components.					
Evaluates and selects subcontractors on their understanding of commissioning procedures for HVAC systems.					

Resource Availability Assessment

Descriptions	1	2	3	4	5
Availability of financial resources for initiating and executing electromechanical project.					
Access to funding sources such as project budgets, grants, or loans					
Flexibility in budget allocation for unforeseen expenses.					
Availability of skilled personnel for various roles in electromechanical projects					
Ability to recruit and retain qualified staff members					
Availability of necessary materials, components, and equipment for project implementation.					
Access to suppliers and vendors for sourcing materials.					
Quality and reliability of materials and equipment available.					
Availability of transportation and logistical support for moving materials and equipment to project sites.					
Infrastructure support such as access roads, utilities, and facilities for project operations.					
Efficiency of supply chain management in ensuring timely delivery of resources.					

Communication Among Project Stakeholders.

Descriptions	1	2	3	4	5
Communication between project team members within the organization.					
Effectiveness of internal meetings, updates, and status reports.					
Collaboration and information sharing among different departments involved in the project.					
communication with external stakeholders such as clients, contractors, and suppliers					
Clarity and consistency in conveying project requirements and expectations.					
Communication with the client regarding project progress, milestones, and deliverables.					
Communication between different departments or divisions within the organization.					
Communication across different functional areas involved in the project (e.g., engineering, procurement, operations).					

Regulatory Compliance and Permitting Issues

Descriptions	1	2	3	4	5
Familiarity with local, regional, and national regulations governing electromechanical projects.					
Awareness of specific regulatory requirements related to HVAC system installation, operation, and maintenance.					
Ease of navigating permitting processes for obtaining necessary approvals and licenses.					
Timeliness and efficiency of permit issuance for electromechanical projects.					
Challenges encountered in obtaining permits and approvals for HVAC system projects.					
Identification of compliance gaps or discrepancies during project execution					
Difficulty in ensuring full compliance with regulatory requirements throughout the project lifecycle.					

Awareness of changes or updates to regulations affecting electromechanical projects.					
Ability to adapt project plans and strategies in response to regulatory changes.					
Challenges posed by evolving regulatory landscapes for HVAC system projects.					
Engagement with regulatory agencies, authorities, and stakeholders involved in permitting processes.					
Influence of stakeholder engagement on permit approvals and compliance outcomes.					

Energy Efficiency Awareness

Descriptions	1	2	3	4	5
Familiarity with the principles of energy efficiency in electromechanical systems					
Awareness of strategies and technologies for improving energy efficiency in HVAC systems.					
Knowledge of energy efficiency standards and certifications applicable to electromechanical systems.					
Familiarity with industry-specific energy efficiency benchmarks and guidelines.					
Understanding of the importance of complying with energy efficiency standards in project implementation.					
Experience in implementing energy-saving measures in electromechanical projects.					
Proactive measures taken to optimize energy performance during project execution.					
Utilization of monitoring tools and systems to assess energy efficiency performance.					
Regular evaluation of energy consumption and efficiency metrics in electromechanical projects.					
Availability of educational resources and materials for improving energy efficiency awareness.					

Quality Management Implementation Challenges

Descriptions	1	2	3	4	5
Familiarity with industry-specific quality standards and regulations applicable to electromechanical projects.					
Knowledge of quality management principles and methodologies (e.g., ISO standards) for project implementation.					
Importance of complying with quality standards in ensuring project success and customer satisfaction.					
Implementation of quality control processes and procedures throughout the project lifecycle.					
Implementation of quality control processes and procedures throughout the project lifecycle.					
Integration of quality assurance measures to ensure adherence to project specifications and requirements.					
Management of supplier and vendor relationships to ensure quality of materials and components.					
Challenges encountered in maintaining quality control over external suppliers and vendors.					
Documentation of quality-related processes, inspections, and tests during project execution.					
Importance of documentation in demonstrating compliance with quality standards and regulatory requirements.					
Training programs or initiatives focused on quality management for project team members.					
Challenges in ensuring adequate training and skill development for maintaining quality standards.					
Development of quality-related skills and competencies among project personnel.					

PART FOUR: Integration of Cutting-Edge Technologies in Electromechanical Framework

1. Please rate the effectiveness of the current electromechanical framework, particularly in relation to the integration of cutting-edge technologies?

Strongly Disagree☐	Disagree ☐	Neutral ☐	Agree ☐	Strongly Agree ☐

2. How satisfied are you with the level of integration of cutting-edge technologies within the electromechanical framework at your organization?

Very Dissatisfied☐	Dissatisfied☐	Neutral ☐	Satisfied ☐	Very Satisfied ☐

3. How well do you think the integration of cutting-edge technologies has enhanced the efficiency of operations within your organization's electromechanical systems?

Not Enhanced☐	Slightly Enhanced ☐	Neutral ☐	Enhanced ☐	Highly Enhanced ☐

4. To what extent do you believe that the integration of cutting-edge technologies has improved the performance of the electromechanical systems in your organization?

Not Improved☐	Slightly Improved☐	Neutral ☐	Improved ☐	Significantly Improved ☐

5. Please rate the level of innovation demonstrated by the implementation of cutting-edge technologies within the electromechanical framework at your organization.

Very low☐	Low ☐	Neutral ☐	High ☐	Very high ☐

6. To what extent do you agree that the integration of cutting-edge technologies has contributed to the sustainability goals of your organization?

Strongly Disagree☐	Disagree ☐	Neutral ☐	Agree ☐	Strongly Agree ☐

7. How effectively do you believe the integration of cutting-edge technologies has addressed the challenges faced by the electromechanical systems in your organization?

Not Effectively☐	Slightly Effectively ☐	Neutral ☐	Effectively ☐	Highly Effectively ☐

8. How likely are you to recommend the integration of cutting-edge technologies to other organizations in the industry?

Very Unlikely ☐	Unlikely ☐	Neutral ☐	Likely ☐	Very likely ☐

PART FIVE: Recommendations for Mitigating HVAC System Implementation Challenges

1. How effectively do you believe the strategies used in the installation address the challenges encountered during HVAC system implementation?

Not Effectively☐	Slightly Effectively ☐	Neutral ☐	Effectively ☐	Highly Effectively ☐

2. To what extent do you agree that proper planning can mitigate challenges during HVAC system implementation?

Strongly Disagree☐	Disagree ☐	Neutral ☐	Agree ☐	Strongly Agree ☐

3. How satisfied are you with the level of coordination among stakeholders involved in HVAC system implementation to overcome challenges?

Very Dissatisfied☐	Dissatisfied☐	Neutral ☐	Satisfied ☐	Very Satisfied ☐

4. Please rate the effectiveness of communication channels in addressing and resolving challenges encountered during HVAC system implementation.

Not Effectively ☐	Slightly Effectively ☐	Neutral ☐	Effectively ☐	Highly Effectively ☐

5. To what extent do you believe that adequate training and skill development can mitigate challenges during HVAC system implementation?

Strongly Disagree☐	Disagree ☐	Neutral ☐	Agree ☐	Strongly Agree ☐

6. How well do you think proactive risk management strategies can mitigate potential challenges during HVAC system implementation?

Very poorly☐	Poorly ☐	Neutral ☐	Well ☐	Very well ☐

7. How satisfied are you with the level of support and resources provided to address challenges during HVAC system implementation?

Very Dissatisfied☐	Dissatisfied☐	Neutral ☐	Satisfied ☐	Very Satisfied ☐

8. Please rate the effectiveness of problem-solving mechanisms in resolving challenges encountered during HVAC system implementation.

Not Effectively☐	Slightly Effectively ☐	Neutral ☐	Effectively ☐	Highly Effectively ☐

Additional Comments (if you have any):

Thank you for taking the time to participate in this questionnaire regarding the assessment of challenges in the implementation of electromechanical projects in Ethiopia, with a focus on the Unilever Manufacturing Plant in the East Zone Industry. Your feedback and insights are invaluable in understanding the nuances and complexities of this topic.

1. **Recommendations for Addressing Challenges**

_____

_____

_____.

2. **Insights from Similar Projects**: If you have been involved in or have knowledge of similar electromechanical projects in Ethiopia or other regions, I welcome any

insights or comparisons that you believe may be relevant to this study. Understanding how challenges are addressed in similar contexts can provide valuable context and guidance for future projects.

_____

_____

_____.

3. **Areas for Further Research:** Are there any specific areas related to the implementation of electromechanical projects in Ethiopia that you believe warrant further research or investigation?

_____

_____

_____.