

CHALLENGES AND PROSPECTS OF LOGISTICS DIGITALIZATION IN ETHIOPIA: THE CASE OF ETHIOPIAN SHIPPING AND LOGISTICS.

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CHALLENGES AND PROSPECTS OF LOGISTICS DIGITALIZATION IN ETHIOPIA: THE CASE OF ETHIOPIAN SHIPPING AND LOGISTICS SERVICE ENTERPRISE.

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Declaration

I hereby declare that the work which is being presented in this thesis entitled "C***hallenges and prospects of logistics digitalization in Ethiopia: the case of Ethiopian shipping and logistics.***" is original work of my own, has not been presented in any of other university and that all sources of material used for the thesis have been duly acknowledged

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Signature

Date

Certification

This is to certify that Mignote Mekasha has carried out his thesis work on the topic entitled "C***hallenges and prospects of logistics digitalization in Ethiopia: the case of Ethiopian shipping and logistics.***" The work is original and is suitable for submission for the award of a Master's Degree in Logistics and Supply Chain Management.

Advisor Zelalem Tadesse (Ph.D.)	**Signature**	**Date**

ADDS ABABA UNIVERSIT SCHOOL OF COMMERCE

DEPARTMENT OF LOGISTIC AND SUPPLY CHAIN MANAGEMENT

CHALLENGES AND PROSPECTS OF LOGISTICS DIGITALIZATION IN ETHIOPIA: THE CASE OF ETHIOPIAN SHIPPING AND LOGISTICS.

Approved by Board of Examiners

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Abbreviation and Acronyms

AI	Artificial Intelligence
CLM	Council of Logistics Management
DT	Digital transformation
ESL	Ethiopian shipping and Logistics
ICT	Information and Communication Technology
IoT	Internet of things
KPI	Key Efficiency Indicators
ROI	Return on Investment
SCM	Supply Chain Management
SPSS	Statistical Package for the Social Sciences

Abstract

Logistics digitalization is increasingly recognized as a key driver of operational efficiency, transparency, and competitiveness in modern supply chains. Despite its potential, the implementation of digital logistics systems in Ethiopia remains uneven and fragmented. The Ethiopian Shipping and Logistics Services Enterprise (ESL), as the country's sole sea transportation provider and a central actor in international trade, has introduced various digital initiatives; however, its operational efficiency continues to lag behind regional and global benchmarks. This study examines the challenges and prospects of logistics digitalization in Ethiopia, with particular emphasis on ESL. A mixed-methods research approach was employed to enhance analytical rigor and triangulation. Quantitative data were collected through self-administered questionnaires from 139 managerial and senior staff members, selected using stratified random sampling. Qualitative data were obtained through semi-structured interviews with key stakeholders. Data processing involved editing, coding, and tabulation to ensure accuracy and consistency before analysis. Explanatory statistical techniques were applied using SPSS version 20, including mean and standard deviation analyses, Pearson product-moment correlation, and multiple regression analysis to examine relationships between variables. The findings reveal that logistics digitalization at ESL has resulted in positive but partial improvements in cost reduction, error minimization, and overall efficiency. However, challenges persist in technological infrastructure and regulatory policy, as well as the effect of logistics digitalization, the influence of digitalization on international trade, and the effect of data security on the implementation of logistics digitalization. Regression results confirm that logistics digitalization is a significant determinant of operational efficiency ($R^2 = 0.989$). The study concludes that stronger system integration, process reengineering, capacity building, and data governance are essential for achieving sustained digital transformation in Ethiopia's logistics sector.

Chapter One

1. Introduction

1.1 Background of the study

Digitalization has profoundly transformed the global logistics industry, reshaping how goods are transported, managed, and delivered. Technologies such as the Internet of Things (IoT), big data analytics, cloud computing, artificial intelligence (AI), and mobile applications have revolutionized logistics and supply chain operations, driving greater efficiency, transparency, and flexibility (LinkedIn; Liu & Chiu, 2021). Through these digital tools, logistics service providers can optimize operational processes, automate inventory management, track shipments in real time, and leverage data-driven decision-making. This transformation enhances overall efficiency, reduces operational costs, and improves customer satisfaction, enabling companies to remain competitive in an increasingly complex global market (Barbara et al., 2022; Flora, 2023; Strategyand.pwc.com).

The logistics sector, particularly shipping lines, plays a pivotal role in facilitating international trade. Globalization has amplified demand for shipping services, intensifying competition among providers and compelling them to adopt innovative strategies to maintain and expand market share (Lezhnina & Balykina, 2021). In this context, digitalization is not only a tool for operational improvement but also a critical driver of strategic competitiveness, allowing companies to achieve the connected, highly efficient supply chain ecosystems envisioned under Industry 5.0.

In Ethiopia, the Ethiopian Shipping and Logistics Service Enterprise (ESL) serves as the backbone of the nation's import-export economy. Established in August 2016 through the merger of four former enterprises Ethiopian Shipping Lines Share Company, Ethiopian Maritime and Transit Service Enterprise, Dry Port Enterprise, and Comet Transport Share Company ESL provides comprehensive logistics services, including sea freight transport, stevedoring at the Port of Djibouti, multimodal transport, freight forwarding and clearing, dry ports, warehousing, and liner services. Operating primarily through the Port of Djibouti and with agency networks in all trading areas, ESL has adopted global practices such as slot charter agreements to ensure reliable weekly shipments (Ethiopian Shipping Lines, 2023).

ESL's role in the national economy is critical. Efficient logistics are essential for accelerating industrialization, boosting exports, importing capital, and increasing per capita income. Recognizing this, the Ethiopian government has emphasized digital transformation in logistics

as a strategic priority under initiatives such as Digital Ethiopia 2025, which seeks to modernize key sectors, including logistics, through IT-enabled services and advanced supply chain management (Federal Democratic Republic of Ethiopia, 2018).

Globally, the transition from traditional to digital supply chains relies on an integrated suite of technologies, including big data analytics, AI, IoT, 5G networks, cloud logistics, and machine learning (Nagy et al., 2023a; Singh et al., 2023). By adopting these tools, logistics companies can reduce operational costs, improve service quality, and respond effectively to dynamic market demands. For ESL, digitalization offers the potential to enhance operational efficiency, improve transparency, and streamline processes across the supply chain.

Despite these opportunities, Ethiopia's logistics sector faces significant barriers to digital transformation, including limited infrastructure, inadequate access to advanced technology, regulatory challenges, and a shortage of skilled personnel. Understanding these challenges and exploring strategies for overcoming them is crucial for enhancing the efficiency and competitiveness of the logistics sector. ESL provides a case study for examining the dynamics of digitalization in Ethiopia, highlighting both the potential benefits and the obstacles that must be addressed to foster growth and efficiency in national logistics.

1.2 Statement of the problem

Digitalization has the potential to transform the logistics industry by enhancing efficiency, transparency, flexibility, and overall supply chain performance. Through the adoption of digital technologies, organizations can optimize planning, procurement, and operational processes, improve real-time tracking and information sharing, and strengthen customer service delivery (LinkedIn, 2021; Liu & Chui, 2021; Barbara et al., 2022; Flora, 2023).

The Ethiopian Shipping and Logistics Services Enterprise (ESL), as the country's sole sea transportation provider, has adopted various digital technologies with the aim of improving operational efficiency, reducing costs, enhancing product traceability, and strengthening inventory and warehouse management systems. Despite these efforts, ESL continues to face significant challenges related to logistics digitalization, data security, technological infrastructure, and regulatory and policy frameworks. While digitalization presents considerable opportunities for improving operational efficiency, these challenges constrain the full realization of its benefits and limit ESL's ability to enhance competitiveness and service delivery.

Although ESL has played a strategic role in Ethiopia's international trade for more than five decades, its operational efficiency remains below regional and global benchmarks. This performance gap is reflected in Ethiopia's low rankings on indicators such as the Ease of Doing

Business and trading across borders, which negatively affect customer satisfaction, trade facilitation, and investment attractiveness. In response, the Ethiopian government has identified logistics digitalization as a key reform priority. However, implementation has been inconsistent due to systemic challenges, including inadequate ICT infrastructure, limited system interoperability, weak legal and regulatory frameworks, and fragmented operational practices.

Against this backdrop, this study titled "Challenges and Prospects of Logistics Digitalization in Ethiopia: The Case of Ethiopian Shipping and Logistics Services Enterprise" seeks to examine the key challenges and opportunities associated with logistics digitalization at ESL. Specifically, the study assesses the effects of logistics digitalization, data security challenges, technological infrastructure, and regulatory and policy factors, while exploring prospects for enhancing operational efficiency, competitiveness, and supply chain performance. The findings of this study are expected to provide valuable insights to inform policy formulation, strategic decision-making, and the successful implementation of digital transformation initiatives within Ethiopia's logistics sector.

1.3 Research questions

1. What is the effect of logistics digitalization on operational efficiency at Ethiopian Shipping and Logistics Services Enterprise (ESL)?
2. What data security challenges affect the implementation of logistics digitalization at ESL?
3. How does logistics digitalization influence international trade facilitation at ESL?
4. What technological infrastructure and regulatory policy challenges hinder logistics digitalization at ESL?

1.4 Objectives

1.4.1 General objective

The general objective of this study is to examine the challenges and prospects of logistics digitalization at Ethiopian Shipping and Logistics Service Enterprise (ESL)**.**

1.4.2 Specific objectives

- ✓ To determine logistic digitalization on the efficiency of operation efficiency on ESL
- ✓ To examine logistics digitalization challenges on data security on ESL
- ✓ To determine the effects of logistic digitalization on international trade facilitation on ESL
- ✓ To assess the challenge of logistic digitalization on technology infrastructures and regulatory policy on ESL2025.

1.5 Significance of the research

This research provides both empirical and theoretical contributions by assessing ESL's digitalization status, identifying key challenges, and proposing practical solutions. The findings support improved operational efficiency, cost reduction, faster service delivery, enhanced customer satisfaction, and greater competitiveness. Additionally, the study offers evidence based insights to guide strategic decisions on technology adoption and resource allocation, while also serving as a useful case study for other state-owned and international logistics organizations pursuing digital transformation.

1.6 Scope of the research

This research is theoretically scoped around digitalization, supply chain strategies, organizational aspects, and specific logistics technologies, with a particular focus on Ethiopian Shipping and Logistics Service Enterprise (ESL) and its operations within Ethiopia. Geographically, the study is limited to Ethiopia, with emphasis on ESL's headquarters in Addis Ababa and the logistics hubs and transport networks influencing its operations, while excluding the broader Ethiopian logistics sector and ESL's international shipping activities. Conceptually, the study examines the Logistics Digitalization, Data Security Challenges, Technological Infrastructure, Regulatory and Policy challenge on operational efficiency, and service delivery. This focused scope allows for an in-depth analysis of logistics digitalization challenges and opportunities within a single, strategically important organization.

1.7. Limitation of the study

Almost every research faces different limitations in different degrees. The researcher faced different problems that made the study hard to conduct properly such as respondents did not return the questionnaire on time; due to the interviewers appointed according to their program. Besides, in case of the current peace and security problems happened in our country may phase challenges on gathering the institutions are military institutions and they may perform their day to day activities on security issues.

1.8. Organization of the study

The study was organized in five major chapters. The first chapter deals with the introduction part of the paper including background of the study and study area, statement of the problem, objectives of the study, research questions, the significant of the study, scope of the study, definitions of terms. The second chapter was focus on relevant literature review. The third chapter will deal with research Methods of the study. The fourth chapter was present the overall findings of the study which prevail about the effect of inventory management practices on military operational efficiency in selected higher educational institutions. Finally, chapter five was incorporate

summary of major findings, conclusion and recommendation part of the study.

Chapter Two

2. Review of Related Literature

This chapter has the discussion of theoretical and empirical literature relevant to the study. Accordingly, and is divided into three broad sections: theoretical literature review, empirical literature review, and conceptual framework.

2.1 Theoretical literature

Global digital transformation spending is projected to reach $3.4 trillion by 2026, with businesses investing in it 23% more likely to acquire new customers. COVID-19 has increased the budget for digital transformation, with 79% of companies admitting to increase spending. However, 47% of companies haven't started, and 59% worry it might be too late. 55% of businesses believe they have less than a year before financial and market share losses (CRM, 2024).

Digital transformation in logistics operations is crucial for meeting market demands and ensuring long-term success. However, 72% of logistics executives lack industry knowledge about digitalization. A comprehensive technology roadmap is needed to address this. Data analytics and automation are essential components, improving customer service, worker productivity, and setting logistics companies apart from competitors (Levi Olmstead, 2024).

Digital transformation (DT) refers to the process of integrating digital capabilities/technologies into multiple areas of the business to meet the ever-changing market and business requirements. DT is about planning for future working methods and allowing new technology to tackle current business difficulties. Enhancing efficiency, fostering innovation, and adding value are the common objectives of digital transformation for a firm. Media professionals and the industry are adamantly claiming that digital transformation is essential for competition and that its rate is crucial (Zhang, 2024).

Many government agencies and commercial companies have tried their hand with digital transformation. This presents a crucial dilemma for the companies: is this a large adoption phase rather than a trend cycle that begins with a peak of inflated expectations and leads to a trough of disillusionment? (CRM, 2024) What are the corporations attempting to accomplish if this is a major adoption phase? What do they want to accomplish, and what is the objective? And do their goals and the actual situation differ from one another? (Vedashubham Pandiyan, 2022).

SCM functions as a method for coordinating multiple operations to move products and services

from suppliers until they reach customers. Before digitalization supply chain management primarily worked with human labor, paper forms along with traditional sequential systems. The previous strategies used to function well but now struggle against the sophisticated patterns of present-day markets that combine complex logistics with demanding customers (Financial Times, 2025). Organizations pursue effective solutions aimed at improving supply chain monitoring and safety during this time of need. Digitalization serves as a revolutionary power in supply chain management that combines Internet of Things (IoT) and artificial intelligence (AI) and block chain and cloud computing systems. Multiple technological systems form a connected data-based system which improves process automation and enhances both visibility and decision quality. The supply chain digitalization market will reach more than $13.5 billion by 2027 according to latest market research from Grand View Research (2024). AI and machine learning technologies implement control tower supply chain monitoring which helps businesses forecast disruptions along with operation optimization (Financial Times, 2025).

The secure and transparent functionality of block chain technology enables stakeholders to track goods effectively which builds their trust (Liu et al., 2022). The term operational efficiency in SCM stands for delivering products and services at affordable prices quickly and keeping consistent quality levels. Operation efficiency necessitates three main elements including waste reduction and productivity enhancement with optimized material, information and financial stream. Industrial supply chain systems encounter operational limitations because they have restricted supplier monitoring capabilities beyond primary relationships and suffer from manual input errors which create efficiency problems (Financial Times, 2025). Seeking operational enhancement through digital transformation allows businesses to cut their supply chain expenses by 30% while generating 10% revenue growth according to McKinsey & Company (2023). Digitalization fixes these challenges by providing immediate data sharing along with full supply chain visibility to enhance system-wide operational results (American Public University, 2025).

Digitalization activities produce multiple operational benefits at multiple organization levels. Conditioned enterprises can address their supply chain problems while improving demand forecasting through real-time data generation together with automation and predictive analysis capabilities. Deloitte (2023) states that IoT sensor technology enables organizations to reduce equipment maintenance expenses by 25% and increase asset operational efficiency by 20% Organizations that adopt autonomous planning within digital factories obtain instant decision-making capabilities and improved cooperation to deliver better supply chain outcomes (Ernst & Young, 2025). The research evaluates the core methods digital supply chain adjustments use to

enhance operational outcomes. The study examines core digital transformation technologies then studies how supply chain metrics change before describing successful digital updates. The research document investigates both the traditional obstacles that firms face when digitizing their operations as it examines emerging supply chain management patterns that will guide future industry directions. Digital supply chain transformation drives a total operational system transformation which produces multiple potential opportunities for productivity enhancement. Organizations can build sustainable efficient supply chain systems through using modern technology with their data initiatives to manage current international market scenarios.

Despite the numerous benefits, the process of digitalizing logistics is not without its challenges. Companies face several hurdles as they attempt to integrate digital technologies into their logistics operations. Some of the key challenges include:

1. **High Initial Investment Costs**

   Implementing digital technologies like AI, IoT, and blockchain requires significant capital investment in terms of infrastructure, hardware, and software. Small and medium-sized logistics companies often struggle with these upfront costs. Additionally, these technologies require continuous upgrades and maintenance, further straining the financial resources of businesses.

2. **Data Security and Privacy Risks**

   With digitalization comes an increased risk of cyberattacks and data breaches. Logistics companies handle vast amounts of sensitive data, including customer information, financial records, and shipment details. Ensuring data security is critical, but protecting digital infrastructure from cyber threats is an ongoing and costly challenge. Many logistics firms also need to comply with stringent data protection regulations, such as GDPR, which adds complexity to their operations.

3. **Integration with Legacy Systems**

   Many logistics companies rely on legacy systems that were not designed to work with modern digital technologies. Integrating digital solutions with outdated systems can be complex and costly. The transition can also lead to temporary disruptions in operations, causing delays in shipments and negatively affecting customer satisfaction.

4. **Skills Gap and Workforce Readiness**

   The logistics workforce may lack the technical skills required to manage and operate advanced digital systems. Employees need to be trained in the use of AI tools, IoT devices, and data analytics platforms. Upskilling the workforce takes time and resources, and

companies may face resistance to adopting new technologies from employees who are accustomed to traditional ways of working.

5. **Regulatory and Compliance Issues**

   The logistics sector is subject to a variety of regulations, and the adoption of new technologies must align with these requirements. For example, the use of drones for delivery may face regulatory hurdles regarding airspace management and safety concerns. Similarly, autonomous trucks must comply with traffic laws and safety regulations, which can vary across regions. Keeping up with the evolving regulatory landscape can be a significant challenge for logistics companies.

6. **Resistance to Change**

   The digitalization of logistics often faces internal resistance from employees and management. Established companies, in particular, may be resistant to adopting new technologies, as doing so often requires a complete overhaul of existing processes and workflows. Without effective change management strategies, organizations risk employee disengagement and poor adoption of digital solutions.

7. **Supply Chain Disruptions**

   While digitalization aims to improve supply chain resilience, it can also introduce new vulnerabilities. For instance, technical failures or cyberattacks on digital systems can disrupt the entire logistics network, causing delays in shipments and financial losses. Companies must invest in robust disaster recovery and backup systems to mitigate such risks.

8. **Fragmented Ecosystem**

   The logistics industry is highly fragmented, with many players, including shipping companies, warehouses, customs agencies, and retailers. Achieving end-to-end digital integration across all stakeholders in the supply chain is challenging. Different companies may use different platforms, creating silos of information and reducing the efficiency of the digital ecosystem.

2.2 Empirical literature

Empirical literatures are simply referring to evidence from different sources of observation and report. There are several studies conducted in the field of determinants of digitalized revenue tax system and its relationship.

2.2.1 Historical development of logistic management

Initially Logistics was a military activity concerned with getting soldiers and arms to the battlefront, but it is now seen as an integral part in the firm ‘s production process to carry raw

materials, semi-finished goods and finished goods to market and customer ‘s (Kumar & Shirisha, 2014).

Firms have always and everywhere carried out typical activities today included in the concept of logistics, such as inventory and transportation. Almost every sphere of human activity is affected directly or indirectly by the logistics process (Lambert & Stock, 1993). However, before the development of the discipline of logistics, the historical practice was to manage them separately, without any co-ordination (Gilbert & Ballou, 1999).

The Ballou model is a framework used in logistics to evaluate and select logistics operation modes for enterprises. It considers the importance of logistics to enterprise success and the enterprise's operational logistics capacity. The model improves management efficiency by guiding the selection of the most suitable mode. Feng Li et al. developed an evaluation index system using this model to determine the best logistics operation mode for an enterprise (Li et al., 2019).

Logistics as the part of a supply chain involved with the forward and reverse flow of goods, services, cash, and information including the managing of all transportation material handling, warehouse inventory, order processing and distribution, third-party logistics, and reverse logistics in logistics activities (Stevenson, 2009).

The 1950s, logistics was thought of in military terms. It had to do with procurement, maintenance, and transportation of military facilities, material, and personnel. Although a few authors before this time began talking about trading one cost for another, such as transportation costs with inventory costs, and discussed the benefits to the firm of getting the right goods to the right place at the right time, the organization within the typical firm around the activities currently associated with logistics was fragmented (Ballou, 2007).

Lambert & Stock, 1993 observe that some principles of logistics were taken into consideration by the economic theory even then at the beginning of the 1990s, but they were not applied by the companies until the 1960s. Initially, logistics was just one of the centers of cost in a firm. It is only in recent years – earlier in USA and later in Europe - that business organizations have recognized the strategic contribution of logistics in achievement of competitive advantage (Christopher, 1992).

Logistics management is treated as a part of the supply chain management that deals with management of goods in an efficient way. It is the management process that integrates the movement of goods, services, information, and capital, right from the sourcing of raw material to the consumer. The goal of the logistics management is to provide the right product with the

right quality at the right time in the right place at the right price to the ultimate customer (Ristovska et al., 2017).

Logistics optimizes production and distribution processes using resources, promoting efficiency and competitiveness. The transportation system, which accounts for one-third of logistics costs, is crucial in a logistics chain. It plays a significant role in the entire production process, from manufacturing to delivery to consumers and returns. Good coordination between components maximizes benefits (Yue et al., 2005).

Merriam-Webster defines logistics as the handling of the details of an operation. Stevenson, 2009defines logistics as the part of a supply chain involved with the forward and reverse flow of goods, services, cash, and information. He includes the managing of all transportation, material handling, warehouse inventory, order processing and distribution, third-party logistics, and reverse logistics in logistics activities (Stevenson, 2009)

2.2.2 Logistics management

Ever since the Council of Logistics Management (CLM) adopted the definition of logistics in 1984, the integration of somewhat disparate activities of transportation, procurement, inventory control, distribution management, and customer service has been a major thrust in many firms. Realizing the synergies that exist in these functions, many companies have extended the concept further upstream and downstream to include entities outside the company to include vendors and their vendors and customers and their customers (Bagchi & Skjoett-Larsen, 2004).

Logistics means planning and organizing activities that ensure that resources are in place so that the process can be effectuated accordingly in efficient and effective manner (Mellat-Parast & Spillan, 2014)

Logistics management is the process of strategically managing the procurement, movement and storage of materials, parts, and finished inventory (and the related information flows) through the organization and its marketing channels in such a way that current and future profitability are maximized through the cost-effective fulfillment of orders (Christophor, 2016).

Logistics management is the part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, services, and related information from the point of origin to the point of consumption to meet customer requirements. Logistic resources, such as tanks, pipelines, and ships, have the main objective of making products, equipment, and raw material flow easier throughout processes to maximize profits (GARG, 2020).

2.2.3 Logistic digital transformation

The accessibility of digital technologies drives the rise of digital transformation across different sectors of society. By 2026, global digital transformation spending is forecast to reach 3.4 trillion U.S. dollars. As technologies evolve and integrate into people's day-to-day lives, businesses are beginning to invest in digital transformation as a driver of market growth and value.

(Source: Measuring the ROI of Digital Transformation https://kissflow.com/digital-transformation/roi-of-digital-transformation/)

In a survey conducted in 2015 with over 400 executives from large firms in Europe, Scandinavia, the Asia-Pacific region, and North America it was observed that the Scandinavian firms appeared to have less interest and focus in pursuing digital transformation than their Asia-Pacific and North American counterparts (Andersson et al., 2018). But after the terms like digital transformation and digitalization became the buzzwords in the Ethiopian government and private companies in 2018, many large companies desired to become the 'digital leaders' in their respective industries.

Digital transformation is usually associated with both digital offerings and digital processes. Digital processes include the integration of digital capabilities into internal organizational operations including sourcing, supply, production, sales, ordering, and logistics. A controlled manufacturing facility, linked workflows, data flows across factories to improve workflows, data flows across various subgroups managing the product lifecycle management, and many more are examples of digital capabilities for the digital process. Digital offerings are the digital features that are included in the goods and services that the company provides. The organization is able to comprehend client usage patterns using embedded sensors and software in the product or service, which results in smart goods and new business models (Porter & Heppelmann, 2014).

The Ethiopian government launched the Digital Ethiopia 2025 Strategy to develop digital infrastructure and ensure access to digital services for all Ethiopians, laying the foundation for a digital economy. The projection for the Digital 2025 shows landmark achievements of the national strategy in developing digitalization in Ethiopia. Acknowledging the achievements and progress made by the Digital Ethiopia 2025, Strategy in developing digital infrastructure, expanding digital services and commerce, digital finance, and digital literacy over the past five years, the Ethiopian government announced preparations for a more ambitious strategy, Digital Ethiopia 2030, to realize a digital economy after the current strategy's completion. (Source: Ethiopia's digital leap: A timeline of significant changes Ethiopian Press Agency https://press.et/herald/?p=109128)

According to Andersen and colleagues' study on digital transformation in Swedish businesses showed that many businesses place more value on the digital processes than the digital services (Andersson et al., 2018).

In Estonia, digital technologies like the IoT have the potential to raise labor productivity by up to 20% in businesses that use IoT (Burinskiene & Daškevič, 2024). Bigliardi and his colleagues reviewed a transformative shift in the industry, mainly driven by the integration of digital technologies to enhance efficiency, competitiveness, and innovation (Bigliardi et al., 2022).

Retaining competitiveness in a market that is changing quickly requires the incorporation of digital technologies into logistical procedures. The digitization of the supply chain has enabled companies to optimize planning, sourcing, and procurement strategies, enhancing their overall efficiency (Jemison, 1987; Liu & Chiu, 2021).

Moreover, digitalization has transformed the logistics industry in a number of ways. Supply chain digitization involves three main areas: data management, process integrations, and the use of digital tools in physical process execution. Digitized data management tools collect large volumes of data, improve processes like demand forecasting and distribution, and enhance process integration. Digital tools in physical process execution improve picking paths and efficiency, while warehouse robots aid in fast fulfillment. These factors contribute to a better supply chain solution (Flora, 2024).

Digitization improves supply chain execution and planning, financial management, lead time reduction, and decision-making. Digital inventory offers real-time visibility, allowing for automatic notifications for inventory restocking and lowering stock out costs. Digitization also removes manual work across departments, resulting in faster operations. Advanced tracking and analytics capabilities give significant information for better decision-making, including precise demand forecasts and inventory planning.

2.1.1 Logistics Digitalization

Logistics digitalization has been identified as an important transformation in supply chain and logistics operations that has been fueled by the application of modern digital technologies like the Internet of Things (IoT), artificial intelligence (AI), big data analytics, blockchain, and cloud computing. According to the literature, logistics digitalization is defined as the concept of applying digital technologies in logistics operations for boosting information flow, coordination, and decision-making in supply chain activities (Verdes and Mironescu, 2023). Unlike normal automation, logistics digitalization has the ability to facilitate the flow of information in real-time, enabling supply chain managers to adopt reactiveness in managing logistics operations

rather than being reactive. The literature highlights that technologies like IoT sensors and digital platforms have been able to improve overall inventory tracking, transportation, and warehousing operations of supply chain partners (Meshali and Lemtaoui, 2024).

Empirical and conceptual studies further investigate and illustrate that logistics digitalization has a strong positive impact both on supply chain efficiency and general organizational efficiency. Digital tools enhance demand forecasting accuracy, optimize routing and scheduling, and support integrated planning of logistics functions. Recent research suggested that through digital transformation, coordination within suppliers of goods, providers of logistics services, and customers is enhanced. This brings forth the beneficial outcomes of decreased lead times, reduced logistics costs, and enhanced quality of service. Digitalization thus allows an informative approach to decision-making on a strategic, tactical, and operational scale, very relevant in complex and dynamic environments. Based on available literature, it can be identified that the following competitive advantages are definitely pursued by firms adopting digital logistics capabilities: enhanced agility, responsiveness, and operational transparency.

Despite its considerable advantages, there are some challenges and barriers discussed in the literature that prevent effective logistics digitalization. Some widely cited constraints include exorbitant implementation costs, cyber security risks, shortage of digital infrastructure, and shortage of capable skilled personnel to handle advanced digital systems (Zeng et al., 2025). More importantly, resistance to change and weak organizational digital culture hinder the digital transformation process most within public sectors or resource-constrained institutions.

2.1.2 Data security challenges

Additionally, with the trend of more digitization of logistics systems, the literature has identified challenges in the area of data security. Various research papers clearly discuss the fact that the application of new paradigms, such as the Internet of Things (IoT), cloud, and big data, has increased vulnerability to cyber threats, meaning that the logistics and supply chain information systems are prone to hacking, data robbery, or unauthorized entry (Enache, 2023; Faisal et al., 2024). For instance, even though the application of IoT helps facilitate tracking, the existence of vulnerable links in the area of network security due to the current lack of adequate embedded security mechanisms against such threats to the operational, strategic, or critical information of the logistics system has been identified (Faisal et al., 2024). Finally, the literature highlights the fact that confidentiality, integrity, and availability (CIA triad) are commonly jeopardized due to

the lack of adequate encryption, entry restrictions, or unaddressed legacy systems, which are quite prevalent in the logistics context (Faisal et al., 2024).

Existing literature has pointed towards different types of cyber-attacks and vulnerabilities, which have proven to be challenging for digital logistics systems to overcome. Narrative reviews for the threats that exist in digital supply chains have pointed towards the threats of ransomware, phishing, and other attacks like Distributed Denial-of-Service (DDoS), and malware that can act as threats to the operations and the date of the logistics company, including customer data and shipments (Faisal et al., 2024). This can be added by the use of multiple third-party and digital supply partners, which can lead to the entire supply chain being threatened with the breach of security at any single supply link, thus showing the connections that can exist in the different threats in the digital supply logistics (Transportation Research Part E, 2021; supply chain attack definition). In addition to the various threats, existing literature has pointed towards the lack of data available for the forensic analysis that has to occur in the actual recovery process in the logistics systems (Transportation Research Part E, 2021).

The works underlines the organizational and strategic dimensions of data security challenges in logistics digitalization, emphasizing those technical solutions will not work without comprehensive risk management frameworks. Systematic reviews on cyber security risk management indicate a consensus that such digital transformation often races ahead of an organization's ability to secure digital assets, leading to vulnerabilities related to human errors, procedural weaknesses, and coordination gaps across sectors (Haque et al., 2025; Saeed et al., 2023). Cyber security research within the context of supply chains further identifies the fragmented regulatory environment and inconsistent cyber security policy across regions and sectors as complicating factors toward standardizing protective measures (Faisal et al., 2024). Collectively, these works identify an urgent need for integrated security frameworks combining advanced technologies-such as blockchain for maintaining data integrity-with robust governance and continuous risk assessment to address the shifting cyber threat landscape in logistics digitalization.

2.1.3 Technological Infrastructure

This includes issues related to inadequate infrastructure, such as limited internet connectivity, outdated technology, and insufficient integration of digital tools. These barriers hinder the smooth implementation of digital solutions.

Digital transformation has become a cornerstone of modern business strategy, driven by the need to remain competitive in an increasingly digital world. However, the mere adoption of technology for its own sake can lead to wasted resources and misaligned investments. To maximize the return on investment (ROI) from digital initiatives, businesses must strategically align their technology investments with overarching strategic goals and priorities. Taking on digital transformation for transformation’s sake can waste resources. Align your technology investments with overarching strategic goals and priorities. Track key metrics to measure ROI and efficiency ultimately driving ROI from your digital investments.

Digital transformation is not an end in itself but a means to achieve specific business outcomes. The alignment of technology investments with strategic goals ensures that digital initiatives contribute directly to the organization's overall objectives. As highlighted in the context of digital transformation, the integration of digital tools and technologies should empower business owners to make data-driven decisions and drive operational efficiency (Sehgal, 2024). This alignment is particularly crucial in industries where digital disruption is reshaping traditional business models, creating both opportunities and challenges for established companies (Zadak, 2018).

The role of IT in this context has evolved from being a mere support function to a strategic enabler of business value. IT must now translate its technical capabilities into business language, ensuring that its services and frameworks contribute directly to organizational sustainability and innovation. This shift underscores the importance of moving beyond a purely financial perspective to include organizational and process-related improvements as key metrics for success (Rösch & Schumacher, 2017).

The use of advanced digital tools, such as big data analytics and artificial intelligence, can provide real-time insights into the efficiency of digital initiatives. These tools enable organizations to track key efficiency indicators (KPIs) and make data-driven decisions to optimize their digital strategies. For instance, in the logistics and energy sectors, digital technologies such as IoT, AI, and block chain have enabled real-time supply chain visibility, predictive maintenance, and streamlined operations, leading to significant efficiency gains (Attah et al., 2024).

2.1.4 Regulatory and policy

Regulatory and policy environments play a critical role in shaping the efficiency and viability of digital logistics networks, as digital supply chains transcend borders that establish differing

policies on the protection of privacy, movement of data, and e-commerce compliance. It is asserted that cross-border flows of data, which form the essence of logistics digitization and which allow for real-time monitoring, cloud-synchronized control, and seamless application interface connectivity, are affected by differing national privacy laws that impede the efficiency of worldwide logistics networks (Singh & Prerna, 2025; Kaya & Shahid, 2025).

Lastly, the literature highlights the need for harmonized international policy frameworks and standards that can resolve national sovereignty, data protection, and digital trade facilitation in digital logistics. International agreements and model laws such as the UNCITRAL Model Law on Electronic Transferable Records (MLETR) aim to provide uniform legal recognition for electronic logistics documentation, reducing legal uncertainty for digital transactions across borders (UNCITRAL Model Law, 2017). Similarly, proposals for WTO-level e-commerce rules underscore the importance of interoperable regulatory approaches to manage data governance consistently while preserving flexibility for legitimate public policy objectives such as privacy and security (WTO cross-border flows research, 2025). These studies collectively point to a policy landscape where regulatory coherence balancing protection, interoperability, and trade facilitation remains a crucial challenge and significance for advancing digital logistics globally.

2.2.4 Operational Efficiency

The process of incorporating information and communication technology (ICT), Internet of Things (IoT), artificial intelligence (AI), cloud computing, and data analytics into logistics can be referred to as logistics digitalization. From the literature, one can establish that logistics digitalization increases the efficiency of logistics operations by allowing real-time sharing of information, automation of logistics operations, and logistics decision-making using data analytics. Digitalized logistics operations also minimize logistics manual processing, logistics errors, logistics lead time, and logistics coordination of activities such as logistics transportation, storage, inventory, and order fulfillment. The literature has particular emphasis on the fact that logistics digitalization of logistics operations provides logistics visibility and transparency, which is fundamental for logistics planning on timeliness and accuracy (Meshali & Lemtaoui, 2024; Yang, 2025).

Also affirming these factors are empirical researches that prove the important positive role of digitalization of logistics and supply chains in improving operational efficiency. According to researches, companies that have implemented digital solutions in managing supply chains can ensure better efficiency in cost management, delivery, agility, and services in contrast to traditional

approaches. Digitalization allows for automation of common tasks in the field of logistics and optimization of analytical processes of forecasting and inventory management in supply chains, leading to improved efficiency in operations. This has also been supported by Wang et al. in 2025 that efficiency in logistics functions as an intervening variable between digitalization of supply chains and the competitiveness of businesses. Also supported are systematic reviews in journals like Gupta in 2024 that advocate that digitalization of supply chains improves operational efficiency with the aid of processes and intelligent decisions (International Journal of Information Management Data Insights in 2023).

In the Ethiopian scenario, specifically in the case of the Ethiopian Shipping and Logistic Service Enterprise (ESLSE), the existing studies establish that the adoption and implementation of ICT and digital logistics have a significant positive relationship with operational efficiency, though implementation is still at a developing stage. Based on the Addis Ababa University theses, the existing evidence establishes that the use of ICT in the ESLSE brings efficiencies in the area of coordination, sharing of information, and implementation of logistics, resulting in overall improvements in operational efficiency (Abebe, 2019). However, there are certain issues, such as a lack of digital infrastructure, a lack of qualified talent, and incomplete integration of the system, that exist and hinder the overall benefits that can be derived through the implementation of digitalization (Abebe, 2019; Ethiopian e-logistics studies).

Operational efficiency within logistics refers to the ability of logistics and supply chain systems to maximize throughput, optimize resources, minimize costs, and ensure timely delivery of goods and services. While digitalization promises substantial improvements in efficiency, both organizational and technological challenges often constrain its effective implementation and realization of benefits.

1. Integration with Legacy Systems

A major barrier to improving operational efficiency stems from the difficulty of aligning new digital technologies with existing legacy infrastructure. Many organizations depend on long-standing Enterprise Resource Planning (ERP), warehouse management, or transportation systems that were not designed for seamless integration with modern platforms such as IoT, cloud, or AI systems. This fragmentation leads to data silos, inconsistent visibility, and operational bottlenecks, ultimately affecting efficiency outcomes Nozari et al. (2022).

2. Data Security and Privacy Risks

As logistics operations become more interconnected through digital solutions, data security and

privacy emerge as critical challenges. Increased data flows across digital supply chains elevate vulnerability to cyberattacks, breaches, and unauthorized access, which not only disrupt normal operations but can erode stakeholder trust and cause financial loss. Addressing cybersecurity while maintaining efficiency is thus a complex operational challenge, Syed (2024)

3. High Implementation and Operational Costs

Although digital systems can reduce operational costs over the long run, the initial investments required for digital technologies are high. Costs involve not only purchasing and deploying ICT infrastructure but also upgrading legacy systems, securing data platforms, and maintaining new solutions. These upfront and ongoing expenses can delay digital adoption, slowing gains in operational efficiency especially for small or resource-constrained enterprises.

4. Workforce Skills Gap

Efficient use of digital systems requires workforce competencies in areas such as data analytics, cybersecurity, AI, cloud computing, and IoT management. Many logistics organizations face a skills gap, where existing staff lack the technical training needed to implement and manage digital solutions effectively. This results in underutilization of technologies and operational inefficiencies. Digital transformation thus requires not only technology but also staff development and training Ageron, Gunasekaran, & Spalanzani (2020)

5. Resistance to Change and Organizational Culture

Operational efficiency gains can be stifled by organizational resistance to change. Employees and managers accustomed to traditional workflows may view digital transformation with skepticism, fearing job displacement or added complexity. Resistance can slow adoption, create pockets of non-compliance with new processes, and reduce the speed of realizing efficiency improvements. Effective change management is therefore essential to overcome cultural barriers Nozari et al. (2022).

6. Supply Chain Complexity and Coordination

Logistics systems are inherently complex, involving numerous stakeholders (suppliers, carriers, distributors, regulators, and customers) across geographies. Each may use different technologies and standards, creating coordination challenges that affect operational visibility and efficiency. Fragmented systems and misaligned processes make it difficult to establish end-to-end synchronization, impeding the smooth operation of digital logistics platforms.

7. Customer Expectations and Market Pressures

In a highly competitive market, customers increasingly demand faster delivery times, real-time tracking, transparency, and sustainability outcomes. While digital tools offer solutions, meeting

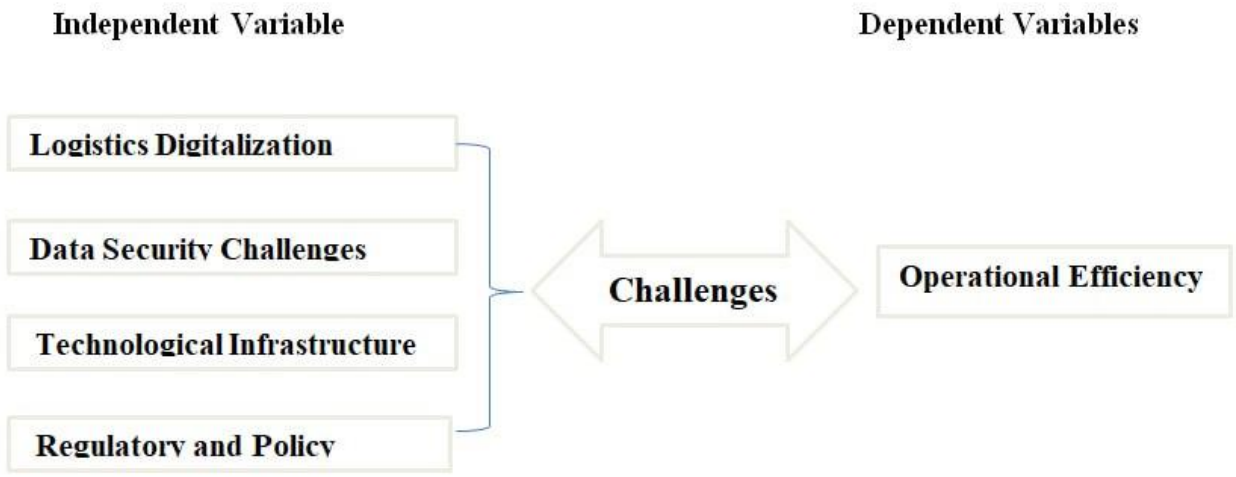
these expectations requires agile and robust digital ecosystems. Organizations that fail to meet rising expectations due to technological constraints or implementation lag-risk operational inefficiencies and loss of market share Syed (2024).

2.2 The Research gaps

The empirical and theoretical review reveals a lack of comprehensive research on the challenges, and prospects of logistics digitalization. The practice of digitalization in SCM has limited adoption of digital technologies in supply chains and need for more supportive policies and infrastructure improvements. Digital transformation of logistics centers not fully explored. Application of practical tools in logistics centers needs more research. Therefore, it is critical to address this research gaps by conducting a comprehensive study that covers the practices, challenges, and prospects of logistics digitalization as a whole and in general, rather than separately. Additionally, the studies consider the impact of other new technologies as part of the digitalization. As a result, it is important to fill this research space by conducting thoroughly challenges and prospects of the multimodal operation under the context of ESL.

2.3. Conceptual framework

Figure 1: conceptual frame work of logistic digitalization in ESL, 2026



Source: Designed by researcher based on literature

This study assumes that logistics digitalization is the main driving force influencing organizational efficiency at ESL. However, its effectiveness is shaped by several challenges. Specifically, logistics digitalization affects operational efficiency and international trade facilitation, while its implementation is constrained by data security, technological infrastructure, and regulatory and policy challenge.

Chapter Three

3. Research Methodology

3.1 Description of the Study Area

The Ethiopian Shipping and Logistics is a merger of four enterprises which were working independently in the sea transport sector. These were Ethiopian Shipping Lines Share Company, Ethiopian Maritime and Transit Service Enterprise, Dry Port Enterprise; and the former Comet Transport Share Company which was consolidated in to the new company, August, 2016. Among the major companies that has helped coming in to being of the new merger is the former Ethiopian Shipping Lines Share Company (ESL), established March 1, 1956 E.C with a capital of 50,000 (fifty thousand) Ethiopian birr. ESL has its headquarters located in the heart of Addis Ababa, Ethiopia, with main branches at Djibouti, Modjo, and Kality (the former Comet) and other branches in Mekelle, Dire Dawa, Kombolcha, Semera and Gelan towns. It also has a Maritime Training Institute at a place called Babogaya in Bishoftu (former Debrezeit) Town (https://www.eslse.et/overview.php).

3.2 Research Approach

Based on the given statement of the problem this study used data collection methods qualitative and quantitative and integrates results gained from both methods in the analysis phases. According to Abowitz, and Toole, (2010), mixed methods were considered as a tool to triangulate the result of a single approach through multiple methods. The quantitative method was selected because it helped to gather large data and comprehensive issues at a specified time (Kothari 2004). A qualitative method will have selected based on the assumption that enables the researcher to generate meaning and phenomena within the real framework of the research respondents and to feel the gap left by the quantitative one. Therefore, mixed-method approaches were adopted to make the study more reliable and tangible

3.3 Research design

The research design is the framework or blueprint that the research used as a guideline for how

it gathered, analyzed, interpreted the data, and applied it for the given entire research. (Zikgmud, 2003). In order to investigate the cause-and-effect relationship between the independent and dependent variables, this study employed an explanatory (causal) research design, which was determined by the study's problem and aims (Thornhill, et.al 2009).

3.4 Population and sample

The source population for this study comprised professionals holding managerial and senior officer positions at Ethiopian Shipping and Logistics Services Enterprise (ESL), including directors and coordinators (team leaders). In addition, customers were included as participants in the qualitative component of the study. To determine the sample size, the researcher first obtained a list of staff members from the six organizational circles of ESL and then calculated the sample size accordingly (Adams et al., 2007).

As illustrated in Table 1, a total of 139 respondents were selected using a convenience sampling technique for the self-administered questionnaire. Of these, 95 respondents were drawn from the head office, while 30 respondents each were selected from Gelan Dry Port and Mojo Dry Port.

Furthermore, in-depth semi-structured interviews were conducted with 14 key stakeholders, including managers, employees, customers, and representatives of logistics management stakeholders, to gain deeper insights into their perspectives on the challenges and prospects of logistics digitalization.

Table 3.1: The total population of ESL 2026

NO	LIST OF EMPLOYEE IN Ethiopian Shipping and Logistics	TOTAL NUMBERS OF EMPLOYEES IN EACH DEPARTMENT
1	Senior officers working in ESL	14
2	Customers	22
3	Lower-level employers	178
	Total	214

Source: own survey, (2026).

3.5. Sampling Design

A sample design was the framework that works as the foundation for the selection of a study sample and touches many other important aspects of a study (lavrakas 2008). In a wide-ranging situation, survey researchers are concerned about obtaining some type of information through a survey for some population, or universe, of interest. One must explain a sampling frame that signifies the population of interest, from a sample is to be drained.

3.5.1. Sampling Technique

A sample has been identified as a part of the target population and researchers should carefully select the sample to represent the population of the study (Cooper and Schindler 2008). According to Sarantakos, (2005), explanation, in order to achieve representativeness, sampling procedures should follow certain standards and methodological principles. Sampling procedures vary considerably. Sarantakos, (2005), explain that a sample could be constructed through self-selection or, as was common, could be determined by researchers.

In this study the sampling technique to be used was stratified random sampling technique. As explained by Yamane, (1967), Stratified random sampling is useful method for data collection if the population is heterogeneous. As indicated before in the population part, since the target population in this study was heterogeneous. Therefore, researcher first divides research participants into different strata based on the department. To give an equal chance for each stratum in order to be select representative sampling, stratified random sampling techniques used to draw samples from the strata, while, non-probability sampling /convenience / sampling approach, were using to select samples for interview questions in order to gain tangible and detailed information from the concerned respondents. For this study, the researcher was select five (5) interviewee respondents for reliable information.

3.5.2. Sample Size Determination

In the determination of sample size, the three criteria were very important to gather the required data from sample respondents. According to Salganik, (2006), these included the level of precision, the level of confidence or risk and the degree of variability in the attributes being measured that enable the researchers to determine the appropriate sample size. Therefore, by considering these issues sample size to collect data through a questionnaire for this research was determined by using Yamane's, (1967), formula.

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

Where:

n = sample size
N = population size
e = level of precision or acceptance sampling error (0.05)
1 = designates the probability of the event occurring

Therefore:

$$n = \frac{214}{1+214(0.05)2} = 139$$

The study 139 (65%) respondents were used as sample for this study to gather data through questionnaire.

3.5.3. Sample Distribution Plan

The researcher was deemed necessary to take an independent sampling for each Ethiopian Shipping and Logistics to ensure equal representation because ELS have a different number of employees. Therefore, the sample size for each Ethiopian Shipping and Logistics was calculated by using a proportion. The study was used a proportionate sample allocation formula so as to make each stratum sampled identically with the proportion of the population. Therefore, the proportional sample size from each stratum was calculated by using the following formula.

$$nh = (Nh/ N) * n$$

Where:

nh = was the sample size for individual Ethiopian Shipping and Logistics.

Nh = the total number of employees in each Ethiopian Shipping and Logistics

N = the total number of employees in Ethiopian Shipping and Logistics

n = was the total sample size

Table 3.2 Population sample for each Department

No	List of ESL	Total no of employees in each ESL	No of sample size in each ESL	Percent
1	Senior officers working in ESL	14	9	64%
2	Customers	22	14	63%
3	Lower-level employers	178	116	65%
Total		214	139	65%

Source: Own survey, (2026).

3.6. Data Source and Types

3.6.1. Data Sources

In order to collect valuable and all-round data from the sample population, both primary and secondary data sources were used. The primary data sources were the selected people directly engaged in senior officers working in ESL, directors and coordinators (team leaders), and logistics management stakeholders, and technology related managers, Customers, Lower-level

employers. The secondary data sources were ESL annual reports, feedback, and other internet sources.

3.6.2. Data Types

Data are realities, figures, and additional relevant materials past and present serving as bases for study and analysis (Maxwell, Delaney and Kelley 2017). There are two types of data namely primary data and secondary data on which the study kept in mind. For the effectiveness and reliability of the study in bringing good value to the collected data, the study employed primary and secondary data in assessing the challenges and prospects of logistics digitalization in Ethiopian.

3.6.2.1. Primary Data

As stated by Kothari, (2004), Primary data were those which are collected anew and for the first time, and this happens to be original in character. The sources of primary data were Ethiopian Shipping and Logistics, senior officers working in ESL, directors and coordinators (team leaders), and logistics management stakeholders, and technology related managers, Customers, Lower-level employers. These five groups of respondents were selected because their daily activities are related to the objectives of the study.

3.6.2.2. Secondary Data

Secondary data are those data obtained from literature sources, which have already been collected by other people for some other purposes; it is second-hand information which includes both raw data and published one (Corti and Thompson 2006). The study extracted data from recorded documents at Ethiopian Shipping and Logistics which seemed relevant to the study on assessing the challenges and prospects of logistics digitalization in Ethiopian.

3.7. Data Collection Instruments

3.7.1. Interview

The interview method is the method of gathering data that involves the demonstration of oral - verbal reply and stimuli in expressions of oral – verbal answers. The personal interview is the technique of gathering data that requires a person known as the interviewer requesting questions generally in a face to face contact with the other persons. During the interviewee may also ask certain questions and the interviewer replies to these questions, but typically, the interviewer

starts the interview and collects the information (Kothari 2004). For this study, structured and open-ended interview questions were forwarded to selected respondents such as senior officers working in ESL.

3.7.2. Questionnaire

The questionnaire is simply a formal set of questions for drawing information (Kothari 2004). The study constructed structured questionnaires with close-ended questions so as to grasp the reliable and valid data regarding assessing challenges and prospects of logistics digitalization in Ethiopia: the case of Ethiopian shipping and logistics to which these questionnaires were filled by the, senior officers working in ESL, directors and coordinators (team leaders), and logistics management stakeholders, and technology related managers, Customers, Lower-level employers. Closed-ended questions were easier to analyze, easier to administer and were economical in terms of time and money and also Preferable to eliminate biases. Most of the questions were adopted and some of them were modified by the researcher.

3.7.3. Review of Documents

The documentation method is about gathering data from a secondary source. The documentary sources of data play a key part in distributing knowledge in all disciplines. The documentary sources of data for research purposes include published books, journals, research reports, newspapers, yearly reports of the organization to be studied and other unpublished literary works (Grossman, Martin and Weitzman 2006). For this study, the researcher used the Ethiopian Shipping and Logistics' annual reports, feedback, and other internet sources.

3.8. Data Collection Procedures

The primary data was collected using self-administered questionnaires. Emphasis was placed on individuals, who were ESL members, who had worked for the above one year in the Ethiopian Shipping and Logistics and who could provide the requisite information. Data collected from respondents was summarized and tabulated. To give a clearer view of the data gathered, statistical tools like graphs and will also employ. Secondary data was data that are previously accessible that is, they bring up to the data which have previously been gathered and analyzed by someone else (Kothari 2005). It was analyzed to assess its suitability, adequacy, reliability, and accuracy.

3.9. Data Analysis Methods

Data processing involved in editing, coding, and tabulation of data before data is analyzed. Editing was done to ensure that the data are accurately consistent uniformly entered and were arranged to facilitate coding and tabulation. The data were organized now rows and columns to facilitate a foundation for several statistical computations. So, the researcher had organized, analyzed, and expressed the data by using both descriptive and inferential data analysis to examine the challenges and prospects of logistics digitalization in Ethiopian.

Statistical techniques were used on the way to analyze the data from the sample employees and management. Statistical package for social scientists (SPSS) version 20 was used in the data processing. Statistics including the standard deviation and mean has been used to analyze the data among the different groups. The standard deviation and mean was used to refer to the data obtained from the independent variables and the dependent variables.

Inferential statistics were also used to allow the researcher to present the data obtained in research in statistical format, to facilitate the identification of important patterns and to make data analysis more meaningful. Inferential statistics is employed when generalizations from a sample to the population are made (Schuler 2000). The statistical methods used in this research include the Pearson Product Moment Correlation as well as regression analyses. The association between these variables was measured by using multiple regression analysis. Lastly, the finding of the study was interpreted, the conclusion was drawn and a recommendation has been forwarded. The relation was assumed linear in the form of:

$$\mathbf{Y} = \boldsymbol{B0} + \boldsymbol{B1X1} + \boldsymbol{B2X2} + \boldsymbol{B3X3} + \mathbf{B4X4} + \mathbf{e}$$

Where

Y	is Operational Efficiency	$\boldsymbol{X1}$	is Logistics Digitalization
$\boldsymbol{B0}$	is the intercept of the model	**X2**	is Data security challenge
$\boldsymbol{B1}$ …. $\boldsymbol{B}4$ is the coefficient of the independent variable		$\boldsymbol{X3}$	is Technological Infrastructure
		X4	is Regulatory and Policy
e	is Error		

3.10. Validity and Reliability

The analysis of data should be sufficiently adequate to expose its importance and methods of analysis used were appropriate. The reliability and validity of scores on instruments, added standards for creation knowledge claims, lead to meaningful clarifications of data.

3.10.1. Validity Test

Validity mentions to the degree to which the measurement instrument measures what it planned to measure. It is used to suggest determining whether the findings are correct from the standpoint of the researcher, the participant, or the readers an account (Creswel 2003).

According to Kothari, (2004), explanation validity is the greatest serious standard and specifies the extent to which an instrument measures what it is supposed to measure. To confirm the quality of this research design content validity of the research instrument was checked. The content validity was verified by the advisor of this research, who looks into the appropriateness of questions and the scales of measurement.

Moreover, copies of the questionnaire were distributed to twenty-four respondents as a pilot test. This was done to find out whether the developed instruments measure what it will mean to measure, and also to check the clarity, length, structure, and phrasing of the questions. This test also helps the researcher to get valuable comments to modify some questions.

3.10.2. Reliability

The reliability of an instrument brings up to its capability to create consistent and stable measurements. Cooper and Schindler, (2003), explain reliability tests the strength, equivalence, and internal consistency of an instrument. Reliability as the amount of constancy with which tool measures the attribute it is designed to measure (Polit 2014). The best common reliability coefficient is Cronbach's alpha which estimates internal consistency by defining how all items on a test related to all other items and to the total test - internal coherence of data. In this study, to ensure the instrument of reliability, Cronbach's Alpha was used to test of the reliability of proposed constructs. The researcher conducted a pilot test on 24 employees which were 10% of the total sample population before getting into the main data collection activity.

Table 3.3 Reliability statistics of the pilot test

Cronbach's Alpha	N of Items
.948	30

Source: SPSS Result, 2026.

Bhattacherjee, (2012), argued that a reliability coefficient of .70 is considered “acceptable" in most social science research situations. Cronbach’s alpha model of the pilot test showed 0.948 and implying that the measurements in this study were internally consistent and stable.

The reliability test of the main data for this study was also performed by using Cronbach’s alpha testing method for each variable as indicated below in table 3.4.

Table 3.4 Reliability test for the main data

Variable	No of items	Cronbach's Alpha
Logistics Digitalization	6	.82
Data security challenges	6	.90
Technological Infrastructure	6	.86
Regulatory and Policy	5	.81
Operational Efficiency	7	87

Source: SPSS Result, 2026.

As shown in the above table 3.4, the test results indicate that all of the components in the study had relatively high internal consistency as shown in each variable above were Logistics Digitalization = .82, Data security challenges = .90, Technological Infrastructure = .86, Regulatory and Policy = .81, and Operational Efficiency = .87 it is acceptable.

3.11. Ethical Consideration

In undertaking researches, there is an ethical accountability to do the work fairly and with integrity. The basic principle of ethical research is to preserve and protect the human dignity and rights of all subjects involved in a research project (Leedy and Ormrod 2013). In this regard, the researcher assumed that the respondents’ information is confidential and used only for the study purpose. The researcher also committed to reporting the research findings in a complete and honest manner, without confusing others about the nature of the results. As rule, therefore the study will not be raising any ethical anxiety.

Chapter Four

4. Results and Discussions

4.1. Introduction

This chapter contains two parts, namely the demographic characteristics of the respondents and analysis of data which were collected through questioner and interview. Out of the total 250 population of the organization 100 employees that is 38.6%% of the total population was selected to fill out the questionnaire and participate on interview sessions. The questionnaires were distributed to 78 employees. The response rate was 90.7% for the self-administered questionnaire. Interview was conducted with 14 senior officers and 2 randomly selected customers of ESL in order to analyze the level of agreement with the respondents towards different variables, the researcher used percentage as descriptive statistics tool. Finally, the results are discussed below.

4.2. Demographic profiles of Respondents

Table 4.1: Respondents profile

No	Items	Categories	F	%
1	Sex /Gender	Male	101	72.7
		Female	38	27.3
2	Age	18 – 25 years	-	-
		26 - 35 years	40	24.7
		36 - 45 years	60	45.8
		46 - 55 years	35	28.9
		Above55 years	4	.5
3	Work experience	< 1 year	16	11.5
		1-2 year	10	7.2
		2-3 year	54	38.8
		>3 year	59	42.4
4	Area of specialization	marketing	15	10.8
		Logistics and supply management	11	7.9
		Transport management	12	8.6
		Shipping sector	37	26.6
		multimodal	22	15.8
		ICT	42	30.2
		Above 20 years.	69	36.3
5	Education level	Diploma	31	22.3
		Degree	97	69.8
		Masters	9	6.5
		PhD	2	1.4

The demographic characteristics of the respondents indicate that the study largely captured the views of a male and mature workforce. With 72.7% of respondents being male and only 27.3% female, the findings mainly reflect male perspectives, which may be linked to the traditionally male-dominated nature of logistics and ICT-related roles at ESL. Age-wise, the dominance of respondents aged 36 - 45 years (45.8%), followed by those aged 46–55 years (28.9%) and 26–35 years (24.7%), and suggests that most participants are in their prime working years. This implies that respondents are likely to possess sufficient organizational knowledge and practical exposure, making their responses reliable for assessing logistics digitalization and efficiency issues.

In terms of professional background, the majority of respondents had considerable work experience, with over 81% having more than two years of experience. This high level of experience enhances the credibility of the findings, as experienced employees are better positioned to evaluate operational changes and digitalization impacts. Furthermore, the dominance of ICT (30.2%) and shipping sector professionals (26.6%), alongside other logistics-related specializations, indicates that respondents were drawn from relevant technical and operational areas. This diversity of expertise strengthens the interpretation of the results, as it reflects informed opinions from employees directly involved in or affected by logistics digitalization at ESL.

The educational background of the respondents indicates a strong dominance of degree holders. As shown by the data, 69.8% (97 respondents) hold a Bachelor's degree**, r**epresenting the largest proportion of the sample. This suggests that the majority of participants possess adequate academic training and professional competence relevant to the study.

Respondents with a Diploma qualification account for 22.3% (31 respondents)**,** indicating a considerable representation of mid-level professionals. Meanwhile, those holding a Master's degree constitute 6.5% (9 respondents**)**, and only 1.4% (2 respondents) possess a PhD**,** reflecting limited participation from highly advanced academic levels.

Overall, the demographic profile indicates that the study successfully engaged a relevant, experienced, and operationally knowledgeable workforce**,** thereby providing a sound basis for analyzing the challenges and impacts of logistics digitalization at ESL. While the findings are strong at the operational level, greater inclusion of highly specialized and senior academic professionals could further enrich strategic perspectives in future studies.

4.3. Descriptive analysis on logistics digitalization on operational efficiency at ESL

Table 4.2: Descriptive analyses on logistics digitalization

No	Items	*f*	Descriptive Frequency Table							
			Scale					NP	Mean value	SD
			5	**4**	**3**	**2**	**1**			
2.1	The use of digital logistics systems at ESL has reduced the time required to process logistics operations.	*f*	32	32	-	40	35	139	2.90	1.566
		%	23	23	-	28.8	25.2			
2.2	Logistics digitalization has improved the accuracy of operational data and documentation at ESL.	*f*	4	18	1	51	65	139	1.88	1.117
		%	2.9	12.9	0.7	36.7	46.8			
2.3	Digital technologies have enhanced coordination and information sharing among departments at ESL.	*f*	31	36	1	38	33	139	2.96	1.546
		%	22.3	25.9	0.7	27.3	23.7			
2.4	The adoption of digital logistics platforms has reduced operational costs at ESL.	*f*	26	27	2	43	41	139	2.67	1.529
		%	18.7	19.4	1.4	30.9	29.5			
2.5	Logistics digitalization has improved the overall reliability and consistency of service delivery at ESL.	*f*	12	9	3	67	48	139	2.06	1.187
		%	8.6	6.5	2.2	48.2	34.5			
2.6	The implementation of digital systems has increased the overall operational efficiency of ESL.	*f*	9	31	1	47	51	139	2.28	1.335
		%	6.5	22.3	0.7	33.8	36.7			
Grand mean of logistics digitalization									2.46	1.38

Table 4.2.1: stated about *"The use of digital logistics systems at ESL has reduced the time required to process logistics operations."* This item received a mean score of 2.90, indicating a low to moderate level of agreement among respondents. The standard deviation of 1.566 suggests a relatively wide spread of responses. While 46% of respondents strongly agreed (23%) and agreed (23%), a combined 54% (28.8% disagreed and 25.2% strongly disagreed) expressed disagreement. These results indicate that the majority of respondents did not perceive digital logistics systems as significantly reducing processing time at ESL.

Table 4.2.2: stated about *"Logistics digitalization has improved the accuracy of operational data and documentation at ESL."* This item recorded a mean score of 1.88, one of the lowest among the items, indicating strong disagreement. The standard deviation of 1.117 reflects relatively consistent responses. Only 15.8% of respondents strongly agreed (2.9%) or agreed (12.9%), whereas a substantial 83.5% (36.7% disagreed and 46.8% strongly disagreed) expressed disagreement. These findings suggest that the majority of respondents believed logistics digitalization has not improved data accuracy and documentation at ESL.

Table 4.2.3: stated about *"Digital technologies have enhanced coordination and information sharing among departments at ESL."* This item achieved a mean score of 2.96, indicating a moderate level of agreement. The standard deviation of 1.546 implies considerable variation in responses. While 48.2% of respondents strongly agreed (22.3%) and agreed (25.9%), a slightly higher proportion of 51% (27.3% disagreed and 23.7% strongly disagreed) expressed disagreement. This result indicates mixed perceptions among respondents regarding the role of digital technologies in enhancing coordination and information sharing.

Table 4.2.4: stated about *"The adoption of digital logistics platforms has reduced operational costs at ESL."* This item received a mean score of 2.67, reflecting a generally low level of agreement. The standard deviation of 1.529 indicates a wide dispersion of responses. Although 38.1% of respondents strongly agreed (18.7%) and agreed (19.4%), a majority of 60.4% (30.9% disagreed and 29.5% strongly disagreed) reported disagreement. These findings imply that most respondents did not perceive digital logistics platforms as effective in reducing operational costs.

Table 4.2.5: stated about *"Logistics digitalization has improved the overall reliability and consistency of service delivery at ESL."* This item recorded a low mean score of 2.06, indicating weak agreement. The standard deviation of 1.187 suggests relatively low variability in responses. Only 15.1% of respondents strongly agreed (8.6%) or agreed (6.5%), whereas 82.7% (48.2% disagreed and 34.5% strongly disagreed) expressed disagreement. These results demonstrate that the majority of respondents did not believe logistics digitalization has improved service reliability and consistency at ESL.

Table 4.2.6: stated about *"The implementation of digital systems has increased the overall operational efficiency of ESL."* This item obtained a mean score of 2.28, indicating low agreement. The standard deviation of 1.335 reflects moderate variability in responses. While 28.8% of respondents strongly agreed (6.5%) or agreed (22.3%), a combined 70.5% (33.8% disagreed and 36.7% strongly disagreed) expressed disagreement. This suggests that most respondents perceived digital systems as having limited impact on improving operational efficiency.

Overall, the grand mean score of 2.46 with a standard deviation of 1.38 indicates an overall low to moderate perception of the impact of logistics digitalization on operational efficiency at ESL. This suggests that although digital logistics initiatives have been introduced, their expected

benefits have not been fully realized, possibly due to implementation challenges, insufficient staff competency, or system integration issues.

4.4. Descriptive analyses on the effect of s of data security challenge on logistics digitalization at ESL

Table 4.3: Descriptive analyses on the effect of data security challenges on logistics digitalization

No	Items	*f*	Descriptive Frequency Table							
			Scale					NP	Mean value	SD
			5	**4**	**3**	**2**	**1**			
3.1	Concerns about data security limit the effective use of digital logistics systems at ESL.	*f*	5	61	1	45	27	139	2.80	1.286
		%	3.6	43.9	0.7	32.4	19.4			
3.2	The risk of cyber-attacks poses a major challenge to logistics digitalization at ESL.	*f*	35	47	-	30	27	139	3.24	1.516
		%	25.2	33.8		21.6	19.4			
3.3	ESL lacks adequate cyber security measures to protect digital logistics data.	*f*	7	36	2	38	56	139	2.28	1.357
		%	5.0	25.9	1.4	27.3	40.3			
3.4	Data breaches or unauthorized access negatively affect trust in digital logistics systems at ESL	*f*	10	20	-	55	54	139	2.12	1.269
		%	7.2	14.4	-	39.6	38.8			
3.5	Insufficient staff awareness and training on data security hinder logistics digitalization at ESL.	*f*	1	79	-	27	32	139	2.93	1.311
		%	0.7	56.8	-	19.4	23			
3.6	Weak data protection and privacy policies affect the successful implementation of logistics digitalization at ESL.	*f*	-	81	2	29	27	139	2.99	1.257
		%	-	58.3	1.4	20.9	19.4			
Grand mean of data security challenges									2.73	1.33

Table: 4.3.1 Concerned about data security limit the effective use of digital logistics systems at ESL. The frequency results show that 61 respondents (43.9%) agreed and 5 respondents (3.6%) strongly agreed with the statement, while 45 respondents (32.4%) disagreed and 27 respondents (19.4%) strongly disagreed. The survey received only 1 response from a respondent who identified as neutral. According to the 2.80 mean values, the respondents displayed slightly below-average agreement, which means they disagreed though they showed some divide in their opinions. The standard deviation of 1.286 reflects a moderate dispersion of responses, which shows that people have different opinions about how data security worries impact their ability to use digital logistics systems.

Table 4.3.2: stated about The ESL Company faces significant difficulties in digital logistics because of the threat of cyber-attacks. The frequency distribution shows that 47 respondents (33.8%) agreed and 35 respondents (25.2%) strongly agreed, which means that most respondents believe cyber-attack risks represent a major threat. The situation presents 30 respondents (21.6%) who disagreed and 27 respondents (19.4%) who strongly disagreed, while no respondents chose the neutral response option. The mean score of 3.24 indicates overall agreement with the statement. The high standard deviation of 1.516 demonstrates that respondents held highly diverse opinions, but the majority of respondents identified cyber-attacks as a serious problem.

Table 4.3.3: stated about ESL lacks sufficient cyber security defenses needed to secure its digital logistics information. The frequency data reveal that 36 respondents (25.9%) agreed and 7 respondents (5.0%) strongly agreed with the statement, while a larger proportion disagreed: 38 respondents (27.3%) disagreed and 56 respondents (40.3%) strongly disagreed. The survey received only 2 responses from respondents who identified as neutral. The mean value of 2.28 indicates general disagreement, which shows that most respondents believe ESL has sufficient cyber security protections. The standard deviation of 1.357 shows moderate variability in responses, which demonstrates that most people disagreed with the statement

Table 4.3.4: stated about Digital logistics systems at ESL lose public confidence when hackers obtain unauthorized access to data or when data breaches occur. The survey results showed that 20 respondents (14.4%) agreed to the statement and 10 respondents (7.2%) strongly agreed, but 55 respondents (39.6%) rejected the statement and 54 respondents (38.8%) strongly rejected it. The survey received no responses that indicated neutrality. The low mean score of 2.12 indicates strong overall disagreement, which shows that respondents largely do not consider data breaches or unauthorized access as major factors that reduce trust. The standard deviation of 1.269 shows moderate dispersion of responses, which indicates that most respondents tended to disagree with the statement

Table 4.3.5: stated about Insufficient staff awareness and training on data security create barriers for ESL to develop their digital logistics capabilities. The frequency results show that a majority, 79 respondents (56.8%), agreed with the statement, while only 1 respondent (0.7%) strongly agreed. The other 27 respondents (19.4%) disagreed and 32 respondents (23.0%) strongly disagreed with the statement. The survey received no responses from people who selected the

neutral answer. The mean score of 2.93, which falls near the midpoint, shows that people have divided opinions but lean slightly toward agreement. The standard deviation of 1.311 indicates that people hold different opinions about how staff awareness and training prevent the organization from succeeding.

Table 4.3.6: stated about Logistics digitalization at ESL suffers from implementation problems because the company has established inadequate data protection and privacy policies. The frequency distribution shows that 81 respondents (58.3%) agreed with the statement while no respondents supported the statement at a strong level. 29 respondents (20.9%) disagreed with the statement and 27 respondents (19.4%) strongly disagreed with the statement. The survey received only 2 responses from respondents who identified as neutral. The mean value of 2.99 indicates that most respondents believe weak data protection and privacy policies reduce the organization's ability to execute successful operational implementation. The standard deviation of 1.257 shows moderate dispersion of responses, which means people have different opinions yet they tend to agree with the statement.

Overall, the grand mean of 2.73 with a standard deviation of 1.33 indicates that respondents showed moderate agreement about how data security difficulties impacted their ability to digitize logistics processes at ESL. People acknowledge data security problems as difficulties, yet their opinions differ based on particular elements which cause some areas to receive agreement while other areas face disagreement.

4.5. Descriptive analyses on digitalization influence on international trade facilitation at ESL

Table 4.4: Descriptive analyses on the influence of digitalization

No	Items	*f*	Descriptive Frequency Table							
			Scale					NP	Mean value	SD
			5	**4**	**3**	**2**	**1**			
4.1	Logistics digitalization has reduced the time required for international cargo clearance at ESL.	*f*	3	3	-	62	71	139	1.60	0.796
		%	2.2	2.2	-	44.6	51.1			
4.2	The use of electronic documentation has simplified cross-border trade procedures at ESL.	*f*	-	26	-	76	37	139	2.11	1.005
		%	-	18.7	-	54.7	26.6			
4.3	Digital logistics systems have improved coordination with customs, ports, and international trade partners.	*f*	21	38	-	47	33	139	2.76	1.458
		%	15.1	27.3	-	33.8	23.7			

4.4	Real-time tracking and information sharing have reduced delays in international shipments handled by ESL.	*f*	1	79	-	27	32	139	2.93	1.311
		%	0.7	56.8	-	19.4	23			
4.5	Logistics digitalization has increased transparency and predictability in international trade operations at ESL.	*f*	4	24	3	67	41	139	2.16	1.118
		%	2.9	17.3	2.2	48.2	29.5			
4.6	Overall, logistics digitalization has enhanced ESL's role in facilitating international trade.	*f*	1	79	-	27	32	139	2.93	1.311
		%	0.7	56.8		19.4	23			
Grand mean of the influence of digitalization									2.415	1.167

Table: 4.4.1 stated about the digitalization of logistics operations has enabled ESL to achieve faster international cargo clearance times than before. The frequency distribution shows that 3 respondents who make up 2.2 percent of the total population strongly agreed with the statement while another 3 respondents who also make up 2.2 percent of the total population agreed with it. The majority of respondents showed disagreement with the statement as 62 respondents who represent 44.6 percent of the total population disagreed and 71 respondents who make up 51.1 percent of the total population strongly disagreed with it. The results show no respondents selected a neutral option. The mean value of 1.60 demonstrates strong disagreement between participants who believe that logistics digitalization creates faster cargo clearance times. The 0.796 standard deviation value shows low response variation which means that most participants shared the same opinion that they disagree with the statement.

Table: 4.4.2 stated about the implementation of electronic document systems has made it easier for ESL to conduct international trade operations. The frequency results show that 26 respondents (18.7%) agreed, while no respondents strongly agreed or were neutral. The group showed disagreement with the statement as 76 respondents (54.7%) disagreed and 37 respondents (26.6%) strongly disagreed with it. The mean score of 2.11 indicates general disagreement with the statement, implying that electronic documentation is not perceived as significantly simplifying procedures. The standard deviation of 1.005 reflects relatively low dispersion which means that respondents held consistent views about their responses.

Table: 4.4.3 stated about Digital logistics systems has developed better links with customs authorities and port operations and international trade partners. From the frequency data, 38 respondents (27.3%) agreed and 21 respondents (15.1%) strongly agreed, while 47 respondents

(33.8%) disagreed and 33 respondents (23.7%) strongly disagreed. The study found no participants who selected the neutral response option. The mean value of 2.76 suggests a moderate level of agreement, though opinions are clearly divided. The standard deviation of 1.458 shows significant response variation which indicates that participants had different views about coordination improvements

Table: 4.4.4 stated about ESL has experienced fewer delays in its international shipments through the implementation of real-time tracking and sharing of information. The frequency distribution shows that a majority, 79 respondents (56.8%), agreed and 1 respondent (0.7%) strongly agreed with the statement. The opposing group included 27 respondents who disagreed and 32 respondents who strongly disagreed. The mean score of 2.93 indicates a moderate tendency toward agreement that real-time tracking has reduced delays. The standard deviation of 1.311 suggests moderate variability in respondents' opinions.

Table:4.4.5 stated about Logistics digitalization has improved visibility and forecasting capabilities for ESL's international trade activities. The frequency results show that 24 respondents (17.3%) agreed with the statement while 4 respondents (2.9%) strongly agreed and 67 respondents (48.2%) disagreed along with 41 respondents (29.5%) who strongly disagreed. The small group of respondents 3 people (2.2%) selected the neutral option. The mean value of 2.16 indicates overall disagreement which means that digitalization has not brought about significant enhancements in operational transparency and predictability. The standard deviation of 1.118 shows that participant's responses to the survey had a moderate level of spread

Table: 4. 4.6 stated about Logistics digitalization has improved all areas of ESL's international trade support activities. The frequency distribution shows that 79 respondents (56.8%) agreed with the statement while 1 respondent (0.7%) strongly agreed. The two groups of responders who disagreed with the statement included 27 respondents (19.4%) and 32 respondents (23.0%) who strongly disagreed. The study results show that the mean score of 2.93 demonstrates moderate support among participants for the view that logistics digitalization has improved ESL's international trade activities. The standard deviation of 1.311 shows moderate variability in perceptions.

Overall interpretation (Grand Mean); The grand mean of 2.415 with a standard deviation of 1.167 shows that people at ESL perceive logistics digitalization to have low to moderate effects

on international trade operations. The real-time tracking system and the overall support for operations show moderate agreement while the operational results particularly cargo clearance time and electronic documentation and transparency show weak efficiency which indicates a minimal overall effect.

4.6. Descriptive analyses on technological infrastructure and regulatory policy challenges

Table 4.5: On technological infrastructure and regulatory policy challenges

No	Items	*f*	Descriptive Frequency Table							
			Scale					NP	Mean	SD
			5	**4**	**3**	**2**	**1**			
5.1	Inadequate ICT infrastructure limits the effective implementation of logistics digitalization at ESL.	*f*	23	16	3	31	66	139	2.27	1.545
		%	16.5	11.5	2.2	22.3	47.5			
5.2	Frequent system failures or poor network connectivity hinder digital logistics operations at ESL.	*f*	23	13	-	66	37	139	2.42	1.403
		%	16.5	9.4	-	47.5	26.6			
5.3	Dependence on outdated or legacy systems reduces the effectiveness of logistics digitalization at ESL.	*f*	19	20	-	53	47	139	2.36	1.424
		%	13.7	14.4	-	38.1	33.8			
5.4	Lack of system interoperability among stakeholders creates challenges for logistics digitalization at ESL.	*f*	5	15	-	80	39	139	2.04	1.021
		%	3.6	10.8	-	57.6	28.1			
5.5	Existing regulatory and policy frameworks do not adequately support logistics digitalization at ESL.	*f*	24	24	-	40	51	139	2.50	1.543
		%								
Grand mean of technological Infrastructure and policy challenges									2,32	1.387

Table: 4. 5.1 stated about Inadequate ICT infrastructure limits the effective implementation of logistics digitalization at ESL. The frequency distribution shows that 16 respondents (11.5%) agreed and 23 respondents (16.5%) strongly agreed with the statement, while a larger proportion disagreed: 31 respondents (22.3%) disagreed and 66 respondents (47.5%) strongly disagreed. A small number, 3 respondents (2.2%), were neutral. The mean value of 2.27 indicates overall disagreement, suggesting that most respondents do not perceive ICT infrastructure inadequacy as a major limitation. The standard deviation of 1.545 reflects relatively high variability in responses, indicating differing views among respondents.

Table: 4. 5.2 stated about frequent system failures or poor network connectivity hinder digital logistics operations at ESL. From the frequency results, 13 respondents (9.4%) agreed and 23 respondents (16.5%) strongly agreed, while 66 respondents (47.5%) disagreed and 37

respondents (26.6%) strongly disagreed. No neutral responses were reported. The mean score of 2.42 suggests general disagreement, indicating that system failures and network issues are not widely seen as serious obstacles. The standard deviation of 1.403 shows moderate dispersion, reflecting some variation in respondents' perceptions.

Table: 4. 5.3 stated about Dependence on outdated or legacy systems reduce the effectiveness of logistics digitalization at ESL. The frequency distribution indicates that 20 respondents (14.4%) agreed and 19 respondents (13.7%) strongly agreed, whereas 53 respondents (38.1%) disagreed and 47 respondents (33.8%) strongly disagreed. No neutral responses were recorded. The mean value of 2.36 indicates a tendency toward disagreement, suggesting that most respondents do not strongly perceive legacy systems as reducing effectiveness. The standard deviation of 1.424 reflects moderate variability in opinions.

Table: 4. 5.4 stated about Lack of system interoperability among stakeholders creates challenges for logistics digitalization at ESL. According to the frequency data, only 15 respondents (10.8%) agreed and 5 respondents (3.6%) strongly agreed, while a large majority disagreed: 80 respondents (57.6%) disagreed and 39 respondents (28.1%) strongly disagreed. No neutral responses were reported. The low mean score of 2.04 indicates strong overall disagreement, implying that interoperability issues are not perceived as a significant challenge. The standard deviation of 1.021 suggests relatively low variability, indicating consistent responses among respondents.

Table: 4. 5.5 stated about Existing regulatory and policy frameworks do not adequately support logistics digitalization at ESL. The frequency results show that 24 respondents (17.3%) agreed and 24 respondents (17.3%) strongly agreed, while 40 respondents (28.8%) disagreed and 51 respondents (36.7%) strongly disagreed. No neutral responses were indicated. The mean value of 2.50 suggests a mixed perception, though leaning slightly toward disagreement regarding policy and regulatory inadequacy. The standard deviation of 1.543 indicates high dispersion, reflecting diverse opinions on this issue.

Overall interpretation (Grand Mean): The grand mean of 2.32 with a standard deviation of 1.387 indicates general disagreement that technological infrastructure and policy issues pose serious challenges to logistics digitalization at ESL. Although some respondents acknowledge issues related to ICT infrastructure, system reliability, and policy support, the overall perception

suggests these factors are not considered major barriers, with considerable variation in views across items.

4.7. Descriptive analysis on operational efficiency of ESL

Table 4.6 operational efficiency of ESL

No	Items	*f*	Descriptive Frequency Table							
			Scale					NP	Mean	SD
			5	**4**	**3**	**2**	**1**			
6.1	Digital logistics systems have reduced the time required to complete operational processes at ESL	*f*	4	18	1	51	65	139	1.88	1.117
		%	2.9	12.9	0.7	36.7	46.8			
6.2	Logistics digitalization has helped ESL reduce operational and administrative costs.	*f*	31	36	1	38	33	139	2.96	1.546
		%	22.3	25.9	0.7	27.3	23.7			
6.3	The accuracy of logistics operations has improved due to the use of digital systems at ESL.	*f*	26	27	2	43	41	139	2.67	1.529
		%	18.7	19.4	1.4	30.9	29.5			
6.4	Digital platforms have improved coordination and workflow among ESL departments.	*f*	12	9	3	67	48	139	2.06	1.187
		%	8.6	6.5	2.2	48.2	34.5			
6.5	The reliability and consistency of logistics service delivery have improved through digitalization.	*f*	9	31	1	47	51	139	2.28	1.335
		%	6.5	22.3	0.7	33.8	36.7			
6.6	Digital systems have reduced operational errors and rework at ESL.	*f*	5	61	1	45	27	139	2.80	1.286
		%	3.6	43.9	0.7	32.4	19.4			
6.7	Overall, logistics digitalization has significantly enhanced operational efficiency at ESL.	*f*	35	47	-	30	27	139	3.24	1.516
		%	25.2	33.8		21.6	19.4			
Grand mean of operational efficiency									2.56	1.36

Table: 4. 6.1 stated about Digital logistics systems have reduced the time required to complete operational processes at ESL. The frequency distribution shows that only 18 respondents (12.9%) agreed and 4 respondents (2.9%) strongly agreed with the statement, while the majority disagreed: 51 respondents (36.7%) disagreed and 65 respondents (46.8%) strongly disagreed. A very small proportion, 1 respondent (0.7%), was neutral. The mean value of 1.88 indicates strong overall disagreement, suggesting that digital logistics systems are not perceived to have significantly reduced operational processing time. The standard deviation of 1.117 reflects relatively low variability, indicating general consistency in respondents' views.

Table: 4. 6.2 stated about Logistics digitalization has helped ESL reduce operational and administrative costs. The frequency results indicate that 36 respondents (25.9%) agreed and 31 respondents (22.3%) strongly agreed, while 38 respondents (27.3%) disagreed and 33 respondents (23.7%) strongly disagreed. Only 1 respondent (0.7%) was neutral. The mean score

of 2.96 suggests a moderate tendency toward agreement, implying that digitalization is perceived to have contributed to cost reduction. The standard deviation of 1.546 indicates high variability in responses, reflecting differing opinions among respondents.

Table: 4. 6.3 stated about the accuracy of logistics operations has improved due to the use of digital systems at ESL. From the frequency data, 27 respondents (19.4%) agreed and 26 respondents (18.7%) strongly agreed, whereas 43 respondents (30.9%) disagreed and 41 respondents (29.5%) strongly disagreed. A small proportion, 2 respondents (1.4%), was neutral. The mean value of 2.67 indicates a mixed perception with a slight inclination toward agreement. The standard deviation of 1.529 shows considerable dispersion, suggesting notable variation in respondents' assessments of accuracy improvement.

Table: 4. 6.4 stated about Digital platforms have improved coordination and workflow among ESL departments. The frequency distribution reveals that only 9 respondents (6.5%) agreed and 12 respondents (8.6%) strongly agreed, while a large majority disagreed: 67 respondents (48.2%) disagreed and 48 respondents (34.5%) strongly disagreed. Three respondents (2.2%) were neutral. The low mean score of 2.06 indicates overall disagreement, suggesting that digital platforms have not effectively improved interdepartmental coordination and workflow. The standard deviation of 1.187 reflects moderate variability in responses.

Table: 4. 6.5 stated about The reliability and consistency of logistics service delivery have improved through digitalization. The frequency results show that 31 respondents (22.3%) agreed and 9 respondents (6.5%) strongly agreed, while 47 respondents (33.8%) disagreed and 51 respondents (36.7%) strongly disagreed. Only 1 respondent (0.7%) was neutral. The mean value of 2.28 indicates general disagreement, implying that improvements in service reliability and consistency are not strongly perceived. The standard deviation of 1.335 suggests moderate dispersion in respondents' views.

Table: 4. 6.6 stated about Digital systems have reduced operational errors and rework at ESL. The frequency distribution indicates that a relatively large proportion, 61 respondents (43.9%), agreed and 5 respondents (3.6%) strongly agreed with the statement. In contrast, 45 respondents (32.4%) disagreed and 27 respondents (19.4%) strongly disagreed, with only 1 respondent (0.7%) remaining neutral. The mean score of 2.80 reflects a moderate level of agreement,

suggesting that digital systems are perceived to have reduced errors and rework to some extent. The standard deviation of 1.286 indicates moderate variability.

Table: 4. 6.7 stated about Overall, logistics digitalization has significantly enhanced operational efficiency at ESL. According to the frequency data, 47 respondents (33.8%) agreed and 35 respondents (25.2%) strongly agreed, while 30 respondents (21.6%) disagreed and 27 respondents (19.4%) strongly disagreed. No neutral responses were reported. The mean value of 3.24 indicates clear overall agreement that logistics digitalization has enhanced operational efficiency. The relatively high standard deviation of 1.516 suggests some divergence in opinions, though the general trend is positive.

Overall interpretation (Grand Mean): The grand mean of 2.56 with a standard deviation of 1.36 indicates a moderate perceived improvement in operational efficiency due to logistics digitalization at ESL. While respondents generally acknowledge positive effects on cost reduction, error reduction, and overall efficiency, they largely disagree that digitalization has significantly improved processing time, coordination, and service reliability. This suggests that the benefits of digital logistics systems are recognized, but their impact is uneven across different dimensions of operational efficiency.

4.8. Analysis of challenges and prospects of logistics digitalization on the operational efficiency of ESL

The study applied multiple regression analysis via SPSS version 25 to evaluate the effect of procurement practices on operational efficiency. Correlation and moderation tests explored relationships and the role of employee's competency. Normality test was also checked to examine the effect of study variables. Reliability and validity were ensured through Cronbach's Alpha.

4.8.1. Correlation analysis

Table: 4.7 Correlation analysis

		Effect of logistics digitalization on ESL	Effect of data security on the implementation of logistics digitalization	Influence of digitalization on international trade	Challenges of technological infrastructure and regulatory policy on ESL	Operational Efficiency of ESL
Effect of logistics digitalization on ESL	Pearson Correlation	1				
	Sig. (2-tailed)					
Effect of data security on the implementation of logistics digitalization	Pearson Correlation	.869**	1			
	Sig. (2-tailed)	.000				
Influence of digitalization on international trade	Pearson Correlation	.842**	.917**	1		
	Sig. (2-tailed)	.000	.000			
Challenges of technological infrastructure and regulatory policy on ESL	Pearson Correlation	.606**	.616**	.629**	1	
	Sig. (2-tailed)	.000	.000	.000		
Operational Efficiency of ESL	Pearson Correlation	**.986****	**.918****	**.883****	**.648****	1
	Sig. (2-tailed)	.000	.000	.000	.000	

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

The correlation analysis reveals strong and statistically significant relationships among the main study variables at the 0.01 level. The effect of logistics digitalization shows a very strong positive correlation with the operational efficiency of ESL ($r = .986$, $p < .01$), indicating that improvements in digital logistics are closely associated with enhanced operational efficiency. Similarly, data security ($r = .918$, $p < .01$) and the influence of digitalization ($r = .883$, $p < .01$) also demonstrate strong positive relationships with operational efficiency, suggesting that secure and effective digital systems contribute substantially to organizational outcomes. Technological infrastructure and regulatory policy challenges are moderately and positively correlated with operational efficiency ($r = .648$, $p < .01$), implying that addressing these challenges is important for efficiency improvement. In contrast, gender shows a significant negative correlation with all core study variables, indicating differences in perceptions across gender groups. Overall, the results confirm that logistics digitalization and related factors are key determinants of ESL's operational efficiency.

This finding is consistent with prior research, which indicates that effective digitalization of logistics processes significantly enhances operational efficiency and efficiency outcomes (Zailani et al., 2015). According to Zailani, Iranmanesh, and Foroughi (2015), organizations that successfully integrate digital technologies into their logistics and supply chain operations

achieve better coordination, cost efficiency, and service efficiency, supporting the strong positive correlations observed in this study.

4.8.2. Diagnostics Tests of Regression Model

The statistical model of linear regression analysis produces accurate results when implemented according to its specific guidelines. The model uses patterns in the independent variable to predict the dependent variable. The model predictions of linear regression must receive data confirmation because this validation process enables the technique to maintain its predictive power (Hayes, 2015). The section begins by applying multiple diagnostic tests to evaluate the data before the regression model calculation. The diagnostics methodically verify all basic linear regression assumptions, which results in dependable and accurate analysis outcomes. The testing process at this point includes three main assessments: testing for linearity to establish a direct relationship between variables, for normality to determine if error terms follow a normal distribution, and for multicollinearity to identify high intercorrelations among independent variables. The diagnostic procedures play a critical role in supporting both effective data analysis and accurate data interpretation processes.

4.8.3. Multicollinearity Test

Multicollinearity exists when two or more independent variables display high correlation within a regression model (Hair et al., 2023). The researchers used Variance Inflation Factor (VIF) and Tolerance measurements to conduct their study on multicollinearity test results. The measurement of multicollinearity typically employs VIFs, which reveal problematic levels through values that exceed 5 or 10, while tolerance values (1/VIF) indicate high correlation when values drop below 0.20 or 0.10 (Myers et al., 2016). The study found that all independent variables had tolerance and VIF values that fell within the 0.10 to 5 range, thus demonstrating that multicollinearity did not occur in this research.

Table: 4.8 Coefficients[a] of Test of Multicollinearity

Model		Collinearity Statistics	
		Tolerance	VIF
1	(Constant)		
	Effect of logistics digitalization on ESL	.228	4.394
	Effect of data security on the Implementation of logistics digitalization	.127	7.859
	Influence of digitalization on international trad	.147	6.808
	Challenges of technological infrastructure and regulatory policy on ESL	.583	1.716

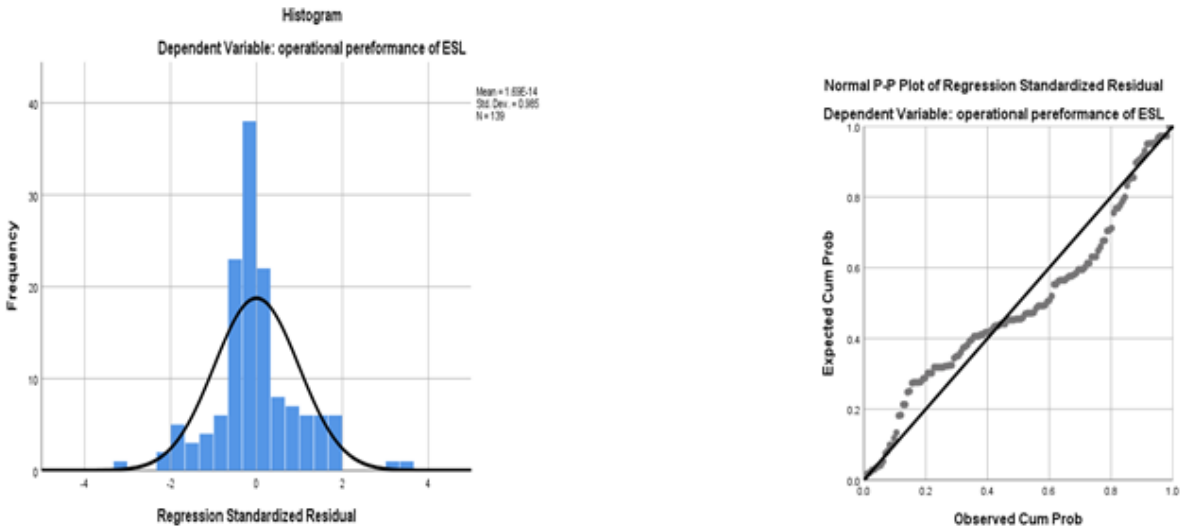
a. Dependent Variable: operational efficiency of ESL

The multicollinearity test shows that all independent variables have acceptable tolerance (0.127–0.583) and VIF values (1.716–7.859), indicating no serious multicollinearity. This means that each predictor contributes unique information to the regression model, and the estimates for operational efficiency of ESL are reliable and not distorted by high intercorrelations.

4.8.4. Normality test

A regression model requires its test statistic to follow a normal distribution as its permissible probability distribution. The residuals must be examined for normal distribution to confirm normality according to Kline 2010. Normal QQ plots were used to determine how the model's error terms were distributed across different locations. The actual data distribution in Table 4.7 corresponds to the diagonal line in the normal Q-Q plot. The data shows normal distribution according to Hair et al 2006 research conclusion.

Figure 2: Q-Q plot and Histogram test of study variables



4.8.5. Test for Normality using Skewness and Kurtosis

The scientific field shows a pattern where 50% of published studies contain at least one statistical mistake according to the research findings of Elliott and Woodward 2007. Many statistical methods including regression analysis, correlation analysis, t-tests, and analysis of variance testing depend on the assumption that data follows a normal distribution pattern. The normality assumption becomes vital because any score above +2 or below -2 reaches a level of statistical significance.

Table 4.9 Test for Normality using Skewness and Kurtosis

Independent variable	Skewness	Kurtosis
Effect of logistics digitalization on ESL	.053	-1.116
Effect of data security on the implementation of logistics digitalization	-.331	-1.389
Influence of digitalization on international trade	-.005	-1.338
Challenges of technological infrastructure and regulatory policy on ESL	.645	-1.280

The study found that logistics digitalization affected ESL with a skewness of 0.053 and a kurtosis of −1.116 while data security impacted logistics digitalization with a skewness of −0.331 and a kurtosis of −1.389. Digitalization affected international trade with a skewness of −0.005 and a kurtosis of −1.338 while technological infrastructure and regulatory policy challenges impacted ESL with a skewness of 0.645 and a kurtosis of −1.280. The variables showed acceptable normal distribution according to their skewness and kurtosis values which stayed within the range of ±2 thus meeting the normality requirement for linear regression analysis.

4.9. Regression Model fit analysis

Table 4.10 Model Summary of regression model

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.994[a]	.989	.988	.11007	.989	2941.224	4	134	.000

a. Predictors: (Constant), Challenges of technological Infrastructure and Regulatory policy, Effect of logistics digitalization, Influence of digitalization on international trade, Effect of data security on the implementation of logistics digitalization

b. Dependent Variable: operational efficiency of ESL

The regression model summary indicates a very strong relationship between the independent variables and the operational efficiency of ESL. The R value of 0.994 confirms a strong positive correlation, while the R Square value of 0.989 shows that 98.9% of the variation in operational efficiency is explained by the predictors. The adjusted R Square of 0.988 further supports the model's reliability in the presence of multiple independent variables. In addition, the low

standard error of the estimate (0.11007) reflects minimal prediction error. The model is statistically significant, as evidenced by the R Square change of 0.989 and the large F change value ($F = 2941.224$, $p < 0.001$), indicating that the independent variables collectively provide a strong explanatory power for operational efficiency, which is consistent with the view of Hair et al. (2019) that high R^2 and significant F-statistics demonstrate a well-fitting regression model.

4.10. ANOVA[a] of regression model

Table 4.11 ANOVAa of regression model

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	142.527	4	35.632	2941.224	.000[b]
	Residual	1.623	134	.012		
	Total	144.151	138			

a. Dependent Variable: operational efficiency of ESL

b. Predictors: (Constant), challenges of technological infrastructure and regulatory policy, effect of logistics digitalization, influence of digitalization on international trade, Effect of data security on the implementation of logistics digitalization

The ANOVA results of the regression model demonstrate that the model successfully explains all operational efficiency metrics of ESL. The regression sum of squares (142.527) exceeds the residual sum of squares (1.623) by a vast margin which shows that independent variables explain most of the total variation in operational efficiency. The model produced a very high F value of 2941.224 with a significance level of $p < 0.001$ which proved that the regression model had a better fit than a model without any predictors. The independent variables selected for this study demonstrate their ability to affect ESL operational efficiency which matches the findings of Gujarati and Porter 2009 who showed that F-statistics determine the validity and explanatory power of regression models.

4.11. Coefficients[a] regression model

Table 4.12 Coefficients[a] regression model

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-.035	.027		-1.297	.197		
	Effect of logistics digitalization	.760	.020	.748	38.927	.000	.228	4.394
	Effect of data security on the implementation of logistics digitalization	.202	.024	.216	8.417	.000	.127	7.859
	Influence of digitalization on international trade	.031	.027	.028	1.159	.249	.147	6.808
	Challenges of technological infrastructure and regulatory policy	.042	.012	.044	3.625	.000	.583	1.716

Dependent Variable: operational efficiency of ESL

The regression coefficient results show that logistics digitalization has a strong positive impact which demonstrates statistical significance on the operational efficiency of ESL (B = 0.760, p < 0.001) because every unit increase in logistics digitalization results in major operational efficiency enhancements. The positive data security impact on logistics digitalization implementation shows a significant relationship with operational efficiency (B = 0.202, p < 0.001) because better data security protection results in substantial operational efficiency gains. Operational efficiency receives a positive and significant relationship from technological infrastructure challenges and regulatory policy difficulties (B = 0.042, p < 0.001) because efficiency improvement requires solving these two problems. The digitalization of international trade shows no statistically significant impact on ESL operational efficiency because the study results show a relationship between the two variables (B = 0.031, p = 0.249).

Mathematically the linear regression result can be expressed as follows **Y = -0.035+0 .760*X*1 + 0**.202***X*2 + 0**.031***X*3 + 0**.042**X*4 + e**

Chapter Five

5. Conclusions and Recommendations

5.1. Summary of finding

This chapter presents a concise summary of the key findings from the study on the effect of logistics digitalization on operational efficiency at the Ethiopian Shipping and Logistics Services Enterprise (ESL). The findings are summarized based on the analysis of survey responses, correlation and regression results, and diagnostic tests of the regression model. The study found that logistics digitalization at ESL has produced positive yet partial improvements in operational efficiency, including increased overall efficiency, cost reduction, and error minimization; however, critical areas such as processing time, interdepartmental coordination, data accuracy, and service reliability remain weak. Data security challenges persist, primarily due to organizational capacity, staff competency, and governance gaps, while technological infrastructure and policy limitations are less significant. Correlation and regression analyses confirmed that logistics digitalization and its supporting factors are key determinants of operational efficiency**,** with the regression model demonstrating strong explanatory power (R^2 = 0.989) and high statistical significance, ensuring that the findings are reliable and interpretable. Overall, logistics digitalization is a strategic driver of efficiency, though its benefits are fragmented and require further strengthening. To achieve sustained and comprehensive improvements, ESL should enhance system integration, reengineer operational processes, strengthen organizational capacity, improve data governance, and ensure effective interdepartmental coordination**,** enabling digital initiatives to generate more consistent and transformative gains across all operational areas.

5.2. Finding

- **Findings on the Effect of Logistics Digitalization on Operational efficiency at ESL**

The findings demonstrate strong dissatisfaction regarding data accuracy and documentation. Respondents overwhelmingly disagreed that logistics digitalization has improved the accuracy of operational data, indicating that manual processes, system errors, or poor data governance may still dominate logistics operations. This outcome highlights a critical weakness, as data accuracy is a foundational requirement for effective digital logistics systems

- **Findings on Data Security Challenges Affecting Logistics Digitalization at ESL**

The data security challenges affect logistics digitalization at ESL. While respondent's express confidence in existing technical security measures, they remain concerned about cyber threats,

staff competency, and policy inadequacies. This implies that the key data security challenges facing ESL are less technical in nature and more related to organizational capacity, training, and governance frameworks.

- **Findings on the Effect of Logistics Digitalization on International Trade Operations at ESL**

The impact of logistics digitalization on international trade operations at ESL as low to moderate. While systems such as real-time tracking and general trade support demonstrate some effectiveness, critical efficiency indicators particularly cargo clearance time, electronic documentation efficiency, and operational transparency remain weak. This finding implies that logistics digitalization at ESL has delivered partial and fragmented benefits, and that stronger system integration, institutional coordination, and process reengineering are required to achieve meaningful improvements in international trade efficiency.

- **Findings on Technological Infrastructure and Policy Challenges Affecting Logistics Digitalization at ESL**

Technological infrastructure and policy issues as serious challenges to logistics digitalization at ESL While isolated concerns exist regarding ICT infrastructure, system reliability, and regulatory support, these factors are not considered dominant barriers. This implies that the challenges limiting the effectiveness of logistics digitalization at ESL are more likely related to organizational, human, and implementation factors rather than technical or policy infrastructure constraints

- **Findings on the Effect of Logistics Digitalization on Operational efficiency at ESL**

Despite weaknesses across specific operational dimensions, respondents generally agreed that logistics digitalization has enhanced overall operational efficiency at ESL. This suggests that the cumulative effect of digital initiatives is viewed positively, even if improvements are incremental rather than transformative.

While respondents acknowledge positive impacts on cost reduction, error minimization, and overall efficiency, they largely disagree that digitalization has significantly improved processing time, interdepartmental coordination, and service reliability. This indicates that logistics digitalization at ESL has delivered partial benefits, and that further improvements require stronger system integration, process reengineering, and enhanced organizational alignment to achieve consistent efficiency gains across all operational areas.

❖ **Correlation Analysis Findings**

The correlation results confirm that logistics digitalization and its supporting factors are key determinants of operational efficiency at ESL. The exceptionally strong correlations indicate that digital transformation is not merely a supporting tool but a central driver of organizational efficiency. Enhancing digital logistics capabilities, strengthening data security, and addressing infrastructure and policy challenges are therefore essential for achieving sustained operational improvements. These findings are consistent with prior empirical research. Zailani, Iranmanesh, and Foroughi (2015) argue that organizations that effectively integrate digital technologies into logistics and supply chain processes achieve superior coordination, cost efficiency, and service efficiency. The strong positive correlations observed in this study provide empirical support for their conclusion and reinforce the strategic importance of logistics digitalization in improving operational efficiency.

❖ **Findings from Diagnostic Tests of the Regression Model**

The diagnostic test results confirm that the regression model meets the required statistical assumptions, ensuring that the regression estimates are stable, unbiased, and interpretable. Consequently, the regression analysis conducted in this study is considered valid and suitable for examining the effect of logistics digitalization and related factors on operational efficiency.

❖ **Findings from Multicollinearity and Normality Tests**

The regression model meets key assumptionsno significant multicollinearity and normally distributed residuals ensuring that the findings on ESL's operational efficiency are statistically reliable and interpretable.

❖ **Regression Model Summary and Findings**

These results indicate that the regression model is well-fitting and robust, aligning with Hair et al. (2019), who note that high R^2 and significant F-statistics reflect strong explanatory capacity of the predictors.

5.3. Conclusion

The study reveals that logistics digitalization at ESL has produced a positive yet partial impact on operational efficiency. Respondents acknowledged improvements in overall efficiency, cost reduction, and error minimization; however, critical areas such as processing time, interdepartmental coordination, data accuracy, and service reliability continue to face challenges. While data security issues are technically manageable, they persist due to organizational, human, and governance factors, whereas technological infrastructure and policy

constraints are not the primary barriers.

Correlation and regression analyses confirm that logistics digitalization and its supporting factors are key determinants of operational efficiency, with strong statistical evidence supporting their influence. The regression model is robust, well-fitting, free from multicollinearity, and exhibits normally distributed residuals, ensuring the reliability and interpretability of the findings. The model demonstrates exceptionally strong explanatory power, with an R^2 of 0.989 and an adjusted R^2 of 0.988, accounting for 98.9% of the variation in operational efficiency. The low standard error and high statistical significance ($F = 2941.224$, $p < 0.001$) further underscore the robustness of the predictors in explaining ESL's efficiency outcomes.

Logistics digitalization emerges as a strategic driver of efficiency, though its benefits remain fragmented. To achieve sustained and comprehensive improvements, ESL must prioritize system integration, operational process reengineering, organizational capacity building, and enhanced data governance and interdepartmental coordination. These measures will enable digital initiatives to generate more consistent and transformative gains across all operational areas, aligning with empirical evidence that effective digital logistics integration enhances organizational efficiency and service efficiency.

5.4. Recommendation

Based on the study findings, the following recommendations are proposed to strengthen the effectiveness of logistics digitalization and enhance operational efficiency at the Ethiopian Shipping and Logistics Services Enterprise (ESL)

- ESL should prioritize improving data accuracy and documentation by establishing robust data governance frameworks. This includes standardizing data entry procedures, minimizing manual processes, implementing real-time validation mechanisms, and assigning clear accountability for data ownership and quality control. Accurate and reliable data are foundational for effective digital logistics and informed decision-making.
- To address weaknesses in processing time, coordination and service reliability ESL should integrate fragmented digital systems across departments and operational units. Seamless interoperability between logistics, customs, finance, and trade-related systems will reduce duplication, delays, and information silos, thereby improving operational flow and efficiency.
- ESL should undertake comprehensive business process reengineering to align operational

workflows with digital systems. Special attention should be given to international trade operations, including cargo clearance, electronic documentation, and tracking processes, to ensure that digital tools deliver measurable improvements rather than incremental gains.

- Since key challenges are organizational rather than technical, ESL should invest in continuous staff training and digital competency development. Targeted capacity-building programs should focus on system utilization, cybersecurity awareness, data management, and change management to enhance staff readiness and reduce operational risks associated with digitalization.
- While technical security measures are perceived as adequate, ESL should reinforce data security through stronger governance frameworks. This includes updating cybersecurity policies, clarifying roles and responsibilities, conducting regular audits, and ensuring compliance with international data protection standards to mitigate human-related security vulnerabilities.
- ESL should establish cross-functional coordination mechanisms to ensure that digital initiatives are implemented holistically rather than in isolation. Clear communication channels, shared performance indicators, and collaborative digital platforms will enhance coordination and ensure consistent efficiency gains across departments.
- Given the partial benefits observed, ESL should adopt a phased digital transformation roadmap supported by performance monitoring and evaluation frameworks. Key operational efficiency indicators such as processing time, service reliability, and cost efficiency should be continuously tracked to assess the effectiveness of digital initiatives and guide timely corrective actions.
- ESL should position logistics digitalization as a core strategic priority rather than a supporting function. Senior management commitment, adequate resource allocation, and alignment of digital initiatives with organizational goals will enable digital transformation to deliver sustained and transformative operational efficiency improvements.

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Annex 1

School of Commerce

Dear Respondent,

I am a student at University of Addis Ababa School of commerce undertaking Masters' Degree in Logistics and Supply Chain Management. I request you to spare your time to fill this questionnaire that is intended to find out **Challenges and prospects of logistics digitalization in Ethiopia: the case of Ethiopian shipping and logistics.** Kindly spare a few time to fill the attached questionnaire to enable me complete the study for which I will be very grateful. You are kindly requested to fill in the blank spaces at the end of each question or statement or simply put a tick where appropriate. This information will be used purely for academic purposes and will be treated in strict confidence. You need not include your name. Any additional information that you might feel is necessary for this study is welcome. Your participation in this study will be valuable as it will contribute to the achievement of the study objectives. Please respond as honestly and truthfully as possible.

Thanks in advance for your support.

Name: Mignot Mekasha

Email Address:

SECTION 1: BACKGROUND INFORMATION

Please tick (√) the box that matches your answer to the questions and give the answers in the spaces provided as appropriate.

1. Gender? Male ☐ Female ☐
2. Academic level. Diploma and below ☐
   Degree ☐ Master ☐ PhD ☐
3. work experience? Less than a Year ☐ 1 – 2 years ☐
   3- 5 years ☐ 5 - 7 years ☐ More than 7 years ☐
4. Age of respondent
   18 – 25 years ☐ 26 - 35 years ☐ Above55 years ☐
   36 - 45 years ☐ 46 - 55 years ☐
5. Area of speciation

Marketing ☐ Shipping sector ☐ Logistics and supply management ☐
Transport management ☐ multimodal ☐

I. Question related about logistics digitalization at ESL, and how do siloed operations affect its implementation?

No	Items	SD	D	N	A	SA
1.1	ESL uses integrated digital systems to manage its logistics and supply chain operations.					
1.2	Digital technologies are effectively applied in tracking, monitoring, and coordinating logistics activities at ESL.					
1.3	Most logistics processes at ESL are supported by digital platforms rather than manual procedures.					
1.4	Siloed operations among ESL departments limit effective information sharing through digital systems.					
1.5	Lack of coordination between departments negatively affects the implementation of logistics digitalization at ESL.					
1.6	Siloed organizational structures reduce the overall effectiveness of digital logistics systems at ESL.					

II. Question related about data management and security challenges hinder digitalization at ESL

No	Items	SD	D	N	A	SA
2.1	ESL lacks a well-integrated data management system to support digital logistics operations.					
2.2	Poor data quality (inaccuracy, inconsistency, or incompleteness) limits effective digital decision-making at ESL.					
2.3	Difficulties in data sharing across departments hinder the implementation of digital logistics systems.					
2.4	Concerns about data security reduce the adoption of digital technologies in ESL's logistics operations.					
2.4	ESL does not have sufficient cybersecurity measures to protect digital logistics data.					
2.6	Fear of data loss, breaches, or unauthorized access slows down digital transformation at ESL					

III. Question related about dependency on legacy systems and lack of process automation limit the prospects of logistics digitalization at ESL

No	Items	SD	D	N	A	SA
3.1	ESL relies heavily on legacy systems that are incompatible with modern digital logistics technologies.					
3.2	Existing legacy systems limit system integration and data sharing across logistics functions at ESL.					
3.3	Frequent system breakdowns or inefficiencies in legacy systems hinder digital transformation efforts.					
3.4	Most logistics processes at ESL are still performed manually rather than through automated digital systems.					
3.5	Lack of process automation reduces operational efficiency in ESL's logistics activities.					
3.6	Limited automation constrains ESL's ability to fully benefit from logistics digitalization					

IV. Question related about shortage of skilled digital labor and policy or strategic issues affect ESL's ability to achieve its digital transformation goals

No	Items	SD	D	N	A	SA
4.1	ESL faces a shortage of employees with adequate digital skills to support logistics digitalization.					
4.2	Limited access to continuous digital training hinders employee readiness for digital transformation at ESL.					
4.3	The lack of skilled digital professionals slows the implementation of advanced logistics technologies.					
4.4	Existing policies do not sufficiently support ESL's digital transformation objectives.					
4.5	The absence of a clear digital transformation strategy limits effective implementation of digital initiatives.					

V. Question related about Level of Logistics Digitalization

No	Items	SD	D	N	A	SA
5.1	Real-time tracking and monitoring technologies are used for logistics activities.					
5.2	Digital platforms are integrated across different logistics functions and departments.					
5.3	Data generated from logistics operations is systematically collected, stored, and used for decision-making.					
5.4	Logistics processes are largely automated with minimal reliance on manual procedures.					
5.5	Information sharing with partners (suppliers, customers, customs, and ports) is conducted through digital systems.					
5.6	The organization uses advanced digital technologies (ERP, IoT, cloud-based systems) in logistics management.					
5.7	Employees are capable of effectively using digital logistics systems in their daily tasks.					

Thank you again for your participation!

Appendix 2

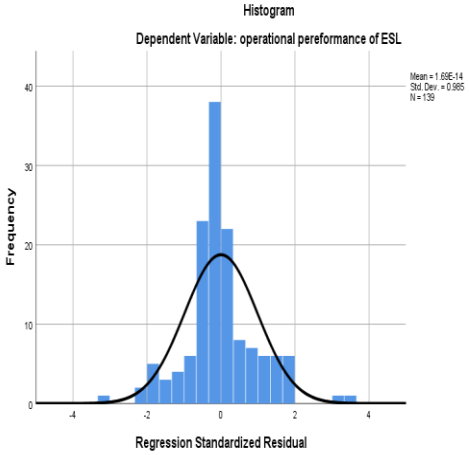
Correlations

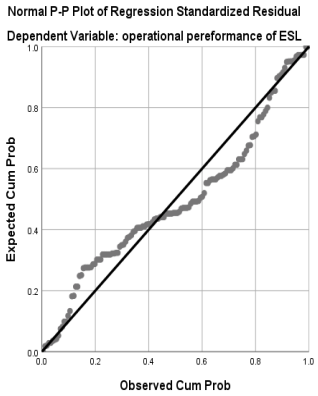
		Effect of logistics digitalization on ESL	Effect of data security on the Implementation of logistics digitalization	Influence of digitalization on International trade	Challenges of technological Infrastructure and regulatory policy on ESL	operational Efficiency of ESL
Effect of logistics digitalization on ESL	Pearson Correlation	1	.869**	.842**	.606**	.986**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	139	139	139	139	139
Effect of data security on the Implementation of logistics digitalization	Pearson Correlation	.869**	1	.917**	.616**	.918**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	139	139	139	139	139
Influence of digitalization on International trade	Pearson Correlation	.842**	.917**	1	.629**	.883**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	139	139	139	139	139
challenges of technological Infrastructure and regulatory policy on ESL	Pearson Correlation	.606**	.616**	.629**	1	.648**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	139	139	139	139	139
operational Efficiency of ESL	Pearson Correlation	**.986****	**.918****	**.883****	**.648****	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	139	139	139	139	139

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

Model		Collinearity Statistics	
		Tolerance	VIF
1	(Constant)		
	Effect of logistics digitalization on ESL	.228	4.394
	Effect of data security on the Implementation of logistics digitalization	.127	7.859
	Influence of digitalization on international trad	.147	6.808
	Challenges of technological infrastructure and regulatory policy on ESL	.583	1.716

Figure 2: Q-Q plot and Histogram test of study variables





Independent variable	Skewness	Kurtosis
Effect of logistics digitalization on ESL	.053	-1.116
Effect of data security on the implementation of logistics digitalization	-.331	-1.389
Influence of digitalization on international trade	-.005	-1.338
Challenges of technological infrastructure and regulatory policy on ESL	.645	-1.280

Coefficients[a] regression model

Table 4.9 Coefficients[a] regression model								
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-.035	.027		-1.297	.197		
	Effect of logistics digitalization	.760	.020	.748	38.927	.000	.228	4.394
	Effect of data security on the implementation of logistics digitalization	.202	.024	.216	8.417	.000	.127	7.859
	Influence of digitalization on international trade	.031	.027	.028	1.159	.249	.147	6.808
	Challenges of technological infrastructure and regulatory policy	.042	.012	.044	3.625	.000	.583	1.716