

**GREEN LOGISTICS PRACTICES, INFRASTRUCTURE QUALITY,
OPERATIONAL FLEXIBILITY AND LOGISTICS OPERATIONAL
EFFICIENCY OF LOGISTICS FIRMS IN UGANDA**

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DECLARATION

I, **Emmanuel Kibuuka**, hereby affirm that this dissertation, titled “*Green Logistics Practices, Infrastructure Quality, Operational Flexibility and Logistics Operational Efficiency of logistics firms in Uganda.*”, is my original work. It has not been previously published or submitted to any university or institution of higher learning for academic purposes. All sources and materials not originating from me have been duly acknowledged.

Signature Date.....

APPROVAL

This is to certify that this dissertation, titled “*Green Logistics Practices, Infrastructure Quality, Operational Flexibility and Logistics Operational Efficiency of logistics firms in Uganda*”, has been submitted to the academic Board of examiners with our approval as appointed University Supervisors.

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DEDICATION

I sincerely dedicate this dissertation to the Almighty God, whose boundless grace and constant blessings have made this achievement possible. To my dear parents my mother, Ms. Rita Matuka and my late father Mr. Stephen Sserrunkuma your love, wisdom and unwavering support have been the foundation of my success. I further dedicate this work to my beloved siblings, Michael, Maria, Mariana and Marcellus, with the hope that it inspires you to follow your dreams with courage, faith and determination.

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LIST OF ABBREVIATIONS

| | |
|----------|--|
| RBV | : Resource-Based View |
| GLP | : Green Logistics Practices |
| IQ | : Infrastructure Quality |
| LOE | : Logistics Operational Efficiency |
| OF | : Operational Flexibility |
| QHSE | : Quality, Health, Safety, and Environment |
| SEM | : Structural Equation Modeling |
| PLS-SEM | : Partial Least Squares Structural Equation Modeling |
| AVE | : Average Variance Extracted |
| ROI | : Return on Investment |
| LPI | : Logistics Performance Index |
| SDGs | : Sustainable Development Goals |
| AfCFTA | : African Continental Free Trade Area |
| NDPIII | : National Development Plan III |
| WEEE | : Waste Electrical and Electronic Equipment |
| ITS | : Intelligent Transport Systems |
| SPSS | : Statistical Package for the Social Sciences |
| SMARTPLS | : Smart Partial Least Squares software |
| LPG | : Liquefied Petroleum Gas |
| CNG | : Compressed Natural Gas |
| VRIN | : Valuable, Rare, Inimitable, Non-substitutable |
| KPI | : Key Performance Indicator |
| TQM | : Total Quality Management |
| JIT | : Just-In-Time |
| ISO | : International Organization for Standardization |

ABSTRACT

This study examined the mediating role of operational flexibility in the relationship between green logistics practices, infrastructure quality and logistics operational efficiency among logistics firms in Uganda. Anchored in the Resource-Based View (RBV) theory, the research conceptualized infrastructure quality and green logistics practices as strategic resources, with operational flexibility serving as a dynamic capability that enhances efficiency. A cross-sectional survey design was employed, targeting 216 respondents from 72 logistics firms within the Kampala Metropolitan Area. Data was analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The findings revealed that infrastructure quality is the most significant predictor of logistics operational efficiency ($\beta = 0.357$, $p < 0.001$) and exerts a substantial indirect effect through operational flexibility ($\beta = 0.300$, $p = 0.002$). It also demonstrated a strong direct influence on operational flexibility ($\beta = 0.746$, $p < 0.001$). Conversely, green logistics practices such as fuel efficiency initiatives, route optimization and reverse logistics had a significant direct effect on logistics operational efficiency ($\beta = 0.245$, $p = 0.008$) but no significant impact on operational flexibility ($\beta = 0.034$, $p = 0.819$). The model accounted for 81.2% of the variance in logistics operational efficiency ($R^2 = 0.812$) and 59.6% in operational flexibility ($R^2 = 0.596$), indicating high predictive power. These findings suggest that while sustainable practices contribute to efficiency through cost reduction and reliability, infrastructure quality remains fundamental to both efficiency and adaptability. The study recommends that logistics firms and policymakers prioritize investments in resilient transport infrastructure and adopt digital innovations such as GPS tracking and telematics to enhance flexibility and competitiveness within Uganda's logistics sector.

CHAPTER ONE: INTRODUCTION

1.0 Introduction

This study explored the mediating role of operational flexibility in the relationship between green logistics practices, infrastructure quality and logistics operational efficiency among logistics firms in Uganda. The chapter began by providing an overview of the research background and articulating the research problem, objectives, purpose and hypotheses. It further delineated the study's scope and emphasized its significance. In addition, the chapter presented the conceptual framework and defined the key terms essential for understanding the study

1.1 Background of the Study.

In the past several decades, the rapid expansion of global trade has created a growing need for logistics systems that are fast, dependable, and cost-efficient. Logistics constitutes a vital component as it facilitates the efficient flow and coordination of goods and information between producers, suppliers and consumers in global trade. Although the logistics industry contributes around 11% to the world's GDP, it continues to face significant obstacles such as high operating expenses, inadequate infrastructure and increasing environmental impacts, which account for nearly 5% of global carbon emissions. These challenges emphasize the importance of improving operational efficiency and fostering sustainability throughout global supply chains (Krishnan et al. 2024).

Logistics operational efficiency reflects the ability of a logistics system to deliver products and services promptly and dependably, optimizing resources while minimizing costs (Lee & Johnson, 2013). It focuses on minimizing delays and costs while enhancing overall logistics performance throughout the supply chain (Ouma, 2021). This involves reducing waste, shortening lead times and increasing value creation across key logistics functions such as

transportation, warehousing and order fulfillment (Andrejić, 2013). Efficient logistics operations enhance customer satisfaction, competitiveness and profitability while reducing delivery uncertainty and operational risks (Burity, 2021). In developing economies like Uganda, inefficiencies arising from poor infrastructure, congestion and delays at weighbridges continue to hinder operational performance and increase costs (Tukamuhabwa et al. 2023).

Many organizations have embraced Green Logistics Practices (GLPs) to boost logistics operational efficiency by embedding sustainability into their logistics processes. These approaches seek to lower environmental impacts through measures such as clean transportation methods, efficient energy management in warehouses, eco-conscious packaging and recycling-focused reverse logistics (Chatzoudes et al., 2024). Practical applications of Green Logistics Practices include deploying electric or hybrid vehicles, utilizing route optimization technologies and providing eco-driving training for drivers to lower fuel consumption and emissions; equipping warehouses with solar panels, LED lighting, smart ventilation systems and adopting biodegradable or reusable packaging to minimize waste (Tetteh, 2024). Integrating reverse logistics and recycling processes enables firms to reclaim value from returned or used materials, while digital technologies support paperless operations and allow continuous monitoring of carbon emissions. These approaches contribute not only to environmental sustainability but also to improved operational efficiency and sustained competitive advantage (Rastegardebidi, 2025).

Infrastructure quality is closely tied to logistics operational efficiency and includes elements such as transportation networks, warehousing facilities, ports and ICT systems. High-quality, dependable infrastructure ensures the seamless flow of goods, shortens transit times and supports the effective implementation of green logistics technologies (Nicoletti, 2024).

Dependable infrastructure ensures efficient movement of goods, shortens delivery times and supports the adoption of green logistics technologies (Do, 2024). In Uganda, persistent infrastructure limitations including poor road conditions, limited rail networks and inadequate warehousing pose significant barriers to efficient logistics operations. The 2018 World Bank Logistics Performance Index ranked Uganda 102nd worldwide, with an overall score of 2.5, highlighting weaknesses particularly in infrastructure (2.1) and customs efficiency (2.4). More up-to-date information on these indicators is currently unavailable (World Bank, 2023).

These infrastructure gaps lead to elevated operational costs, higher emissions and frequent delays, highlighting the importance of investing in robust and sustainable infrastructure to enhance logistics operational efficiency. In fast-evolving business environments, operational flexibility, the capacity to swiftly adapt to changing market conditions, customer requirements and unexpected disruptions are essential for maintaining efficiency. Flexible logistics systems can adjust routes, schedules and resource allocation in real time to mitigate risks and sustain performance. Furthermore, both Green Logistics Practices and superior infrastructure facilitate this flexibility by improving digital visibility, enabling real-time coordination and optimizing resource use, thereby strengthening overall logistics operational efficiency (Yousuf, 2021).

The Resource-Based View (RBV) offers the theoretical underpinning for analyzing these relationships. According to the Resource-Based View, firms gain enduring competitive advantage by deploying resources that possess value, rarity, inimitability and non-substitutability (Parrett, 2008). In this model, green logistics initiatives and the quality of infrastructure are treated as key strategic assets that enhance the effectiveness of logistics operations. Meanwhile, operational flexibility acts as a dynamic capability, enabling

organizations to adjust and redeploy these assets in response to evolving market demands and environmental shifts (Tukamuhabwa et al. 2023). Empirical evidence from Uganda remains scarce on the extent to which operational flexibility serves as a mediator between green logistics initiatives, infrastructure quality and logistics operational performance (Seroka, 2014). Closing this research gap is vital for shaping approaches to create logistics systems that are both sustainable and resilient in dynamic markets (Yaifa, 2023).

1.1.1 Historical Background

The term logistics originates from the French word *logistique*, derived from *loger*, meaning to provide lodging, particularly for troops and was adopted into English in the 19th century (Sutherland, 2007). Historically, logistics referred to the planning and supply of armies, exemplified by Alexander the Great's ability to maintain troops over long distances as discussed by (Creveld, 1997) and Antoine-Henri Jomini's 19th-century definition emphasizing movement and supply organization as discussed by (Jomini, 1838). Logistics' strategic importance was highlighted during World War II, where supply chains were critical to the Allied victory. Post-war, logistics became recognized as a key business function as discussed by Drucker (1962), evolving from transportation and warehousing to a comprehensive set of supply chain activities as discussed by (Bowersox, 1996). Globalization, technology and management science innovations such as Scientific Management as discussed by Taylor (1911), Ford's assembly line, Lean Production, Total Quality Management and Six Sigma further shaped logistics operational efficiency by optimizing speed and cost as discussed by Womack (1990) and service quality as discussed by (Deming, 1986). Modern logistics integrates Just-In-Time systems, real-time tracking and networked operations to enhance responsiveness and competitiveness (Christopher, 1998).

In the 21st century, logistics operational efficiency also incorporates sustainability and flexibility, addressing environmental concerns, supply chain disruptions and changing consumer behavior. Green logistics practices have become essential for improving performance as discussed by Srivastava (2007), while operational flexibility helps minimize environmental impact as discussed by (Kusi-Sarpong, 2019). In developing countries like Uganda, where logistics infrastructure remains underdeveloped, effective logistics management is increasingly critical for economic competitiveness and sustainable development.

1.1.2 Theoretical Background

The Resource-Based View (RBV), first introduced by Barney (1991), The Resource-Based View (RBV) asserts that firms can achieve sustainable competitive advantage by acquiring and effectively deploying resources that are valuable, rare, difficult to imitate and non-substitutable (VRIN). From this perspective, a firm's superior performance is largely determined by its internal resources rather than external market conditions. Within the logistics sector, capabilities such as operational flexibility, green logistics practices (GLPs), and the quality of infrastructure constitute strategic resources that can significantly enhance operational efficiency. In particular, GLPs are primarily intangible resources, encompassing organizational routines, environmental knowledge and management practices oriented toward sustainability (Hart, 1995).

Recent advancements in logistics feature AI-driven route optimization, which utilizes real-time traffic and weather data to improve delivery efficiency, as highlighted by Chatzoudes et al (2024), the adoption of electric and LNG-powered fleets, as well as biodiesel-fueled delivery vehicles, as noted by Tetteh (2024) and energy-efficient warehouses equipped with solar panels and smart lighting, the use of circular economy packaging, implementation of

reverse logistics systems and development of binational electric freight corridors, as highlighted by (Rastegardebidi, 2025). These practices are socially embedded, path-dependent, and inherently complex, which makes them challenging for competitors to imitate. Infrastructure quality, on the other hand, represents a tangible resource, including elements such as roads, rail networks, ports, warehousing facilities and ICT systems (Wernerfelt, 1984). Infrastructure quality is a tangible resource, encompassing roads, rail networks, ports, warehousing and ICT systems (Grant, 1991).

In Uganda, however, infrastructure challenges are significant: only about 25% of roads are paved, rural feeder roads are often in poor condition, rail transport is underutilized and border posts face congestion (Nicoletti, 2024). Cold-chain and specialized warehousing are insufficient (Do, 2024). Logistics hubs such as Gulu operate below capacity due to inadequate loading facilities and support services (Tukamuhabwa et al. 2023). These deficiencies limit the ability of firms to fully leverage tangible resources, constrain operational flexibility and reduce logistics operational efficiency.

The Resource-Based View (RBV) underscores that the mere possession of unique resources is insufficient for achieving superior performance; rather, it is the strategic integration and effective management of these resources that convert them into operational and competitive advantages (Zhao, 2018). The Resource-Based View (RBV) asserts that the mere possession of distinctive resources does not automatically lead to superior performance; rather, it is their strategic integration and effective management that translate them into operational and competitive advantages (Barney et al. 2021). RBV emphasizes that merely owning unique resources does not guarantee superior performance; strategic integration and effective management are critical to transforming them into operational and competitive advantages (Agyabeng-Mensah et al. 2020). Proactive environmental strategies, such as investing in

electric fleets, renewable-powered warehouses or AI-enabled logistics systems, reinforce the link between resources and performance. In the Ugandan context, combining investments in green logistics with targeted infrastructure improvements can enhance operational flexibility, reduce delays and improve overall logistics efficiency. Therefore, the RBV offers a strong theoretical basis for understanding how logistics firms can harness Green Logistics Practices, infrastructure quality and operational flexibility to enhance logistics operational efficiency and secure sustainable competitive advantage in both local and global settings.

1.1.3 Conceptual Background

The conceptual framework for this study presents the central concepts and variables that guide the research, providing a coherent and organized representation of their theoretical and practical relationships. It emphasizes three primary components: Green Logistics Practices, infrastructure quality and logistics operational efficiency, with operational flexibility acting as a mediating factor. The framework is anchored in the Resource-Based View (RBV) and reinforced by findings from logistics and operations management literature. By connecting overarching themes in sustainability and logistics management to the specific objectives of this study, the framework establishes a robust basis for both theoretical exploration and empirical investigation (Barney, 1991). The conceptual framework of this study illustrates the main concepts and variables guiding the research, providing a clear and organized depiction of their interrelationships in both theoretical and practical contexts. It centers on three core components: Green Logistics Practices, infrastructure quality, and logistics operational efficiency, with operational flexibility functioning as a mediating variable. The framework is rooted in the Resource-Based View (RBV) theory and informed by relevant literature in logistics and operations management. By connecting broader sustainability and logistics management trends to the specific aims

of this study, it establishes a solid foundation for both theoretical understanding and empirical investigation (Wernerfelt, 1984).

In Uganda, logistics and supply chain firms are progressively adopting Green Logistics Practices to boost operational efficiency while minimizing environmental impact. Companies in the beverage and manufacturing sectors are increasingly embracing waste reduction, cleaner production and recycling initiatives to improve environmental compliance and optimize resource utilization (Ainomugisha, 2025). Previous research has shown that Green Logistics practices including eco-friendly procurement, energy-efficient transportation and product traceability systems can improve sustainability outcomes while strengthening a firm's competitive advantage (Agyabeng-Mensah et al. 2020). These practices constitute intangible, knowledge-driven resources that depend on organizational learning, culture and commitment aligning with the RBV perspective, which views firm-specific resources as key drivers of sustained competitive advantage. (Hart, 1995). Such practices are intangible, knowledge-oriented resources that draw on organizational learning, culture and commitment, reflecting the RBV's emphasis on firm-specific resources as foundations for sustained competitive advantage (Barney, 1991).

Infrastructure quality continues to be a critical factor influencing logistics performance in Uganda. Despite some progress, persistent challenges remain, such as congestion on key transport corridors, limited multimodal connectivity, and poor maintenance of rural roads. Empirical evidence indicates that investments in road infrastructure directly enhance economic growth and logistics performance by reducing travel times and lowering operational costs. (Sebit, 2024). Similarly, improved multimodal transport and trade facilitation systems enhance logistics reliability and competitiveness across East Africa (Mwesigwa, 2019). Further studies highlight inefficiencies within Uganda's transport and

logistics sector stem from high freight costs, limited storage facilities, and weak intermodal connectivity (World Bank, 2017). Within the RBV framework, infrastructure functions as a tangible resource that enhances performance only when effectively complemented by technological and managerial capabilities (Barney, 1991).

Operational flexibility serves as the mediating factor connecting these resources to performance outcomes. It enables logistics firms to adjust to infrastructure challenges, market fluctuations and environmental uncertainties. Ugandan third-party logistics providers have increasingly enhanced agility through local sourcing, expansion of distribution networks, and investment in modern transport fleet (Tukamuhabwa, 2021). These strategies align with broader evidence showing that supply chain flexibility contributes to resilience and adaptability in dynamic markets (Liao, 2010). By adopting flexible operations, logistics firms can mitigate risks, reduce lead times and maintain service reliability despite infrastructural constraints (Zhao, 2018).

In this framework, logistics operational efficiency serves as the dependent variable, capturing a firm's ability to manage logistics in a manner that is timely, reliable and cost-efficient. Research shows that organizations that implement Green Logistics Practices, make effective use of infrastructure, and foster operational flexibility are more likely to realize better logistics performance, including significant reductions in operational costs Srivastava (2007), improved delivery times as discussed by Agyabeng-Mensah et al. (2020) and enhanced service quality as discussed by (Tukamuhabwa, 2021).

Overall, this framework demonstrates the interdependence of tangible and intangible resources in achieving logistics performance. Tangible assets such as roads, warehouses and vehicles provide the physical foundation for logistics activities, while intangible capabilities such as green innovation, flexibility, and adaptive management determine how effectively

these assets are utilized. In line with the RBV theory, firms that strategically integrate both types of resources are better positioned to achieve logistics operational efficiency as discussed by Hart (1995), maintain competitiveness as discussed by Zhao (2018) and contribute to sustainable economic development as discussed by (Wernerfelt, 1984).

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1.1.4 Contextual Background

The worldwide logistics sector is essential for supporting international trade, allowing companies to transport goods across borders efficiently (Rushton, 2017). Within this context, logistics operational efficiency is the capability of a firm to deliver products reliably, promptly and at minimal cost has emerged as a crucial indicator of competitive performance. (Chopra, 2016). Amid rising focus on sustainability and digital transformation, logistics firms are increasingly adopting green strategies and developing flexible capabilities to respond to changing customer expectations and environmental requirements (World Bank, 2023).

In Sub-Saharan Africa, logistics plays a central role in facilitating trade and supporting regional integration initiatives, such as the African Continental Free Trade Area (AfCFTA). Nonetheless, the region still grapples with major performance constraints, notably

insufficient transport infrastructure, as highlighted by the World Bank (2023) and high logistics costs and inefficient border processes (UNCTAD, 2024). These inefficiencies limit trade competitiveness, increase delivery lead times, and constrain export diversification. As a landlocked country, Uganda depends heavily on the Northern Corridor linking the Port of Mombasa to its inland markets. Despite this strategic advantage, the nation continues to face ongoing logistics challenges, such as inadequate road and rail networks and high fuel and transportation costs, as highlighted by AfDB (2023) as well as constrained cold-chain and warehousing capacity, coupled with delays in customs clearance and border processing, as noted by (World Bank, 2023). Such inefficiencies are estimated to cost Uganda roughly UGX 3 trillion annually as reported by Oketch (2025), with logistics expenses accounting for about 18–20% of the sale price of goods as reported by (AfDB, 2023). These dysfunctions reduce logistics operational efficiency, as firms struggle to ensure reliable and cost-effective deliveries amid infrastructure and regulatory bottlenecks.

With growing emphasis on sustainability and digitalization, logistics firms are increasingly embracing green logistics strategies, such as route optimization, eco-driving and load consolidation to reduce costs as discussed by Srivastava (2007) and renewable-energy use in warehouses to reduce environmental impact (Agyabeng-Mensah et al. 2020). These strategies demonstrate how sustainability and operational efficiency can be pursued simultaneously through technological and managerial innovation (Zhao, 2018).

Given these structural challenges, it is important to examine how internal capabilities, particularly operational flexibility, influence the relationship between green logistics practices, infrastructure quality, and logistics operational efficiency. While logistics firms globally are adopting green and adaptive models to reduce environmental impact and enhance responsiveness, empirical studies in Uganda have often considered infrastructure

or environmental practices in isolation. There remains limited investigation into how operational flexibility mediates the impact of green logistics and infrastructure quality on efficiency (Tukamuhabwa, 2021). Understanding this dynamic offers valuable insights for policymakers and firms aiming to strengthen competitiveness, optimize resource utilization and align logistics operations with Uganda's broader green growth and trade facilitation goals (Ainomugisha, 2025).

1.2 Problem Statement

The logistics industry is evolving globally, with sustainability now central to operational efficiency. Efficiency today encompasses cost reduction, reliable service, customer satisfaction, adaptability and environmental responsibility (Sorle, 2024). Even advanced economies like Germany contend with challenges such as emissions, congestion and infrastructure delays (von der Gracht et al. 2018). In Uganda, these challenges are more acute owing to structural and geographic constraints. As a landlocked country, Uganda experiences higher logistics costs compared to coastal nations, with transport costs up to 40% higher than in coastal economies (Ministry of Works and Transport, 2018). Adoption of advanced transportation-management systems (TMS) has enabled cost reductions of about 8–10% through optimized routing and load consolidation (Namakula, 2024). Importers and logistics firms also grapple with infrastructure limitations such as underdeveloped cold-chain capacity, inconsistent digital platforms and weak transport links, all of which hinder operations (Ekaba, 2014). Inefficiencies in transport management and congestion in urban and peri-urban zones further contribute to high logistics costs and delivery delays (Ainomugisha, 2022). Green Logistics Practices offer a means to effectively address these challenges and foster greater operational efficiency within the logistics sector. Strategies such as eco-driving and load consolidation have been shown to positively impact supply chain performance, as highlighted by Hamal (2025), while reverse logistics and

energy-efficient warehousing contribute to cost reduction (Khoa, 2025). In Uganda, implementing sustainable logistics approaches, such as environmentally friendly transport, energy-efficient warehousing and reverse logistics systems, has been connected to higher operational efficiency in both manufacturing and distribution industries (Sanyu, 2025). These practices are consistent with emerging global trends in sustainable logistics, such as the deployment of fuel-efficient and electric freight vehicles and the integration of AI-based route optimization systems to reduce emissions and enhance delivery efficiency as discussed by Agyabeng-Mensah et al. (2020) and energy-efficient warehouses powered by solar energy and carbon-tracking systems for monitoring Scope 3 emissions (Zhao, 2018). This study investigates how operational flexibility through measures such as rerouting and schedule adjustments strengthens the influence of infrastructure quality and Green Logistics Practices on operational efficiency in Ugandan logistics firms, providing insights for developing resilient and sustainable logistics systems.

1.3 Purpose of the study

The study sought to determine how operational flexibility plays the mediator in the relationship between infrastructure quality, green logistics practices and logistics operational efficiency within logistics firms in Uganda.

1.4 Specific Objectives

- i.** To analyze the relationship between infrastructure quality and logistics operational efficiency of Ugandan Logistics firms.
- ii.** To assess the relationship between green logistics practices and logistics operational efficiency of Ugandan Logistics firms.
- iii.** To examine the relationship between infrastructure quality and operational flexibility of Ugandan Logistics firms.

- iv. To assess the relationship between green logistics practices and operational flexibility of Ugandan Logistics firms.
- v. To examine the mediating effect of operational flexibility on the relationship between infrastructure quality, green logistics practices, and logistics operational efficiency of Ugandan Logistics firms.

1.5 Research Questions.

- i. What is the relationship between infrastructure quality and logistics operational efficiency in Ugandan logistics firms?
- ii. What is the relationship between green logistics practices and logistics operational efficiency in Ugandan logistics firms?
- iii. What is the relationship between infrastructure quality and operational flexibility in Ugandan logistics firms?
- iv. What is the relationship between green logistics practices and operational flexibility in Ugandan logistics firms?
- v. Does operational flexibility mediate the relationship between infrastructure quality, green logistics practices, and logistics operational efficiency in Ugandan logistics firms?

1.6 Scope of study

The scope of this study was categorized into three key dimensions: geography, content and time.

1.6.1 Geographical Scope

The study focused on logistics firms operating in Uganda, with particular emphasis on leading companies within the national supply chain and transportation sector. Data

collection was conducted among firms situated in the Kampala metropolitan region, specifically targeting locations within Kampala Central and Wakiso Districts.

1.6.2 Content Scope

The study examined the relationships between infrastructure quality, Green Logistics Practices, operational flexibility and logistics operational efficiency. It assessed the impact of infrastructure quality on logistics performance, evaluated how Green Logistics Practices affect operational outcomes and explored the mediating role of operational flexibility in improving logistics operational efficiency.

1.6.3 Time Scope

This study spans the period from 2016 to 2025, during which empirical data was systematically gathered, critically analyzed and thoughtfully interpreted.

1.7 Significance of the study.

This study contributes to scholarly understanding by utilizing the Resource-Based View (RBV) to investigate how infrastructure quality and Green Logistics Practices influence logistics operational efficiency, with operational flexibility acting as a mediating factor. It provides a basis for further research in developing economies and offers empirical evidence to guide policy decisions on infrastructure investment and green logistics initiatives. The results are particularly relevant to the implementation of Uganda's National Development Plan III and the National Transport and Logistics Policy, illustrating how enhancements in infrastructure and sustainable logistics practices can improve operational performance. Additionally, the study delivers practical recommendations for logistics firms seeking to boost efficiency through environmentally responsible practices and operational adaptability, helping managers reduce costs, respond proactively to market changes and optimize delivery performance. Finally, the research emphasizes the importance of strategic investments in

green logistics and infrastructure, offering insights for donor-funded programs and public-private partnerships aimed at lowering trade costs, strengthening supply chains and promoting sustainability in Uganda.

1.8 Conceptual framework

The conceptual framework depicts how infrastructure quality and green logistics practices influence logistics operational efficiency through operational flexibility. Infrastructure quality, which includes accessibility, reliability and ease of connection, enhances logistics performance by reducing transport time, lowering operational costs and improving connectivity across logistics networks (Sénquiz-Díaz, 2021). Sustainable logistics approaches, including reverse logistics fuel efficiency and route optimization promote cost savings, sustainability and faster deliveries while minimizing environmental impact (Stephen, 2024). Operational flexibility, reflected through agility and adaptability, serves as the mediating factor that enables firms to convert the benefits of infrastructure and green logistics practices into improved logistics operational efficiency (López-Mesa, 2020). As a result, firms with flexible operations supported by efficient infrastructure and green practices experience reduced supply chain costs, quicker risk response times and shorter lead times, thereby achieving higher logistics operational efficiency (Christopher, 2016).

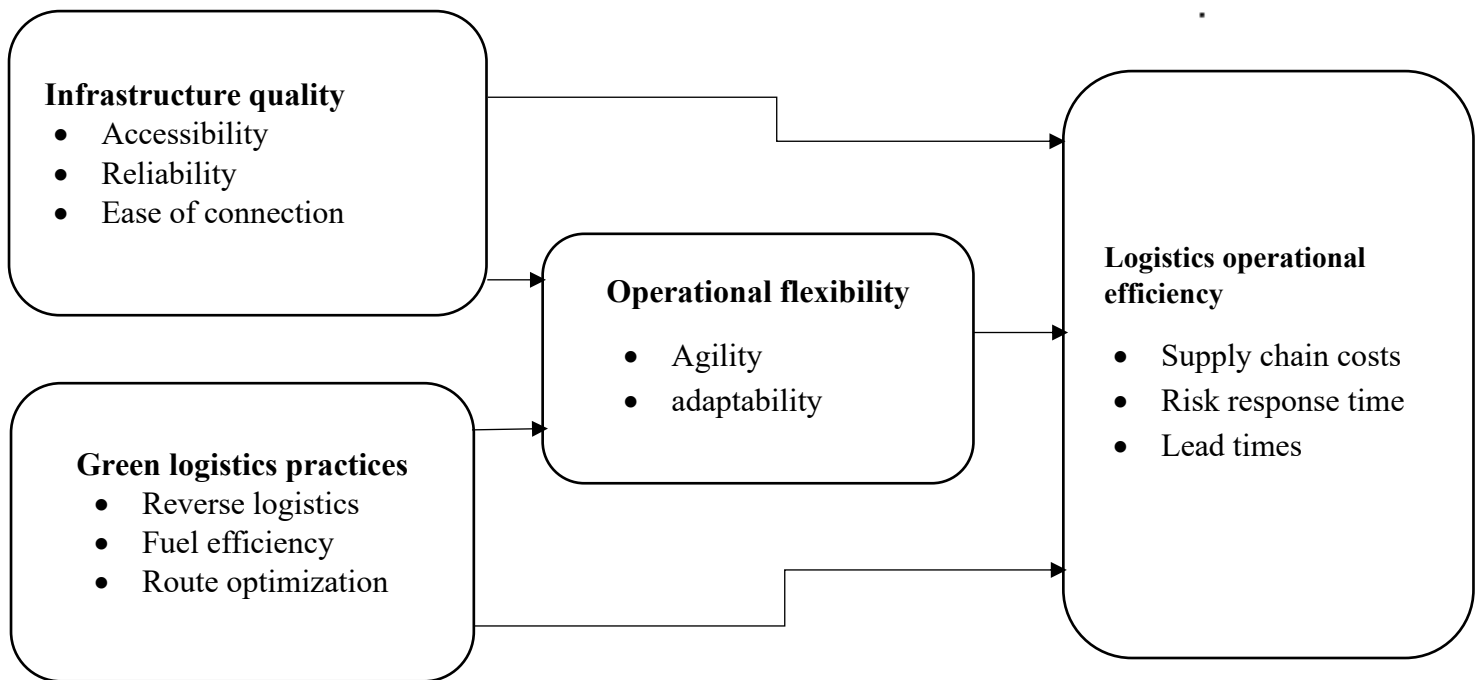


Figure 1.1: *A conceptual framework of green logistics, infrastructure quality, operational flexibility and logistics operational efficiency.*

Adopted from (Widiatmaka et al. 2024), (Mwangeka, 2020), (Huo et al. 2021) & (Stephen, 2024) and modified by the researcher.

Within this study, operational flexibility is positioned as the central mediating factor defined by agility (agility, or the capability to react promptly to disruptions) and adaptability (the ability to modify operations in response to shifting logistics needs) (Shi, 2025). Infrastructure quality is assessed through accessibility, reliability and ease of connection. This includes how easily delivery trucks reach major roads, how consistently power and internet services support warehouse operations and how smoothly goods transition between road and rail transport. Green logistics practices are structured around reverse logistics, fuel efficiency and route optimization involving activities such as collecting returned goods for reuse, maintaining vehicles to reduce fuel consumption and using route-planning tools to avoid congested areas and shorten delivery times (Mandal, 2024). Together, these elements influence logistics operational efficiency, which is measured through supply chain costs, risk

response time and lead times. In practice, delays caused by flooded feeder roads, poor coordination between transport modes or inefficient fuel use can increase costs and slow down deliveries. Similarly, firms that lack flexible scheduling or cannot reroute shipments during disruptions may struggle to meet customer expectations (Amico, 2023). The framework suggests that weaknesses in infrastructure, sustainability practices or operational adaptability can significantly hinder the performance of logistics firms in Uganda (Sénquiz-Díaz, 2021).

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter aims to review the relevant literature related to the study's key concepts, drawing insights from books, journal articles, periodicals, reports, dissertations and theses.

2.1 Theoretical framework

Various studies have used a variety of theories to gain a better understanding of the role of operating flexibility in mediating infrastructure quality, green logistics practices and logistics operational efficiency. This study will adopt the Resource-Based View (RBV) as its theoretical framework to explain logistics operational efficiency in the following manner.

2.1.1 Resource-Based View Theory.

The Resource-Based View (RBV) is a strategic management theory initially developed in the early 1990s (Barney, 1991). The Resource-Based View (RBV) posits that firms can attain long-term competitive advantage by effectively utilizing distinctive internal resources and capabilities. These encompass organizational knowledge, managerial expertise, integrated operational systems and physical infrastructure. In the supply chain context, adopting Green Logistics Practices and ensuring robust infrastructure are considered critical resources that can enhance operational performance and efficiency (Chae et al. 2014). Firm resources are typically understood as the assets and capabilities that enable an organization to perform activities and implement strategies that enhance its efficiency and effectiveness. These resources can be tangible, such as vehicles, warehouses and other physical infrastructure or intangible, including specialized equipment, skilled workforce, organizational knowledge, brand reputation and financial capital. The distinctiveness and strategic significance of these internal resources allow firms to differentiate themselves from competitors and achieve superior performance, serving as the cornerstone for sustained competitive advantage in a

competitive market (Abushaikha, 2014). The Resource-Based View (RBV) theory is relevant to this study as it highlights the importance of internal resources such as Green Logistics Practices and infrastructure quality in creating competitive advantage and improving logistics operational efficiency.

2.2 Conceptual review.

This study reviewed infrastructure quality, green logistics practices, operational flexibility and logistics operational efficiency of Ugandan logistics firms.

2.2.1 Logistics operational efficiency.

Logistics operational efficiency refers to the degree to which a firm's daily logistics activities are carried out smoothly, effectively and in a cost- and time-efficient manner (Burity, 2021). The capability to move goods rapidly, safely, cost-effectively and reliably is seen as critical to a firm's success and as a driver for achieving globalization objectives, as it enhances the overall operational efficiency of logistics operations (Elemo et al. 2023) It is important to recognize that logistics operational efficiency is vital for any firm, as it entails optimizing processes such as transportation and inventory management to ensure timely and cost-effective delivery of goods. Operational flexibility is equally critical, allowing logistics systems to swiftly respond to shifts in demand, supply interruptions or performance challenges without causing significant delays or additional costs. By incorporating flexibility, firms can improve responsiveness, reduce risks and maintain both efficient and resilient logistics operations (Fekanandu, 2024). Understanding the link between logistics operations and a firm's overall performance allows organizations to pinpoint areas for improvement, such as optimizing delivery routes, implementing efficient inventory management strategies and adopting digital solutions. These measures help enhance operational efficiency while maintaining cost-effective logistics processes (Al Zadajali &

Ullah, 2024). Many firms have adopted green strategies to tackle environmental challenges within their supply chains. Research consistently shows that implementing Green Logistics Practices positively influences a firm's operating costs, often leading to greater cost efficiency (Bahru, 2024). The quality of port infrastructure has a positive effect on the logistics operational efficiency (Munim & Schramm, 2018). Operational flexibility is a critical capability that enables firms to enhance efficiency, build competitiveness and sustain long-term performance (Uddin, 2022).

2.2.1.1 Supply chain costs

Cost refers to the resources that are consumed or sacrificed to acquire a good or service (FÜLÖP, 2017). Manufacturing, administration, warehouse, distribution, capital and installation are key to logistics efficiency. Optimizing manufacturing reduces lead times, while streamlining administration improves decision-making. Efficient warehouse management minimizes delays and smart distribution strategies cut transportation costs. Managing capital investments in technology boosts resource utilization and optimizing installation processes lowers on-site costs and improves service. Taken together, these advancements contribute to a more responsive, agile and cost-efficient supply chain, enabling firms to adapt more effectively to market fluctuations (Pettersson & Segerstedt, 2013). It is suggested that the use of real-time information, interconnectivity and emerging technologies will transform food logistics by enhancing efficiency. This transformation holds significant potential to enhance transparency, facilitate faster and more cost-effective deliveries, increase operational flexibility and ensure the timely distribution of high-quality products to the right destinations (Salonitis, 2021).

2.2.1.2 Risk response time

Supply chain risks can prevent companies from reaching operational excellence, which is achieved by optimizing systems, minimizing costs and enhancing speed (Wang et al. 2020). Logistics companies face a wide range of risks that can disrupt operations and affect performance outcomes. According to the International Organization for Standardization (ISO 31000), risk is defined as the effect of uncertainty on objectives and can be understood as the interaction between the potential consequences of an event and the likelihood of its occurrence. In the logistics context, key risks typically arise from economic, technological or IT-related, social, environmental and legal or political factors, all of which can influence the efficiency and reliability of logistics operations (Kavka, 2020). The more complex the logistics processes, the higher the likelihood of encountering risks that could disrupt operations. These risks, if not effectively managed, can hinder logistics operational efficiency by causing delays, increasing costs, and reducing the ability to meet customer demands. Therefore, streamlining and simplifying logistics processes is crucial to minimizing risks and maintaining optimal operational efficiency (Wee et al., 2017). Logistics companies face numerous challenges, ranging from transportation delays and supply chain disruptions to natural disasters and security threats. To maintain operational efficiency, these challenges must be addressed through proactive and systematic risk and crisis management strategies. Effectively managing such risks is crucial for sustaining a competitive advantage, ensuring business continuity and promoting long-term sustainability within the logistics sector (Mizrak, 2023).

2.2.1.3 Lead times

Lead time (LT) is a critical factor in product delivery and serves as a key parameter influencing all supply chain (SC) partners. Variability in lead times can significantly disrupt the performance of the entire supply chain, making the reduction of lead time fluctuations

essential for enhancing inbound logistics efficiency. Since logistics is tasked with ensuring timely deliveries and meeting location-specific commitments, effectively managing lead time is fundamental to achieving overall logistics success. Lead time (LT) is a critical factor in product delivery and serves as an important metric affecting all supply chain (SC) partners. Fluctuations in lead times can have significant repercussions throughout the entire supply chain, making the reduction of lead time variability essential for enhancing inbound logistics performance. Given that logistics is responsible for ensuring timely deliveries and fulfilling location-based commitments within the supply chain, effective management of lead time is fundamental to achieving overall logistics efficiency and success (Ndubi, 2016).

Extended lead times can be detrimental when responding to supply chain disruptions. Without real-time notifications of such events, the replenishment lead time from upstream suppliers may cause delays in addressing the disruption. This lag is particularly critical for downstream customers, as it limits their ability to effectively mitigate the impact of the disruption. Prompt responses are therefore essential to minimizing adverse effects on the supply chain and maintaining continuity in customer service (Chang & Lin, 2019). Financial performance measures should support managerial decision-making and be easy to interpret. One widely used approach for linking operational performance to financial outcomes is the DuPont model, which employs Return on Investment (ROI) as an accounting-based measure of profitability. ROI is straightforward, widely recognized and has been applied in studies examining the relationship between lead time and financial performance (Fredrik Tiedemann, 2021).

2.2.2 Infrastructure quality.

The term “infrastructure” originates from Latin, where “infra” means foundation or base, and “structure” refers to the arrangement of elements, making it broadly applicable across

scientific and non-scientific fields to describe the underlying framework that supports a system or organization (Skorobogatova & Kuzmina-Merlino, 2017). Infrastructure quality is commonly evaluated through three main aspects: accessibility, which measures how easily firms can reach services like electricity, water, roads or ports; ease of connection, which reflects the time and cost to obtain these services; and reliability, which captures the frequency and duration interruptions (Trang & Hong, 2021).

2.2.2.1 Accessibility

The accessibility reflects the subjective experience of how effectively individuals believe they can access key services, goods or destinations, highlighting the personal perception of the ease as discussed as Friman et al. (2020) and reliability of the logistics system in supporting their daily activities and choices (Friman et al. 2020). Accessibility reflects how well a city is connected within the transport network, which is crucial for logistics efficiency. Transport infrastructure is classified as point infrastructure for example airports and network infrastructure, for example, railways. Accessibility to point infrastructure is typically measured by travel time to the nearest facility, while network infrastructure accessibility is assessed via shortest travel times between cities (Jiao et al. 2020).

Improved accessibility through enhanced transport infrastructure directly contributes to logistics operational efficiency by reducing travel times, lowering transportation costs and enabling faster, more reliable delivery of goods. This "time-space convergence" allows for leaner supply chains, better inventory management and supports just-in-time logistics models. However, accessibility benefits are unevenly distributed, often favoring major cities with strong transport links while peripheral regions lag, creating spatial imbalances that logistics operations must navigate. The use of Geographic Information Systems (GIS) to analyze accessibility provides valuable insights for optimizing distribution networks,

locating warehouses, and planning efficient routes. As European infrastructure continues to evolve, aligning logistics strategies with accessibility improvements becomes crucial for enhancing performance, competitiveness and regional economic integration (Gutiérrez et al. 1998). Barrier effects negatively impact accessibility and are closely linked through shared components like transport systems, land use and individual factors. Accessibility frameworks provide a basis for measuring these effects. In logistics, this enables the identification of inefficiencies and supports planning efforts to improve the flow of goods and services (van Eldijk et al. 2020).

2.2.2.3 Ease of connection.

Enhancing connectivity for manufacturing growth relies on well-developed infrastructure, efficient regulatory frameworks, and strong coordination among stakeholders, all of which are fundamental to improving logistics operational efficiency. Connectivity, in this context, refers to the economic linkages between cities, islands and regions, enabling smoother movement of goods and services across geographic boundaries. Promoting investment in both physical infrastructure (such as transport networks and warehousing) and soft infrastructure (such as policies, regulations and digital systems) is essential to streamline logistics operations and boost overall supply chain performance (Prus & Sikora, 2021). Improving transport connectivity is increasingly vital in international trade research and transport policy, as it enhances the efficiency, reliability and competitiveness of global supply chains (Li et al. 2023). Capacity, speed, time and travel-related activities are key factors that determine the connectivity index of intersections by influencing traffic flow, efficiency and overall movement through the intersection (Kumar et al. 2017).

2.2.2.4 Reliability

Infrastructure systems are vital assets for modern businesses, and their reliable operation is

crucial for nations, as any failure can severely affect security, the economy, public health, safety or a combination of these critical areas (Peng, 2022). Infrastructure quality directly affects logistics operational efficiency, as reliable, timely and high-quality services are essential for smooth goods movement. In global markets, higher reliability standards are crucial, and improving infrastructure performance helps minimize delays, reduce costs and enhance competitiveness (Proag, 2021). Reliability is closely linked to dependability and is widely recognized as a key attribute of an effective transport network. It is commonly defined as the likelihood that a system will carry out its intended function over a specific period under certain conditions. This definition emphasizes four main components: probability, function, time, and operating environment. In transport infrastructure, reliability is often assessed by comparing the number of trips completed to those scheduled. Hence, transport reliability refers to the capacity of a transport system to consistently deliver the expected level of service that users depend on to plan their activities. It is important to note that reliability indicators used to evaluate network quality can vary significantly (Fourie & Zhuwaki, 2017).

2.2.3 Green logistics practices

The logistics sector is under rising pressure to meet stricter environmental standards, mainly for two reasons. First, the expansion of freight transport has contributed significantly to congestion, safety concerns, and environmental pollution. Second, there is an increasing demand for more sustainable logistics practices across many countries. Consequently, businesses are increasingly adopting a diverse range of green logistics (GL) initiatives (Vienazindienė et al. 2021). Logistics significantly contributes to environmental pollution and the overuse of resources within supply chains, making it a key area for sustainability interventions (Agyabeng-Mensah et al. 2020). Green logistics practices including green packaging, fuel efficiency measures, carbon emission assessments, route optimization and

reverse logistics are increasingly adopted for their environmental benefits and positive effects on logistics operations. Green packaging is particularly important for reducing solid waste, as packaging materials constitute approximately 33% of the waste stream, highlighting its role in minimizing an organization's carbon footprint. Improving fuel efficiency through regular vehicle maintenance, eco-driving practices and the adoption of alternative fuels such as compressed natural gas (CNG) and liquefied natural gas (LNG) supports both cost reduction and environmental sustainability. Eco-driving, reinforced through driver training and vehicle tracking systems, can reduce fuel consumption by up to 25% while enhancing operational safety and efficiency (Stephen, 2024).

2.2.3.1 Reverse Logistics

Reverse logistics refers to the process of planning, implementing, and controlling the flow of raw materials, in-process inventory, finished goods and related information from the point of consumption back to the point of origin (Nanayakkara et al. 2022). Reverse logistics focuses on recovering value from end-of-life products and properly managing non-recyclables. It includes activities like collecting, inspecting, sorting and processing returned items, as well as distributing them to facilities for appropriate treatment. This system aims to manage product flows from customers back to producers or recyclers for reuse or recycling (Sun et al. 2022). The growing consumption of goods, from food to electronics, has led to a rapid increase in global waste, posing both environmental challenges and potential economic value. Governments advocate for waste collection and recycling, but this process presents logistical issues, including high carbon emissions and the need for efficient transportation plans to manage the collection of valuable but costly waste (Sar & Ghadimi, 2023). The concept of reverse logistics is increasingly attracting interest in both academic and practical fields, as there is a growing focus on integrating environmental and economic considerations to improve the efficiency and effectiveness of reverse logistics operations

(Safdar et al. 2020). Over time, firms have embraced various environmental management strategies to optimize resource use, reduce waste, and align with societal expectations for environmental sustainability, while also seeking to lower sourcing-related costs (Saruchera & Asante-Darko, 2021). Product returns have been rising steadily (Nanayakkara et al. 2022). In certain instances, manufacturers and retailers are legally obligated to accept and recycle products at the end of their useful life. Reverse logistics networks for waste electrical and electronic equipment (WEEE) can be structured to minimize costs and environmental impact while ensuring compliance with regulatory requirement (Lai et al. 2022).

2.2.3.2 Fuel efficiency.

Logistics operations are highly energy-intensive and contribute to environmental degradation. Enhancing energy efficiency is vital for sustainability and is closely linked to operational efficiency. By increasing capacity utilization, logistics providers can reduce energy consumption per unit transported, streamline processes and improve overall operational efficiency (Wehner, 2018). Fleet managers report that fuel costs account for approximately 50% of the operating expenses of cargo and passenger vehicle fleets. To manage these costs, transport companies frequently utilize telematics systems to monitor vehicle performance and track fuel consumption alongside other operational parameters. The collected data enables managers to identify issues such as excessive fuel usage, abrupt braking, and maintenance requirements. Moreover, this information can be used to estimate the fuel consumption of cargo vehicles per kilometer on key regional routes, while also examining the influence of factors such as altitude, road gradient and vehicle age (Huertas et al. 2022). Strategies for improving fuel efficiency in freight transport focus on five key areas. First, shifting from high-emission modes like road transport to lower-carbon alternatives such as rail and inland waterways can significantly reduce emissions, though challenges like infrastructure limitations and flexibility concerns must be addressed. Second,

adopting greener technologies including electric and hybrid vehicles, autonomous driving systems and intelligent transport systems (ITS) can boost energy efficiency through optimized routing, eco-driving, and improved load management. Third, regulatory measures such as emission standards, carbon pricing, and financial incentives play a critical role in encouraging cleaner transport practices. Fourth, a structured roadmap approach, especially in regions like Asia-Pacific, involves setting national targets, conducting emissions assessments and integrating transport strategies into broader climate commitments. Lastly, advancing alternative fuels and modernizing infrastructure, including renewable energy integration and improved corridor connectivity, supports long-term sustainability and energy efficiency across the freight sector (René, 2024). Another strategy for enhancing fuel efficiency is the implementation of eco-driving techniques, which aim to reduce fuel consumption without compromising vehicle mobility. With proper driver training, fuel savings of up to 25% can be achieved. Companies can complement this approach with vehicle tracking systems to monitor driving behavior and fuel usage, enabling the identification of unnecessary or excessive vehicle use, unauthorized private use, poor driving practices, fuel wastage and instances of speeding or idling. Additionally, maintaining vehicles in a safe and efficient condition not only prolongs their operational lifespan but also improves performance and reduces the likelihood of accidents (Mutie et al. 2020).

2.2.3.3 Route Optimization

Route optimization involves efficiently coordinating a fleet of vehicles with fixed capacities to achieve the most effective solution, aiming to minimize the number of trips, total travel time, and the number of vehicles used. Environmentally responsible logistics companies enhance space utilization, plan more direct routes, reduce the number of shipments and handling operations, and shorten transportation distances (Mutie et al. 2020). The increasing demand for prompts delivery of both small and large shipments and transportation costs

have been consistently rising each year. In some instances, these costs have even exceeded the selling prices of products for certain merchants. Consequently, selecting the most efficient transportation method has become a vital strategy for controlling logistics costs. The Vehicle Routing Problem (VRP) has become a major concern in modern transportation, gaining more attention over time. The main objective of in-store delivery is to optimize vehicle usage and determine the most efficient driving route to ensure goods are delivered to customers in the shortest possible time (Xin et al. 2022) Telematics enhance route optimization through machine learning algorithms that adjust routes in real-time, saving fuel and improving efficiency. It offers customizable solutions, integrates with existing systems, and provides real-time alerts for ETAs, maintenance, and re-routes. The platform ensures secure mobile payments, tracks vehicle performance for safety, and monitors driver behavior to reduce accidents and insurance costs (Sharing & City, 2017)

2.2.3.3.1 Use of telematics

The use of telematics has been shown to significantly enhance route optimization in logistics by providing real-time information on vehicle location, traffic conditions and driver behaviour. By integrating GPS and sensor technologies, telematics systems allow fleet managers to analyse traffic patterns, monitor fuel consumption, and evaluate driving performance, thereby identifying the most efficient routes. This capability enables dynamic route adjustments based on current conditions, reducing travel time, fuel costs and the likelihood of delays. Real-time performance tracking ensures that vehicles follow the fastest and most cost-effective routes, ultimately improving logistics operational efficiency and ensuring timely deliveries (Wilde, 2018). Telematics infrastructure can also be integrated with existing supplier and customer relationship management systems, as well as operations support software like warehouse management systems. This integration enables the sharing of real-time information, enhancing coordination between suppliers, customers and logistics

operations. During pick-up and delivery, it provides value-added services such as tracking inventory levels, monitoring delivery status and optimizing delivery times. This seamless exchange of data improves operational efficiency, ensures better customer service and helps streamline supply chain management by providing accurate, up-to-date insights throughout the logistics process (Marentakis, 2021).

2.3 operational flexibility

(Tse-tung & War, 2000) define Logistics flexibility as the ability to rapidly respond to and accommodate changing demands for logistics resources. This definition is concise, clear and effectively captures the essence of flexibility within the logistics context. Flexible supply chains are known to have the ability to adapt quickly and effectively to changes in demand, supply conditions, or external disruptions without compromising performance, time, cost or effort. Key aspects include agility, which enables rapid short-term responses and adaptability, which allows long-term structural adjustments.

A flexible supply chain can better meet customer-specific requirements and handle variability across operations. This flexibility directly contributes to logistics operational efficiency by minimizing backorders, reducing lost sales and ensuring timely and reliable deliveries even during disruptions. It enables smoother coordination across supply chain functions, enhances responsiveness and reduces inefficiencies caused by manufacturing delays, supplier issues or transportation challenges. As a result, organizations can maintain high service levels while optimizing resource use and operational performance (Kurien & Qureshi, 2015).

2.4 Empirical Review

2.4.1 Infrastructure quality and logistics operations efficiency

Poor-quality infrastructure significantly constrains productivity and hampers firms' ability to integrate into markets and export their goods. In a sample of 26 African countries the quality of infrastructure particularly electricity and transport services has a statistically significant positive effect on firm productivity (Bbaale, 2018). The second most important behind electricity for output elasticity of firms meaning poor transport infrastructure raises costs and reduces output (Iimi, 2015). The better infrastructure connectivity enhances trade performance in the RCEP region (Netirith, 2022). Similarly, the Inter-American Development Bank (2021) highlights that reducing domestic transport costs via investments in paved roads, railways and waterways can significantly boost exports in Latin America and the Caribbean. These findings demonstrate that improved transport infrastructure contributes to shorter transit times, broader market accessibility and reduced transportation cost burdens, thereby enhancing logistics operational efficiency through timely deliveries, reduced lead times, and lower operational costs. In the context of third-party logistics (3PL) firms, this relationship is even more pronounced, as well-developed infrastructure and efficient transport systems enable service providers to ensure punctual deliveries, minimize vehicle idle time, and decrease overall transportation expenses factors that collectively strengthen operational efficiency. Similarly, evidence from oil marketing companies in Kenya indicates that transport, handling, storage and customs-clearing infrastructure all exert a positive influence on supply chain efficiency (Okitte, 2024). The road infrastructure is essential for a country's development from a logistics and economic perspective, emphasizing that improved roads lead to better logistics performance (Bayoumi, 2021). Therefore, building upon (Sénquiz-Díaz, 2021), one can hypothesize that quality infrastructure and efficient transport systems form a foundational enabler of logistics

operational efficiency, especially for 3PL firms that depend on timely, cost-effective freight movement, delivery reliability and supply chain responsiveness. However, premised to the above discussion we shall be compelled to hypothesize as follows.

H₁: A strong relationship exists between infrastructure quality and logistics operational efficiency.

2.4.2 Green logistics practices and logistics operations efficiency

logistics firms are key players in promoting the environmental sustainability as discussed by Kim et al. (2024) of the logistics industry since they are involved in the physical networks of the industry, also Blanco & Sheffi (2017) discuss that before logistics decisions have been driven by minimizing cost, maximizing profitability and achieving customer service targets however because of the global call for environmental consideration, firms are now also keen to reduce social and environmental impact of their operations. Thus, transporters are expected to reduce greenhouse gas emissions from their vehicles, warehouse managers have focused on waste and energy reduction strategies and products are redesigned to increase recyclability and reuse, which require different inventory planning needs in turn this leads or enables logistics firms spend less in terms of resources (costs) and also to ensure they have a low carbon foot print from their operations. However, premised to the above discussion we shall be compelled to hypothesize as follows.

H₂: Green Logistics Practices are significantly associated with logistics operational efficiency.

2.4.3 Infrastructure quality and operational flexibility.

Operational flexibility is a critical capability that enables firms to respond to external disruptions, such as sudden demand changes, supply delays or transportation breakdowns, without distorting normal operations (Mezher & El-Khalil, 2021). Firms with higher

operational flexibility can adjust schedules, reroute shipments and optimize resources, which not only minimizes service disruptions but also enhances overall efficiency, profit potential and customer satisfaction (Engineering et al. 2020). However, operational flexibility alone is often insufficient if the underlying infrastructure is poor. Quality transportation networks, including reliable roads, efficient freight corridors and modern warehousing facilities, facilitate the smooth movement of goods and people, enable access to global resources and reduce costs associated with delays, fuel and traffic congestion (World Bank, 2023).

The combination of high-quality infrastructure and operational flexibility creates a synergistic effect that drives logistics operational efficiency. Infrastructure provides the necessary physical and digital resources, while operational flexibility allows firms to leverage these resources effectively during disruptions (Merschmann, 2011). For example, firms operating along well-maintained corridors can reroute deliveries during congestion or emergencies, while those with advanced warehousing systems can adjust inventory flows rapidly in response to demand fluctuations. Consequently, logistics operational efficiency measured through timely deliveries, reduced operational costs and service reliability is maximized when infrastructure quality and operational flexibility are jointly considered (Hofer, 2021). Overall, the literature underscores that infrastructure quality and operational flexibility are complementary drivers of logistics performance. While infrastructure ensures the capability to move goods efficiently under normal conditions, operational flexibility enables firms to maintain efficiency under uncertainty and change. Together, they form a foundation for resilient, cost-effective and responsive logistics operations, particularly in developing economies where infrastructure limitations and frequent disruptions pose significant operational challenges (Agyabeng-Mensah et al. 2020).

H₃: Infrastructure quality is significantly linked to operational flexibility.

2.4.4 Green logistics practices and operational flexibility.

Green logistics practices, such as route optimization, eco-driving and reverse logistics, are essential tools for reducing resource consumption and improving operational outcomes. Route optimization, for example, involves coordinating the fleet to minimize total travel time and the number of trips, thereby reducing fuel costs, emissions and delivery delays, which collectively enhance logistics operational efficiency (Stephen, 2024). Similar findings have shown that optimizing routes and vehicle loads can significantly cut fuel usage and delivery times in developing economies where congestion and infrastructure constraints are common (Tetteh, 2024). When combined with the benefits of operational flexibility, green logistics practices further enhance logistics operational efficiency by allowing firms to adapt their sustainable operations under dynamic conditions. Operational flexibility enables firms to adjust routes, reschedule deliveries and reallocate resources when facing disruptions such as traffic congestion, fuel shortages or equipment breakdowns, ensuring consistent and reliable service delivery (Hofer, 2021). In Uganda, where logistics operations are frequently challenged by poor road conditions, urban congestion, and high transport costs, integrating flexibility into green logistics initiatives allows firms to achieve both sustainability and efficiency objectives (Agyabeng-Mensah et al. 2020). Empirical evidence suggests that firms adopting green logistics practices alongside flexible operational strategies achieve superior performance compared to those implementing sustainability measures in isolation (Acheampong, 2022). For instance, flexible scheduling and dynamic route optimization systems enable logistics firms to maintain timely deliveries even during disruptions, maximizing fuel efficiency and reducing operational costs (Ndichu, 2021). Therefore, the integration of green logistics practices with operational flexibility not only strengthens cost efficiency but also enhances the resilience and adaptability of logistics operations. This

finding supports the present study's conclusion that while green logistics practices directly improve logistics operational efficiency, their full impact is realized when supported by flexible operational systems and infrastructure that allow rapid adaptation to changing market or environmental conditions.

H4: Green Logistics Practices have a significant relationship with operational flexibility.

2.4.5 Infrastructure quality, green logistics practices, operational flexibility and logistics operational efficiency.

Operational flexibility is a critical capability that enables firms to respond to external disruptions, such as sudden changes in demand, supply delays, or transportation disruptions, without severely distorting normal operations (Kazancoglu, 2022). It allows firms to reroute shipments, reschedule deliveries, and optimize resources, thereby converting organizational capabilities into measurable performance gains (Ivanov, 2021). In the context of logistics, operational flexibility has been identified as a key mediating mechanism through which enabling resources, such as high-quality infrastructure and green logistics practices, translate into logistics operational efficiency (Cheng, 2024). From the resource-based view (RBV) perspective, firm-specific resources such as reliable roads, modern warehousing, ICT systems and sustainability initiatives constitute strategic assets that provide potential competitive advantage. However, the mere presence of these resources does not guarantee superior performance unless firms can dynamically leverage them under changing or disruptive conditions (Barney, 1991). Operational flexibility facilitates the effective utilization of these resources by allowing firms to adjust operations in response to congestion (Merschmann, 2011). It also enables firms to manage unexpected demand fluctuations or supply chain shocks effectively, which in turn enhances efficiency, reduces costs and improves service reliability (Hofer, 2021). Empirical studies have demonstrated that

infrastructure quality and green logistics practices alone positively influence logistics operational efficiency. However, their full impact often depends on the firm's operational flexibility. For example, flexible firms can exploit well-maintained transport networks to reroute deliveries during traffic congestion or optimize warehousing operations to respond to sudden demand changes (Cheng, 2024).

Similarly, green logistics practices such as eco-driving and reverse logistics improve efficiency primarily through direct effects (Khoa, 2025). However, their contribution to responsiveness is limited unless coupled with flexibility-enhancing systems and processes (Zhao, 2018).

Therefore, operational flexibility acts as a mediator, enabling firms to translate infrastructure and sustainability investments into higher logistics performance, particularly in volatile and resource-constrained environments like Uganda. Overall, the literature underscores that infrastructure quality and green logistics practices provide the foundation for efficient logistics operations, while operational flexibility functions as the linking mechanism that ensures these resources and practices are effectively deployed under changing conditions. Investigating this mediating role addresses an important theoretical and empirical gap and provides practical guidance for managers aiming to enhance resilience, adaptability and efficiency in logistics operations.

H₅: Operational flexibility serves as a mediating factor in the relationship between Green Logistics Practices, infrastructure quality and logistics operational efficiency.

2.5 Literature Gaps.

Despite the growing body of research examining logistics operational efficiency, green logistics practices, infrastructure quality, and operational flexibility, several important knowledge gaps remain.

First, most existing studies on logistics operational efficiency have been conducted in developed and emerging economies where infrastructure systems, digital technologies and institutional frameworks are relatively advanced. Consequently, there is limited empirical evidence from developing countries, particularly in Sub-Saharan Africa, where infrastructure deficits, regulatory inefficiencies, and market volatility pose unique challenges to logistics operations (Munim & Schramm, 2018). The contextual realities of Uganda characterized by inconsistent transport infrastructure, high fuel costs and low adoption of green logistics remain underexplored.

Second, while previous studies have demonstrated that infrastructure quality positively influences logistics performance, few have examined how different dimensions of infrastructure quality such as accessibility, reliability, and ease of connection individually and collectively affect logistics operational efficiency. The mechanisms through which these infrastructure elements contribute to efficiency improvements within third-party logistics firms remain insufficiently articulated (Bbaale, 2018).

Third, existing research on green logistics practices has largely focused on environmental performance outcomes, such as emissions reduction and resource conservation, rather than operational and strategic outcomes. Limited attention has been paid to how practices like fuel efficiency initiatives, route optimization and reverse logistics directly enhance operational flexibility and efficiency, especially in resource-constrained settings (Agyabeng-Mensah et al. 2020).

Fourth, although operational flexibility is recognized as a critical capability for improving firm performance, its mediating role in transforming resource-based assets such as infrastructure quality and green logistics practices into improved logistics operational efficiency remains underexplored. Few studies have empirically tested this mediating effect

within the logistics sector, particularly in developing economies where adaptability and resilience are vital for competitiveness (Kurien, 2015).

Fifth, prior research has often treated infrastructure quality, green logistics practices and operational flexibility as separate constructs, overlooking their potential interdependence and combined impact on logistics operational efficiency. An integrated model that considers these variables simultaneously, particularly through the Resource-Based View (RBV), is still lacking in empirical literature (Barney, 1991).

Lastly, methodological gaps exist in how logistics operational efficiency is measured. Many studies rely on broad financial indicators or generalized performance metrics, with limited focus on operational measures such as supply chain costs, risk response time and lead time. This limits the practical applicability of findings, especially for third-party logistics firms that depend on operational-level efficiency indicators for strategic decision-making (Al Zadajali, 2014).

The reviewed literature reveals a fragmented understanding of how infrastructure quality and green logistics practices interact through operational flexibility to influence logistics operational efficiency. This study therefore seeks to fill these gaps by empirically examining these relationships within Ugandan logistics firms, contributing to both theory and practice in sustainable and flexible supply chain management.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This chapter describes the research methodology used in the study, covering the design, target population, geographical scope, sample size and selection criteria, sampling methods, data collection tools and procedures, strategies for ensuring data quality, measurement of variables, data handling and analysis techniques, the data collection process and ethical considerations.

3.1 Research Design

The study adopted a cross-sectional survey design to examine the relationships between green logistics practices, infrastructure quality and logistics operational efficiency, with operational flexibility as a mediating factor. Data was collected using structured questionnaires from logistics firms in Kampala and Wakiso Districts. This design was appropriate because it allowed assessment of these relationships at a single point in time, providing a snapshot of logistics performance within Uganda's fast-evolving sector (Creswell, 2014). This design was also appropriate as it enabled systematic data collection, analysis and interpretation to support empirical conclusions in a business context (Saunders, 2019).

The study was purely quantitative, as it relied on numerical data to test hypotheses, identify patterns and establish the strength of relationships among variables objectively. A quantitative approach was suitable because it ensured precision, replicability, and statistical rigor in analyzing firm-level logistics practices. Descriptive statistics summarized respondent and firm characteristics, while correlation analysis and structural equation modeling (SEM) tested associations and mediation effects. SEM was particularly suitable

for analyzing multiple relationships simultaneously, enhancing the accuracy and explanatory strength of the findings (Hair, 2017).

3.2 Study Population

The study targeted a population of 223 logistics firms officially registered and operating within the Kampala Metropolitan Area, as documented by the (Uganda Revenue Authority, 2024). Key respondents within these firms included General Managers, Warehousing Officers, Transport Officers, and Quality, Health, and Safety (QHSE) Officers individually involved in strategic and operational decision-making. These roles were selected due to their practical engagement with logistics processes and sustainability initiatives. The unit of analysis was the individual logistics firm, reflecting the study's focus on firm-level practices and capabilities. Specifically, the research aimed to understand how operational flexibility within these firms mediates the relationship between green logistics practices, infrastructure quality and logistics operational efficiency.

3.3. Study population and Sample size determination.

The study population comprised 223 logistics firms registered and operating within the Kampala Metropolitan Area, as reported by the (Uganda Revenue Authority, 2024). To determine an appropriate sample size, (Yamane's, 1967) simplified formula was applied, which is suitable for survey research at a 95% confidence level and a 5% margin of error.

The formula is expressed as:

$$n = N / (1 + N(e)^2)$$

Where:

- n = required sample size
- N = total population size
- e = margin of error (commonly 0.05 for 95% confidence level)

Given

Population (N) = 223

Margin of error (e) = 0.05

Calculation

$$n = 223 / (1 + 223(0.05)^2)$$

$$n = 223 / (1 + 223(0.0025))$$

$$n = 223 / (1 + 0.5575)$$

$$n = 223 / 1.5575$$

$$n \approx 143.2 \text{ (logistics firms)}$$

Rounded to the nearest whole number, sample size for the study was 143 logistics firms.

This sample was considered sufficient to ensure representativeness and statistical reliability in analyzing the relationships among green logistics practices, infrastructure quality, operational flexibility and logistics operational efficiency.

3.4 Sampling Techniques

The study applied purposive sampling to select respondents who hold key roles in logistics operations, including general managers, warehousing officers, transport officers and QHSE officers, as these individuals possess relevant knowledge for the research (Cooper, 2014). To select firms, a systematic sampling technique was used. From the population of 223 registered logistics firms, the sample size of 143 was determined using Yamane's formula. The sampling interval was calculated as $223 \div 143 \approx 1.5$, rounded to every 3rd firm. After randomly choosing the first firm, every third firm on the list was included, resulting in 72 firms. Each firm provided at least three respondents, giving a total of 216 respondents. This approach ensured representation across the Kampala Metropolitan Area while maintaining efficiency in data collection. This approach ensured representation across the Kampala Metropolitan Area while maintaining efficiency in data collection. To minimize sampling bias, random selection of the first firm and adherence to the systematic interval helped

reduce the likelihood of over- or under-representation of any subgroup. Additionally, purposive selection of knowledgeable respondents ensured that the data collected was relevant and reliable (Etikan, 2015)

3.5 Data Sources

3.5.1 Primary Data

Primary data refers to information collected directly from respondents, making it original and specific to the research problem (Creswell, 2014). For this study, data were primarily collected from logistics firms located within the Kampala Metropolitan Area, focusing on Kampala Central and Wakiso Districts. Information was gathered through a structured questionnaire with closed-ended items, targeting key personnel such as general managers, transport officers, warehousing officers, and QHSE officers. This approach enabled the collection of first-hand, highly relevant data while ensuring consistency, accuracy and control over the quality of the responses.

3.5 Data Collection Method and Instrument

3.5.1 Data Collection Method

The study employed a questionnaire survey method. Questionnaires were administered to respondents based on their availability and preference. Data collection involved physical visits to engage General Managers, Warehousing Officers, Quality, Health, Safety and Environment (QHSE) Officers and Transport Officers. In total, 216 respondents participated in the study.

3.5.2 Data Collection Instrument.

The researcher used a structured, closed-ended questionnaire as the main instrument for the study, which contained a series of predetermined questions to gather information from the participants (Amin, 2005). The questionnaire was structured into five distinct sections, each

aligned with the key variables of the study: green logistics practices, infrastructure quality, operational flexibility, logistics operational efficiency and demographic and firm characteristics. Items within each section were measured using a 5-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). This scaling approach is commonly employed in logistics and organizational research to capture respondents' attitudes, perceptions and evaluations in a standardized and quantifiable manner (Likert, 1932)

3.6 Data Quality Control

To ensure the quality of the instrument, both validity and reliability were used.

3.6.1 Validity

Content validity refers to the degree to which the questionnaire adequately covers the key dimensions of the study (Middleton, 2019). This study focused on four core constructs: green logistics practices, infrastructure quality, operational flexibility and logistics operational efficiency. To ensure content validity, a pilot study was conducted with 25% of the target sample, allowing the researcher to identify and revise ambiguous or unclear items. Additionally, logistics experts, university supervisors and academic peers were consulted to evaluate the questionnaire items for relevance, clarity and comprehensiveness an approach grounded in expert judgment. Following data collection, confirmatory factor analysis was applied (Amin, 2005) to assess convergent validity, using Average Variance Extracted (AVE) as a key metric. All constructs exceeded the recommended AVE threshold of 0.50 (Hair, 2010), with green logistics practices (AVE = 0.606), infrastructure quality (AVE = 0.602), operational flexibility (AVE = 0.734), and logistics operational efficiency (AVE = 0.637), indicating that each construct explained more than half of the variance in its observed variables. Furthermore, the instrument demonstrated strong internal consistency, with

Cronbach’s alpha values of 0.92 for green logistics practices, 0.94 for infrastructure quality, 0.86 for operational flexibility and 0.97 for logistics operational efficiency all well above the acceptable threshold of 0.70. These results confirm that the instrument possessed both high content and convergent validity, making it robust and reliable for measuring the intended construct (Hair, 2010).

Table 3.1: Summary of Pilot Study and Content Validity Results

| Construct | Cronbach’s Alpha | Average Variance Extracted (AVE) | Pilot Study Sample Size | Remarks |
|----------------------------------|------------------|----------------------------------|-------------------------|--|
| Green Logistics Practices | 0.92 | 0.606 | 25% of target sample | <i>High internal consistency and acceptable convergent validity</i> |
| Infrastructure Quality | 0.94 | 0.602 | 25% of target sample | <i>Strong reliability and valid measurement of construct</i> |
| Operational Flexibility | 0.86 | 0.734 | 25% of target sample | <i>Reliable and demonstrates strong convergent validity</i> |
| Logistics Operational Efficiency | 0.97 | 0.637 | 25% of target sample | <i>Excellent internal consistency and valid construct representation</i> |

3.6.2 Reliability

Reliability is the level of internal consistency or stability of the measuring device over time, and when the instrument produces the same results (Saldaña, 2012). To ensure the consistency of the data collected, the reliability of the research instrument was assessed using both statistical measures and pilot testing procedures. Internal consistency reliability was evaluated using Cronbach’s Alpha, with a threshold of 0.70 or higher considered acceptable (Nunnally, 1978). Internal consistency reliability was also assessed in line with contemporary best practices in social science research (Field, 2013). Additionally, composite reliability was computed during the confirmatory factor analysis to complement Cronbach’s Alpha and provide more precise reliability estimates for each construct. (Hair, 2017) A pilot study was carried out with 25% of the target sample to refine the questionnaire and ensure clarity and consistency. Items that negatively affected overall reliability were either revised or removed. These measures helped ensure that constructs such as green logistics practices,

infrastructure quality, operational flexibility and logistics operational efficiency were measured consistently and reliably throughout the study.

3.7 Measurement of Variables

Table 3.2 outlines the measurement of the study variables, including their dimensions, operationalization, measurement scales, and sources. Green logistics practices are measured through reverse logistics, fuel efficiency and route optimization. Infrastructure quality is assessed via accessibility, reliability and ease of connection. Operational flexibility is captured through agility and adaptability, while logistics operational efficiency is measured by supply chain costs, risk response time and lead times. All variables use a 5-point Likert scale based on previous studies.

Table 3.2: Measurement of study Variables

| Study variable | Dimensions | operationalization | Scale | source |
|----------------------------------|---|--|----------------|---------------------------|
| Green Logistics practices. | <ul style="list-style-type: none"> •Reverse logistics •Fuel efficiency •Route optimization | <ul style="list-style-type: none"> • Managing returns • Fuel efficient operations • route optimization software | 5-point Likert | (Stephen, 2024) |
| Infrastructure quality | <ul style="list-style-type: none"> •Accessibility •Reliability •Ease of connection | <ul style="list-style-type: none"> • access to loading and unloading areas • Compliant infrastructure • Efficient connections between transport modes | 5-point Likert | (Widiatmaka et al., 2024) |
| Operational flexibility | <ul style="list-style-type: none"> •Agility •adaptability | <ul style="list-style-type: none"> • Quick response to uncertain conditions | 5-point Likert | (Huo et al., 2021) |
| Logistics operational efficiency | <ul style="list-style-type: none"> •Supply chain costs •Risk response time •Lead times | <ul style="list-style-type: none"> • Low cost, timely and risk responsive operations | 5-point Likert | (Mwangeka, 2020) |

3.8 Data Management and Analysis

Data management is the structured process of collecting, organizing, cleaning, storing and safeguarding data to ensure its accuracy, integrity and usability (Kothari, 2004). Following

data collection, the responses were systematically entered and organized using SPSS to ensure the dataset's accuracy and reliability. To address the research objectives and examine the relationships among the study variables hypothesis testing was employed. After conducting hypothesis testing, correlation analysis (r) was performed to verify the presence of significant associations between variables, a necessary condition for structural modeling. The structural modeling was then conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM), selected for its capability to simultaneously assess both direct and indirect relationships among the constructs.(Ramli, 2018). The PLS-SEM model was evaluated in terms of construct collinearity, the significance and relevance of path coefficients, explanatory power (R^2) and predictive relevance (Q^2) (Khan, 2019). To determine the significance of the relationships, bootstrapping with 5,000 subsample iterations was applied (Hair, 2017). Data preparation and preliminary analyses, including assessments of sampling adequacy and data suitability, were carried out using SPSS and Excel. The reliability and validity analysis, construct reliability and validity, correlation analysis, hypothesis testing, structural modeling and mediation analysis analyses were subsequently performed in SMARTPLS version 4.0.9.0, allowing for a comprehensive evaluation of both direct and mediating effects among the study variables (Dash, 2021). The results are first presented through reliability and validity assessments, followed by outputs displayed in tables and accompanied by detailed textual interpretations.

3.8.1 Correlation and Hypothesis testing Analysis

To test the hypothesized relationships among the study variables, Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed using SmartPLS software. This method was chosen due to its ability to handle complex models with multiple constructs and its robustness against non-normal data distributions, making it suitable for the study's sample size. The analysis involved two main stages: assessment of the measurement model

to ensure reliability and validity of the constructs, and evaluation of the structural model to test hypothesized relationships. Correlation among constructs was examined through path coefficients, while hypothesis testing was conducted using the bootstrapping procedure with 5000 resamples to generate t-values, p-values, and confidence intervals. Hypotheses were considered supported if the path coefficients were significant at $p < 0.05$ with t-values exceeding 1.96. This approach allowed for both the estimation of the strength and direction of relationships and the determination of the statistical significance of the hypothesized effects

3.8.3 Mediation Analysis

The research tested the mediating role of operational flexibility, and the study employed mediation analysis using structural equation modelling. Furthermore, the mediation effect was tested based on the bootstrapping method, which is a robust technique for detecting indirect effects.

3.9 Ethical Considerations

Ethical guidelines are essential for ensuring that research is conducted with integrity, protecting participants and adhering to legal and professional standards. In this study, ethical principles were observed at every stage of the research process including data collection, analysis, reporting, and dissemination with guidance from the supervisors to ensure compliance with accepted ethical standards (Creswell, 2014). Prior to commencing data collection, the researcher received approval from the supervisor, who confirmed that the data collection instrument complied with ethical standards. A formal letter of introduction was obtained from the School of Management and Entrepreneurship, fulfilling the requirements for ethical clearance. Additionally, official letters of introduction and permission were provided to all participating logistics firms, outlining the purpose of the study, its relevance,

the procedures involved, as well as potential risks and benefits. (Babbie, 2010). Participation in the study was entirely voluntary, and all respondents provided their informed consent prior to taking part. The study maintained strict adherence to ethical principles of anonymity and confidentiality, ensuring that neither participant names nor firm identities were disclosed in any reports or publications. Collected data were securely stored in password-protected computer files and locked metal cabinets, with access restricted to the researcher. The researcher expressed gratitude to all participants for dedicating their time to providing responses, and this appreciation was also acknowledged within the data collection instrument. To avoid plagiarism, all sources of information used throughout the study were properly cited, recognizing the contributions of previous researchers.

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION OF RESULTS

4.1 Introduction

This chapter presents, analyzes, and interprets the findings from the study questionnaire, focusing on the mediating role of operational flexibility in the relationship between green logistics practices, infrastructure quality, and logistics operational efficiency. It begins by describing the characteristics of the participating organizations and respondents and then proceeds to present the empirical results obtained from the study.

4.2 Response Rate

Table 4.1 presents the response rate achieved in this study. Out of the targeted 216 respondents drawn from 72 logistics firms, all 216 completed and returned the questionnaires, representing a 100% response rate. This high level of participation demonstrates strong commitment from the firms sampled and provides confidence in the reliability and representativeness of the data. Each firm contributed three respondents, ensuring diverse perspectives from key operational roles such as General Managers, Warehousing Officers, Transport Officers and QHSE Officers. The data were aggregated to the unit of analysis, the firm level, to reflect collective operational insights. Aggregating the data in this way allows the analysis to capture firm-level practices and outcomes rather than individual responses. The high response rate minimizes non-response bias and strengthens the validity of the findings, making them a credible reflection of logistics practices within the Kampala Metropolitan Area.

Table 4.1: Response Rate of Respondents

| Item | Details |
|----------------------------|---|
| Total Targeted Respondents | 216 |
| Total Logistics Firms | 72 |
| Respondents per Firm | 3 |
| Completed Responses | 216 |
| Response Rate (%) | 100% |
| Roles Represented | General Managers, Warehousing Officers, Transport Officers, QHSE Officers |

4.3 Background Characteristics of Firms and Respondents.

The background information was assessed by examining the characteristics of the firms and respondents, as outlined below.

4.3.1 Background Characteristics of Firms

The study engaged a diverse group of logistics firms and professionals operating within the Kampala Metropolitan Area. Most of the firms are well-established, with 34.7% having operated for over 20 years, indicating a mature logistics sector. In terms of ownership, sole proprietorships dominate, making up 45.8% of the sample. Most of these firms are small to medium-sized enterprises (SMEs), with 40.3% employing fewer than 50 staff members. On the individual level, the respondents reflect a youthful and educated workforce. Male participants accounted for 54.2%, and a significant 79.6% hold at least a university degree, showcasing a high level of academic qualification. Despite their youth, 68.9% are under 35 years old and many have substantial experience, with 69.9% having worked in their current organizations for 5 to 10 years. Respondents represented a range of operational roles. The most common were Transport Officers (25.9%), followed by a broad “Others” category (38.0%) that includes various logistics and supply chain professionals, ensuring a well-rounded perspective on industry practices.

Table 4.2:Organizational and Respondents' Characteristics.

| Variable | Category | F | % |
|--|---------------------|----------|----------|
| Number of years in existence | Less than 5 years | 6 | 2.8 |
| | 5 to 10 years | 51 | 23.6 |
| | 10 to 15 years | 54 | 25.0 |
| | 15 to 20 years | 30 | 13.9 |
| | Above 20 years | 75 | 34.7 |
| | Total | 216 | 100 |
| Gender | Male | 117 | 54.2 |
| | Female | 98 | 45.4 |
| | Other | 1 | 0.5 |
| | Total | 216 | 100 |
| Nature of the firm | Sole Proprietorship | 99 | 45.8 |
| | Partnership | 54 | 25.0 |
| | Joint Venture | 21 | 9.7 |
| | Corporation | 33 | 15.3 |
| | Others | 9 | 4.2 |
| | Total | 216 | 100 |
| Number of Employees | Less than 50 people | 87 | 40.3 |
| | 51–100 people | 33 | 15.3 |
| | 101–150 people | 27 | 12.5 |
| | 151–200 people | 21 | 9.7 |
| | Above 201 people | 48 | 22.2 |
| | Total | 216 | 100 |
| Age group | Less than 30 years | 77 | 35.6 |
| | 31–35 years | 72 | 33.3 |
| | 36–40 years | 44 | 20.4 |
| | 41–45 years | 16 | 7.4 |
| | Above 46 years | 7 | 3.2 |
| | Total | 216 | 100 |
| Level of Education | Diploma | 18 | 8.3 |
| | Degree | 172 | 79.6 |
| | Master's degree | 25 | 11.6 |
| | Others | 1 | 0.5 |
| | Total | 216 | 100 |
| Position in organization | General Manager | 36 | 16.7 |
| | Warehousing Officer | 23 | 10.6 |
| | QHSE Officer | 19 | 8.8 |
| | Transport Officer | 56 | 25.9 |
| | Others | 82 | 38.0 |
| | Total | 216 | 100 |
| Number of years working in organization | Less than 5 years | 37 | 17.1 |
| | 5–10 years | 151 | 69.9 |
| | 10–15 years | 21 | 9.7 |
| | 15–20 years | 7 | 3.2 |
| | Total | 216 | 100 |

Source: *Analysis of Descriptive Statistics of Primary data (2025)*

4.4 Reliability and Validity of Study Variables.

The results show that all study variables exhibit strong internal consistency, with Cronbach's alpha values exceeding the recommended threshold of 70% (Nunnally, 1978). The reliability of the study variables is also supported by established best practices in social science research (Hair, 2010). This indicates that the items used to measure each construct are closely related and reliable. Additionally, composite reliability scores for all constructs are above 0.7, further confirming the reliability of the measurement scales. The Average Variance Extracted (AVE) values are all above 0.5, which demonstrates good convergent validity meaning the items effectively capture the intended concepts (Fornell & Larcker, 1981). Overall, these results confirm that the tools used in the study are both reliable and valid, providing confidence in the accuracy and consistency of the data collected.

Table 4.3: Reliability and Validity of Study Variables.

| Study Variables | Cronbach's Alpha | Composite Reliability (rho_c) | Average Variance Extracted (AVE) |
|----------------------------------|------------------|-------------------------------|----------------------------------|
| Green Logistics Practices | 0.927 | 0.939 | 0.606 |
| Infrastructure Quality | 0.934 | 0.943 | 0.602 |
| Logistics Operational Efficiency | 0.942 | 0.950 | 0.637 |
| Operational Flexibility | 0.927 | 0.943 | 0.734 |

Source: PLS-SEM measurement model

4.4.1 Construct Reliability and Validity.

The results show that all items load strongly onto their respective constructs, with loadings above the recommended 0.7 threshold (Hair et al. 2010), confirming item reliability. Cronbach's alpha (ρ_a) and composite reliability (ρ_c) values also exceed 0.7, indicating high internal consistency across all constructs. Additionally, Average Variance Extracted (AVE) values range from 0.700 to 0.875, surpassing the 0.5 benchmark and demonstrating satisfactory convergent validity. Collectively, these findings confirm that the measurement model is both reliable and valid, making it appropriate for subsequent structural analysis.

Table 4.4: Construct Reliability and Validity.

| | | SIL | Cronbach's alpha | Composite reliability (rho_c) | extracted (AVE) |
|--------------------|----------------|-------|------------------|-------------------------------|-----------------|
| Fuel efficiency | GLP_FE1_mean | 0.875 | 0.847 | 0.907 | 0.766 |
| | GLP_FE2_mean | 0.913 | | | |
| | GLP_FE6_mean | 0.836 | | | |
| Reverse Logistics | GLP_RL1_mean | 0.878 | 0.862 | 0.906 | 0.706 |
| | GLP_RL2_mean | 0.837 | | | |
| | GLP_RL3_mean | 0.797 | | | |
| | GLP_RL5_mean | 0.847 | | | |
| Route Optimization | GLP_RO3_mean | 0.894 | 0.878 | 0.925 | 0.803 |
| | GLP_RO4_mean | 0.900 | | | |
| | GLP_RO5_mean | 0.895 | | | |
| Accessibility | IQ_A1_mean | 0.882 | 0.838 | 0.903 | 0.755 |
| | IQ_A3_mean | 0.873 | | | |
| | IQ_A4_mean | 0.852 | | | |
| Ease of Connection | IQ_EOC1_mean | 0.870 | 0.879 | 0.917 | 0.733 |
| | IQ_EOC2_mean | 0.835 | | | |
| | IQ_EOC4_mean | 0.856 | | | |
| | IQ_EOC7_mean | 0.864 | | | |
| Reliability | IQ_R2_mean | 0.877 | 0.870 | 0.912 | 0.721 |
| | IQ_R3_mean | 0.842 | | | |
| | IQ_R4_mean | 0.859 | | | |
| | IQ_R6_mean | 0.816 | | | |
| Lead Time | LOE_LT1_mean | 0.859 | 0.840 | 0.904 | 0.758 |
| | LOE_LT5_mean | 0.857 | | | |
| | LOE_LT7_mean | 0.896 | | | |
| Response Time | LOE_RST1_mean | 0.900 | 0.824 | 0.895 | 0.740 |
| | LOE_RST5_mean | 0.818 | | | |
| | LOE_RST7_mean | 0.860 | | | |
| Supply Chain costs | LOE_SCCI1_mean | 0.884 | 0.891 | 0.921 | 0.700 |
| | LOE_SCCI2_mean | 0.878 | | | |
| | LOE_SCCI3_mean | 0.860 | | | |
| | LOE_SCCI6_mean | 0.819 | | | |
| | LOE_SCCI7_mean | 0.732 | | | |
| Adaptability | OF_AD1_mean | 0.935 | 0.857 | 0.933 | 0.875 |
| | OF_AD2_mean | 0.936 | | | |
| Agility | OF_AG1_mean | 0.879 | 0.882 | 0.919 | 0.739 |
| | OF_AG4_mean | 0.797 | | | |
| | OF_AG6_mean | 0.881 | | | |
| | OF_AG7_mean | 0.879 | | | |

Key: Standardized Item loadings (SIL); Cronbach's alpha (); Composite reliability (rho_c); Average variance extracted (AVE).

Source: PLS-SEM measurement model

4.4.2: Discriminant reliability and validity.

Before testing the study hypotheses, the measurement model was assessed for reliability and validity. All constructs exhibited high internal consistency, with Cronbach's alpha and composite reliability (ρ_c) values exceeding the recommended 0.7 threshold, indicating reliable measurement of the underlying variables. Convergent validity was also established,

as the Average Variance Extracted (AVE) values ranged from 0.606 to 0.875, surpassing the 0.50 benchmark. Discriminant validity was confirmed using the Heterotrait-Monotrait (HTMT) ratio, with all values below the 0.90 threshold, demonstrating that the constructs are empirically distinct. Overall, these results confirm that the measurement instruments for green logistics practices, infrastructure quality, logistics operational efficiency and operational flexibility are both reliable and valid, supporting their use in subsequent structural analyses.

Table 4.5: Discriminant Reliability and Validity.

| | Heterotrait-monotrait ratio (HTMT) - Matrix | | | |
|----------------------------------|---|------------------------|----------------------------------|-------------------------|
| | Green Logistics Practices | Infrastructure quality | Logistics Operatioanl Efficiency | Operational Flexibility |
| Green Logistics Practices | | | | |
| Infrastructure quality | 0.772 | | | |
| Logistics Operatioanl Efficiency | 0.782 | 0.900 | | |
| Operational Flexibility | 0.609 | 0.824 | 0.876 | |

Source: PLS-SEM measurement model

4.5 Correlations Analysis.

The correlation matrix shows that all study variables are positively related, indicating mutually reinforcing relationships. Green logistics practices are strongly correlated with infrastructure quality ($r = 0.730$) and logistics operational efficiency ($r = 0.739$) and moderately with operational flexibility ($r = 0.579$), suggesting that adopting sustainable logistics practices tends to improve infrastructure, efficiency and flexibility. Infrastructure quality exhibits very strong positive correlations with logistics operational efficiency ($r = 0.846$) and operational flexibility ($r = 0.772$), highlighting its central role in supporting effective and adaptable logistics operations. Additionally, logistics operational efficiency and operational flexibility are highly correlated ($r = 0.819$), emphasizing that flexible operations are closely linked to efficient performance. Overall, these results indicate that improvements in one area are generally associated with enhancements in the others,

supporting the theoretical premise that operational flexibility may mediate the effects of green logistics practices and infrastructure quality on logistics operational efficiency.

Table 4.6: Correlation Matrix of Study Variables

| Study Variables | 1.000 | 2.000 | 3.000 | 4.000 |
|--------------------------------------|-------|-------|-------|-------|
| Green Logistics Practices (1) | 1.000 | | | |
| Infrastructure quality (2) | 0.730 | 1.000 | | |
| Logistics Operational Efficiency (3) | 0.739 | 0.846 | 1.000 | |
| Operational Flexibility (4) | 0.579 | 0.772 | 0.819 | 1.000 |

4.6 Hypothesis testing results.

The structural equation modelling results reveal that green logistics practices (GLP) have a significant positive direct effect on logistics operational efficiency (LOE) ($\beta = 0.245$, $t = 2.647$, $p = 0.008$) but do not significantly influence operational flexibility (OF) ($\beta = 0.034$, $t = 0.229$, $p = 0.819$). In contrast, infrastructure quality (IQ) exerts a significant effect on both LOE ($\beta = 0.357$, $t = 5.028$, $p < 0.001$) and OF ($\beta = 0.746$, $t = 5.697$, $p < 0.001$), confirming its central role in driving logistics outcomes. Furthermore, OF significantly contributes to LOE ($\beta = 0.402$, $t = 4.315$, $p < 0.001$), underscoring its importance as an internal capability. Mediation analysis demonstrates that OF does not mediate the GLP–LOE relationship ($\beta = 0.014$, $t = 0.232$, $p = 0.817$), whereas it significantly mediates the IQ–LOE relationship ($\beta = 0.300$, $t = 3.057$, $p = 0.002$), highlighting the indirect pathway through which infrastructure enhances efficiency. The model’s explanatory power is strong, with R^2 values of 0.596 for OF and 0.812 for LOE, while predictive relevance ($Q^2 = 0.722$ for OF and 0.539 for LOE) confirms the model’s robustness. Overall, the findings suggest that while GLP enhances efficiency primarily through direct effects, IQ strengthens efficiency both directly and indirectly via OF, making it a pivotal enabler of logistics operational performance.

Table 4.7: Hypothesis testing result

| | B | μ | α | T stati | P values | Bca | f2 | VIF |
|----------------------------------|----------|-------------------|-----------|---------|----------|--------------|-------|-------|
| GLP -> LOE | 0.245 | 0.257 | 0.093 | 2.647 | 0.008 | 0.08;0.439 | 0.15 | 2.144 |
| GLP -> OF | 0.034 | 0.028 | 0.151 | 0.229 | 0.819 | -0.288;0.305 | 0.001 | 2.141 |
| IQ-> LOE | 0.357 | 0.351 | 0.071 | 5.028 | 0.000 | 0.202;0.484 | 0.193 | 3.519 |
| IQ -> OF | 0.746 | 0.753 | 0.131 | 5.697 | 0.000 | 0.516;1.034 | 0.644 | 2.141 |
| OF -> LOE | 0.402 | 0.396 | 0.093 | 4.315 | 0.000 | 0.179;0.546 | 0.347 | 2.474 |
| | B | μ | α | T stati | P values | | | |
| GLP -> OF -> LOE | 0.014 | 0.006 | 0.060 | 0.232 | 0.817 | -0.112;0.112 | | |
| IQ -> OF -> LOE | 0.300 | 0.301 | 0.098 | 3.057 | 0.002 | 0.123;0.501 | | |
| | B | μ | α | T stati | P values | | | |
| GLP -> LOE | 0.259 | 0.264 | 0.113 | 2.301 | 0.021 | 0.019;0.471 | | |
| GLP -> OF | 0.034 | 0.028 | 0.151 | 0.229 | 0.819 | -0.288;0.305 | | |
| IQ -> LOE | 0.657 | 0.652 | 0.100 | 6.546 | 0.000 | 0.460;0.862 | | |
| IQ-> OF | 0.746 | 0.753 | 0.131 | 5.697 | 0.000 | 0.516;1.034 | | |
| OF-> LOE | 0.402 | 0.396 | 0.093 | 4.315 | 0.000 | 0.179;0.546 | | |
| predictive criteria | R-Square | R-Square Adjusted | Q-Squared | | | | | |
| Operational Flexibility | 0.596 | 0.585 | 0.722 | | | | | |
| Logistics operational efficiency | 0.812 | 0.804 | 0.539 | | | | | |

KEY:

GLP-Green Logistics Practices

IQ-Infrastructure Quality

LOE-Logistics Operational Efficiency

OF-Operational Flexibility

4.6.1 Mediating test

The mediation results (Table 4.7) indicate that green logistics practices (GLP) have a significant positive direct effect on logistics operational efficiency (LOE) ($\beta = 0.245$, $t = 2.647$, $p = 0.008$; 95% BCa CI [0.08, 0.439]), confirming that environmentally sustainable operations enhance performance outcomes. However, GLP does not significantly influence operational flexibility (OF) ($\beta = 0.034$, $t = 0.229$, $p = 0.819$; 95% BCa CI [-0.288, 0.305]), implying that green practices improve efficiency through direct process optimization rather than flexibility enhancement.

Infrastructure quality (IQ), on the other hand, exerts a strong and statistically significant effect on both LOE ($\beta = 0.357$, $t = 5.028$, $p < 0.001$; 95% BCa CI [0.202, 0.484]) and OF ($\beta = 0.746$, $t = 5.697$, $p < 0.001$; 95% BCa CI [0.516, 1.034]), underscoring its foundational role in supporting operational effectiveness and adaptability. Furthermore, OF has a significant positive influence on LOE ($\beta = 0.402$, $t = 4.315$, $p < 0.001$; 95% BCa CI [0.179, 0.546]), demonstrating that flexibility acts as a critical internal capability that enhances responsiveness and efficiency. The mediation analysis further reveals that OF does not mediate the GLP–LOE relationship ($\beta = 0.014$, $t = 0.232$, $p = 0.817$; 95% BCa CI [-0.112, 0.112]), confirming that the influence of green logistics on efficiency is primarily direct. However, OF significantly mediates the IQ–LOE relationship ($\beta = 0.300$, $t = 3.057$, $p = 0.002$; 95% BCa CI [0.123, 0.501]), indicating an indirect pathway through which infrastructure enhances efficiency.

The total effect of IQ on LOE ($\beta = 0.657$, $t = 6.546$, $p < 0.001$; 95% BCa CI [0.460, 0.862]) reveals that approximately 40% of the total influence is mediated through OF, while 60% remains a direct effect. This pattern confirms partial mediation, meaning that infrastructure

quality improves efficiency both directly by reducing delays and costs and indirectly by enabling firms to dynamically adapt to disruptions through flexible operations.

The model exhibits strong explanatory and predictive power, with $R^2 = 0.596$ for OF and $R^2 = 0.812$ for LOE, indicating that the predictors explain 59.6% and 81.2% of the variance, respectively. The Q^2 values of 0.722 for OF and 0.539 for LOE demonstrate substantial predictive relevance and model robustness. Overall, the findings highlight that infrastructure investment not only enhances physical logistics performance but also strengthens adaptive capabilities, positioning it as a pivotal determinant of logistics operational efficiency in Uganda.

Structural model

The results indicate that infrastructure quality has a strong positive effect on operational flexibility ($\beta = 0.746$, $p < 0.001$), suggesting that reliable and accessible logistics infrastructure enables firms to respond effectively to dynamic market conditions (Sénquiz-Díaz, 2021). Operational flexibility, in turn, significantly influences logistics operational efficiency ($\beta = 0.402$, $p < 0.001$), confirming that firms with higher flexibility can better manage disruptions, optimize resource use and maintain timely deliveries, leading to superior operational outcomes (Yousuf, 2019). Additionally, infrastructure quality directly affects logistics operational efficiency ($\beta = 0.357$, $p < 0.001$), highlighting the role of tangible assets such as roads, warehousing facilities, and ICT systems in reducing costs, improving reliability, and enhancing delivery performance (Barney, 1991). Green logistics practices also show a significant, though smaller, direct effect on logistics operational efficiency ($\beta = 0.245$, $p = 0.008$), while their impact on operational flexibility is not significant ($\beta = 0.034$, $p = 0.819$), indicating that eco-friendly practices like route optimization, eco-driving, and reverse logistics enhance efficiency but may require complementary capabilities to influence flexibility (Tetteh, 2024). Overall, the findings

suggest that operational flexibility partially mediates the relationship between infrastructure quality and logistics operational efficiency and that robust infrastructure combined with flexible operations is crucial for achieving superior logistics performance, particularly in developing economies such as Uganda (Ainomugisha, 2025).

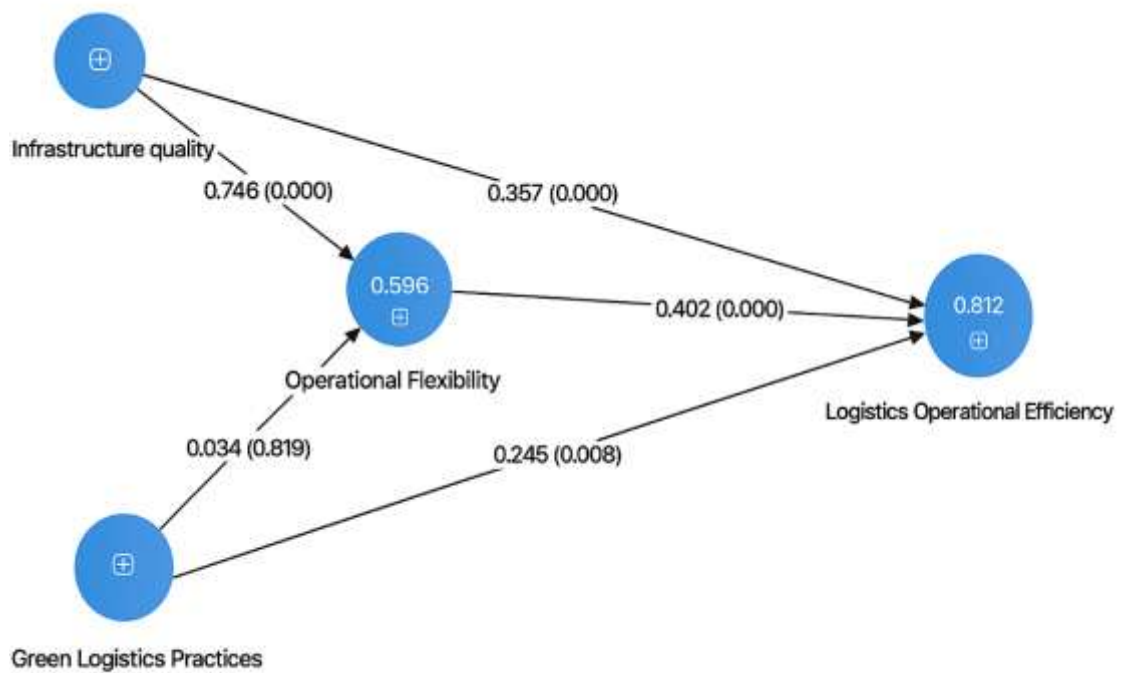


Figure 4.1: PLS-SEM for Logistics operational efficiency

Source: Extracted by Author after PLS-SEM Analysis

CHAPTER FIVE

SUMMARY, DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter provides a detailed discussion of the results in line with the study objectives and hypotheses and further draws conclusions, practical recommendations and suggestions for future research.

5.2 Summary of findings

The This study examined how operational flexibility influences the relationship between green logistics practices, infrastructure quality and logistics operational efficiency among Ugandan logistics firms. Data from 216 respondents across 72 firms mostly SMEs showed that infrastructure quality significantly improves both efficiency and flexibility, while green logistics practices enhance efficiency but do not affect flexibility. Firms which invested in modern warehousing and upgraded access roads to its plant, reported faster order fulfillment and the ability to reroute deliveries during seasonal floods, demonstrating how infrastructure boosts adaptability and performance. In contrast, firms adopting green practices such as fuel-efficient trucks and route optimization like Kampala-based courier companies using GPS systems to cut fuel costs saw improved delivery times and reduced expenses but did not gain notable flexibility. Mediation analysis confirmed that operational flexibility strengthens the link between infrastructure quality and logistics operational efficiency, but not between green practices and efficiency, highlighting infrastructure as a critical driver of logistics performance in Uganda.

5.3 Discussion of findings.

The study highlights that infrastructure quality is a key driver of logistics performance in Uganda, directly improving operational efficiency and enabling flexibility (Agyabeng-

Mensah et al. 2020). Well-developed infrastructure, including paved roads, modern warehouses and reliable transport networks, allows firms to move goods faster, adapt to market changes and handle disruptions (Baffour-Awuah, 2021). For example, companies operating near the Kampala–Entebbe Expressway report shorter delivery times and easier rerouting during traffic congestion (Agyabeng-Mensah et al. 2020). Green logistics practices, such as fuel-efficient vehicles, route optimization and reverse logistics, also enhance logistics operational efficiency by reducing costs and improving delivery speed (Khoa, 2025). However, these sustainability measures do not significantly improve flexibility, indicating that they help firms operate more efficiently but do not necessarily enable faster adaptation to changes (Hamal, 2025). Mediation analysis confirms that operational flexibility strengthens the relationship between infrastructure and logistics operational efficiency, but not between green logistics practices and efficiency (Sanyu, 2025). Overall, the findings emphasize that investing in high-quality infrastructure alongside sustainability initiatives is essential for achieving optimal logistics performance in Uganda (Baffour-Awuah, 2021).

5.4 Relationship between Study Variables.

In this chapter, the discussion of findings is organized according to the five research objectives. First, the relationship between infrastructure quality and logistics operational efficiency shows that well-developed infrastructure, including reliable roads and modern storage facilities, directly improves efficiency and enables firms to handle disruptions effectively (Agyabeng-Mensah et al. 2020). Second, the link between green logistics practices and operational efficiency indicates that sustainable measures such as fuel-efficient transport and route optimization enhance performance, primarily through direct effects (Khoa, 2025). Third, the relationship between infrastructure quality and operational flexibility confirms that robust infrastructure allows firms to adapt quickly to market

changes and supply chain shocks (Merschmann, 2011). Fourth, the connection between green logistics practices and operational flexibility reveals no significant impact, suggesting that sustainability initiatives improve logistics operational efficiency but do not enhance adaptability (Hamal, 2025). Finally, the mediating role of operational flexibility demonstrates that flexibility significantly mediates the effect of infrastructure quality on efficiency, but not the effect of green logistics practices, highlighting infrastructure as both a direct and indirect driver of logistics performance (Hofer, 2021).

5.4.1 What is the relationship between infrastructure quality and logistics operational efficiency in Ugandan logistics firms?

The study confirms that infrastructure quality significantly influences logistics operational efficiency among Ugandan logistics firms, with better roads, transport networks, and storage facilities enabling firms to operate more efficiently by reducing delays, lowering transportation costs, and improving service delivery (World Bank, 2023). This finding aligns with global evidence that well-developed transport and warehousing infrastructure enhances supply chain reliability and reduces logistics costs (von der Gracht et al. 2018). For instance, firms operating along the Kampala–Entebbe Expressway enjoy faster turnaround times and reduced costs, while those on the Kampala–Jinja corridor can handle urgent deliveries and reroute shipments efficiently during congestion (Namakula, 2024).

Modern warehousing facilities in Namanve Industrial Park support better inventory management and reduce emergency transport costs, while also enabling digital systems such as GPS tracking and automated warehousing for real-time route optimization (Ainomugisha, 2022). Conversely, poor rural infrastructure leads to delays and higher vehicle maintenance costs during rainy seasons, illustrating that infrastructure investment not only reduces

operational costs but also enhances competitiveness and national logistics performance (Ministry of Works and Transport, 2018).

5.4.2 What is the relationship between green logistics practices and logistics operational efficiency in Ugandan logistics firms?

The findings indicate that green logistics practices significantly improve logistics operational efficiency by lowering fuel costs, minimizing waste and enhancing delivery reliability (Agyabeng-Mensah et al. 2020). This supports evidence that sustainable logistics enhances both cost efficiency and environmental performance (Khoa, 2025). In Uganda, where firms face high fuel prices and traffic congestion, practices such as route optimization, eco-driving and reverse logistics yield measurable efficiency gains (Sanyu, 2025). For example, route planning software helps urban transport operators reduce idle time and fuel consumption, while distributors adopting reverse logistics recover packaging materials and minimize disposal costs. Some logistics providers also introduce fuel-efficient or hybrid vehicles to reduce emissions and operating costs (Acheampong, 2022). These results affirm that sustainability-oriented operations are not only environmentally beneficial but also strategically enhance efficiency and customer satisfaction (Zhao, 2018).

5.4.3 What is the relationship between infrastructure quality and operational flexibility in Ugandan logistics firms?

Infrastructure quality plays a critical role in enabling operational flexibility, allowing firms to reroute shipments, adjust schedules, and optimize resources during disruptions (Merschmann, 2011). Physical and digital infrastructure serve as key enablers of supply chain adaptability, enabling firms to respond quickly to changing conditions (Hofer, 2021). For example, firms operating near the Kampala–Jinja corridor can efficiently manage congestion or emergency orders, while those in industrial parks leverage advanced

warehousing to handle demand fluctuations (Agyabeng-Mensah et al. 2020). Conversely, poor infrastructure in regions such as Karamoja and West Nile limits adaptability and increases response times, illustrating that Uganda's logistics competitiveness depends not only on infrastructure availability but also on its reliability and integration across regions (Agyabeng-Mensah et al. 2020).

5.4.4 What is the relationship between green logistics practices and operational flexibility in Ugandan logistics firms.

The results indicate that green logistics practices have no significant effect on operational flexibility within Ugandan logistics firms. While these practices support cost reduction and environmental efficiency, they do not appear to enhance a firm's agility in responding to unexpected market or environmental changes (Hamal, 2025). This finding aligns with previous research showing that green practices often target efficiency rather than responsiveness (Agyabeng-Mensah et al. 2020). For example, route optimization reduces emissions and fuel usage but may not assist firms in managing unexpected disruptions such as road closures or supply delays (Khoa, 2025). These results highlight the need to complement sustainability initiatives with flexible planning, IT systems and real-time analytics to enhance supply chain responsiveness (Khoa, 2025).

5.4.5 Operational Flexibility as a Mediator between Green Logistics Practices, Infrastructure Quality, and Logistics Operational Efficiency.

The study found that operational flexibility serves as a partial mediator in the relationship between infrastructure quality and logistics operational efficiency but does not mediate the link between Green Logistics Practices and efficiency. This indicates that high-quality infrastructure not only directly reduces delays and operational costs but also allows firms to respond adaptively to emerging challenges (Agyabeng-Mensah et al. 2020). Firms with

access to modern roads and storage facilities can reroute shipments during floods or reschedule deliveries in response to market fluctuations, enhancing resilience and operational performance (Merschmann, 2011). On the other hand, Green Logistics Practices such as eco-transport and reverse logistics improve efficiency primarily through direct effects, rather than by increasing adaptability (Khoa, 2025). These results emphasize that Ugandan logistics firms can achieve the greatest performance gains by combining infrastructure investment with flexibility strategies, while sustainability initiatives should be integrated with adaptive systems to realize full operational resilience (Hofer, 2021).

5.5 Conclusion

This study investigated the relationships among green logistics practices, infrastructure quality, operational flexibility and logistics operational efficiency in Ugandan logistics firms, with particular focus on the mediating role of operational flexibility (Agyabeng-Mensah et al. 2020). Findings indicate that infrastructure quality is the strongest driver of performance, directly enhancing efficiency and indirectly supporting adaptability through operational flexibility (Merschmann, 2011). Firms with reliable roads, transport networks, and storage facilities can reduce delays, lower costs, and rapidly respond to disruptions such as seasonal floods or sudden demand fluctuation (Hofer, 2021). Operational flexibility significantly mediates the link between infrastructure and efficiency, underscoring infrastructure's critical role in enabling both speed and resilience (Liu, 2023).

Green logistics practices, including fuel-efficient transport, route optimization, and reverse logistics, improve efficiency by cutting costs and enhancing delivery reliability, but they do not significantly enhance flexibility (Khoa, 2025). These findings suggest that sustainability measures provide direct operational benefits rather than adaptability gains (Zhao, 2018). Overall, achieving optimal logistics performance in Uganda requires a dual strategy:

investing in high-quality infrastructure to enable efficiency and flexibility and implementing green logistics practices to deliver sustainable outcomes. These insights offer guidance to logistics managers and policymakers for building a competitive, resilient and environmentally responsible logistics sector that supports economic growth and sustainability.

5.6 Recommendations

Based on the findings of this study, several recommendations are proposed to enhance logistics operational efficiency and flexibility in Ugandan logistics firms. Upgrading and maintaining key transport corridors such as the Kampala–Masaka, Kampala–Jinja and northern Uganda routes should be prioritized by government and policymakers, as improved roads reduce delays, lower vehicle maintenance costs and enhance delivery reliability (Agyabeng-Mensah et al. 2020). Expanding warehousing capacity in industrial hubs such as Namanve and near border points enables firms to manage inventory efficiently and avoid emergency transport costs, while public-private partnerships can provide sustainable funding for these projects, ensuring long-term infrastructure improvements and resilience in logistics operations (World Bank, 2023).

Firms should also integrate sustainable logistics measures into daily operations to reduce costs and improve efficiency. The use of fuel-efficient or hybrid trucks on long routes can lower fuel consumption, minimize operating costs, and reduce vehicle breakdowns (Khoa, 2025). Implementing route optimization software enables firms to avoid urban congestion, plan deliveries during off-peak hours and reroute vehicles efficiently, saving time and fuel (Sorle, 2024). Reverse logistics systems allow firms to recover packaging materials and manage product returns, such as collecting reusable crates or bottles from retailers and redistributing them to production facilities, thereby reducing disposal costs and improving

customer satisfaction (Acheampong, 2022). These sustainable practices deliver operational benefits while strengthening competitiveness and supporting environmental objectives (Zhao, 2018).

Enhancing operational flexibility is crucial for logistics firms to respond effectively to disruptions such as seasonal floods or traffic congestion. Flexible scheduling, cross-trained staff, and adaptable routing strategies enable firms to adjust rapidly to changing conditions (Hofer, 2021). Real-time GPS tracking and dynamic routing tools support rerouting when roads are blocked, while journey management plans ensure trips are risk-assessed, routes are planned with contingencies and drivers are monitored for compliance (Ainomugisha, 2022). In-vehicle monitoring systems allow firms to track vehicle performance, monitor driver behaviour and optimize fuel consumption, with real-time alerts for harsh braking, speeding or route deviations (Liu, 2023). Combined with training programs and process redesigns, these systems equip employees to respond effectively to unexpected changes, improving resilience, service reliability and overall operational efficiency (Namakula, 2024).

Finally, government agencies such as the Ministry of Works and Transport should continue to prioritize road and bridge upgrades on high-traffic trade routes. Policies supporting sustainable logistics, including tax rebates or duty exemptions for eco-friendly fleets, will encourage firms to adopt green practices (World Bank, 2023). Continuous investment in transport infrastructure alongside incentives for sustainability will foster a competitive and resilient logistics sector that contributes to Uganda's economic growth. Implementing these recommendations in an integrated manner, combining infrastructure development, green logistics practices and operational flexibility, will help Ugandan logistics firms achieve optimal performance while supporting broader sustainability objectives (Khoa, 2025).

5.7 Limitations of Study

While this study provides meaningful insights into the linkages between green logistics practices, infrastructure quality, operational flexibility and logistics operational efficiency, it is not without limitations.

First, the research was confined to logistics firms in Uganda, which may restrict the extent to which the findings can be applied to other countries or regions with differing economic, regulatory and infrastructural conditions.

Second, the use of a cross-sectional survey design captured perceptions at only one point in time, limiting the ability to establish causal relationships or track changes across periods.

Third, the study relied on self-reported responses, which may be affected by issues such as social desirability bias or recall inaccuracies.

Fourth, the scope of the research was limited to a specific set of variables, leaving out other possible influences on operational logistics efficiency, including technological advancement, organizational culture and government policy. Lastly, although operational flexibility was examined as a mediating factor, other potential mediators or moderators such as supply chain collaboration or organizational learning were not considered.

5.8 Areas for Further Research.

Based on the limitations and findings of this study, several areas for future research are recommended. First, similar studies could be conducted in other countries or regions to examine whether the relationships among green logistics practices, infrastructure quality, operational flexibility and logistics operational efficiency hold in different economic and infrastructural contexts. Second, longitudinal research could be undertaken to assess how these relationships evolve over time and to better establish causal links. Third, future studies

could explore additional factors that may influence logistics operational efficiency, such as technological adoption, organizational culture, government policies or supply chain collaboration. Fourth, further research could investigate other potential mediators or moderators, such as organizational learning, innovation capacity or digitalization, to understand how these factors enhance efficiency and flexibility. Finally, qualitative research could complement quantitative findings by providing deeper insights into the challenges, strategies, and decision-making processes of logistics firms in implementing green practices and leveraging infrastructure.

REFERENCES

- Abushaikha, I. (2014). *Supply Chain Integration from a Resource-based View Perspective*. September, 1–328.
- Acheampong. (2022). Green logistics and firm competitiveness: Evidence from sub-Saharan Africa. *Journal of Cleaner Production*, 365, 132789.
- AfDB. (2023). *East Africa regional economic outlook: Accelerating trade and logistics integration*.
- Agyabeng-Mensah, Y., Afum, E., Acquah, I. S. K., Dacosta, E., Baah, C., & Ahenkorah, E. (2020). The role of green logistics management practices, supply chain traceability and logistics ecocentricity in sustainability performance. *International Journal of Logistics Management*, 32(2), 538–566. <https://doi.org/10.1108/IJLM-05-2020-0187>
- Ainomugisha. (2025). Towards implementation of green practices for environmental compliance by beverage-producing industries in Kampala, Uganda. *East African Journal of Environment and Natural Resources*, 8(1), 72–88.
- Ainomugisha, E. (2022). Information Technology Adoption, Supply Chain Integration and Logistics Performance. *A Case of Logistics Firms in Uganda (Master's Dissertation)*., 1(June), 540009. <https://doi.org/196.43.150.21>
- Al Zadajali. (2014). Measuring logistics operational efficiency through supply chain performance metrics. *A Case from the Gulf Region*. *Journal of Supply Chain Management and Logistics*, 14(2), 45–58.
- Al Zadajali, A., & Ullah, A. (2024). The Effectiveness of Logistics Services on Firms' Performances – A Literature Review. *American Journal of Economics and Business*

Innovation, 3(1), 125–132. <https://doi.org/10.54536/ajebi.v3i1.1744>

Amico. (2023). *Adapting to Disruptions: Flexibility as a Pillar of Supply Chain Resilience*. <https://doi.org/10.21203/rs.3.rs-2304052/v1>

Amin, M. (2005). Social science research. *Conception, Methodology and Analysis*.

Andrejić, M. M. (2013). Measuring efficiency in logistics. *Vojnotehnicki Glasnik*, 61(2), 84–104. <https://doi.org/10.5937/vojtehg61-1756>

Babbie, E. (2010). *The practice of social research*.

Baffour-Awuah. (2021). Infrastructure development and logistics performance in Africa. *Transport Policy*, 110, 83–95.

Bahru. (2024). *Effect of Green Logistics Management Practices on Operational Performance of Manufacturing Companies in Northern Nigeria*.

Barney. (1991a). Firm Resources and Sustained Competitive Advantage. *Journal of Management*, 17(1), 99–120. <https://doi.org/10.1177/014920639101700108>

Barney, J. B. (1991b). Firm resources and sustained competitive advantage. *Journal of Management*, 17(1), 99–120.

Barney, J. B., Ketchen, D. J., & Wright, M. (2021). Resource-Based Theory and the Value Creation Framework. *Journal of Management*, 47(7), 1936–1955. <https://doi.org/10.1177/01492063211021655>

Bayoumi. (2021). Road transport infrastructure and logistics performance. *A Research Agenda. International Business & Logistics Journal*, 1(2), 16–29.

Bbaale. (2018a). Infrastructure development and firm performance in Sub-Saharan Africa.

- Evidence from Uganda. African Development Review*, 30(3), 275–288.
- Bbaale. (2018b). Infrastructure quality and firm productivity in Africa. *West East Journal of Management and Social Development*, 14(4), 112–130.
- Blanco, E. E., & Sheffi, Y. (2017). *Green Logistics GHG Emissions by*.
<https://doi.org/10.1007/978-3-319-29791-0>
- Bowersox, C. (1996). Logistical management. *The Integrated Supply Chain Process*.
McGraw-Hill.
- Burity, J. (2021a). The Importance of Logistics Efficiency on Customer Satisfaction.
Journal of Marketing Development and Competitiveness, 15(3), 26–35.
<https://doi.org/10.33423/jmdc.v15i3.4537>
- Burity, J. (2021b). *The Importance of Logistics Efficiency on Customer Satisfaction*
American Military University. 15(3), 26–35.
- Chae, B. K., Olson, D., & Sheu, C. (2014). The impact of supply chain analytics on
operational performance: A resource-based view. *International Journal of Production
Research*, 52(16), 4695–4710. <https://doi.org/10.1080/00207543.2013.861616>
- Chang, W., & Lin, Y. (2019). Asia Pacific Management Review The effect of lead-time
on supply chain resilience performance. *Asia Pacific Management Review*, 24(4),
298–309. <https://doi.org/10.1016/j.apmr.2018.10.004>
- Chatzoudes, D., Kadłubek, M., & Maditinos, D. (2024). Green logistics practices: The
antecedents and effects for supply chain management in the modern era. In
Equilibrium. Quarterly Journal of Economics and Economic Policy (Vol. 19, Issue
3). <https://doi.org/10.24136/eq.2864>

- Cheng. (2024). Infrastructure, flexibility, and logistics performance in supply chains. *Evidence from Emerging Economies. Sustainable Logistics Journal*, 17(6), 2462.
- Chopra, S. (2016). Supply chain management. *Strategy, Planning, and Operation*, 6th edition.
- Christopher. (2016). Logistics and supply chain management. *Pearson Education*, 5th ed.
- Cooper, D. R. (2014). *Business research methods*. 12 edition.
- Creswell, J. (2014). Research design. *Qualitative, Quantitative, and Mixed Methods Approaches*, 4th editio.
- Creveld, M. (1997). Supplying war. *Logistics from Wallenstein to Patton*. Cambridge University Press.
- Dash, G. (2021). CB-SEM vs PLS-SEM methods for research in social sciences and technology forecasting. *Technological Forecasting and Social Change*, 173, Article 121092.
https://doi.org/https://doi.org/10.1016/j.techfore.2021.121092?utm_source=chatgpt.com
- Deming. (1986). Out of the crisis. *MIT Press*.
- Do, M. (2024). Infrastructure quality and logistics performance in developing economies: Evidence from Southeast Asia. *Transport Policy*, 150, 87–99.
- Drucker. (1962). The economy's dark continent. *Fortune*.
- Ekaba. (2014). Contribution of Transport Management to Logistics Efficiency of Armed Forces' Duty-Free Shops in Uganda. *A Case Study of Defence Forces Shop, Bombo*.

Master's Dissertation, Uganda Management Institute.

- Elemo, Z., Boson, L. T., & Kant, S. (2023). Effect of Logistics Management Practices on Organizational Performance: the Case of Borland Graphics Interface Manufacturing Company Hawassa Branch, Ethiopia. *Peer Reviewed and Refereed Journal*, 017(2), 12. <http://ijmer.in.doi./2023/12.02.41>
- Engineering, E., Engineering, A., Engineering, E., Engineering, A., & Science, C. (2020). Resilience metrics and measurement methods for transportation infrastructure: The state of the art Wenjuan Sun 1 , Paolo Bocchini 2* , and Brian D. Davison 3 1. *Sustainable and Resilient Infrastructure*, 5(3), 168–199.
- Etikan. (2015). Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics*, 5(1), 1–4. <https://doi.org/10.11648/j.ajtas.20160501.11>
- Fekanandu. (2024). Logistics Management and Operational Efficiency of Food and Beverage Firms in Port Harcourt. *African Journal of Economics and Sustainable Development*, 7(1), 111–122. <https://doi.org/10.52589/ajesd-9xm6nx0q>
- Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. London: SAGE Publications., 4th editio.
- Fourie, C. J., & Zhuwaki, N. T. (2017). A modelling framework for railway infrastructure reliability analysis. *South African Journal of Industrial Engineering*, 28(4), 150–160. <https://doi.org/10.7166/28-4-1763>
- Fredrik Tiedemann, J. W. and E. J. (2021). *Understanding lead-time implications for financial performance : a qualitative study*. 32(9), 183–207.

<https://doi.org/10.1108/JMTM-06-2020-0247>

Friman, M., Lättman, K., & Olsson, L. E. (2020). *Public Transport Quality , Safety , and Perceived Accessibility*.

FÜLÖP, A. (2017). *COSTS , EXPENSES AND PAYMENTS-CONCEPTUAL APPROACHES FÜLÖP ÁRPÁD - ZOLTÁN , LECTURER AT SAPIENTIA UNIVERSITY CLUJ-NAPOCA. July 2016.*

Grant. (1991). The resource-based theory of competitive advantage. *Implications for Strategy Formulation, California Management Review.*, 33(3), 114–135.

<https://doi.org/https://doi.org/10.2307/41166664>

Gutiérrez, J., Monzón, A., & Piñero, J. M. (1998). Accessibility, network efficiency, and transport infrastructure planning. *Environment and Planning A*, 30(8), 1337–1350.

<https://doi.org/10.1068/a301337>

Hair. (2010a). *Multivariate data analysis*.

Hair. (2017). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). 2nd editio.*

Hair, J. F. (2010b). *Multivariate data analysis. Upper Saddle River, NJ: Prentice Hall, 7th.*

Hamal. (2025). The impact of green logistics on supply chain efficiency and cost reduction. *Journal of Academic Advancement*.

Hart. (1995). A natural-resource-based view of the firm. *Academy of Management Review*, 20(4), 986–1014. <https://doi.org/https://doi.org/10.5465/amr.1995.9512280033>

Hofer. (2021). The effect of supply chain flexibility on operational performance.

International Journal of Operations & Production Management, 41(2), 132–152.

Huertas, J. I., Serrano-Guevara, O., Díaz-Ramírez, J., Prato, D., & Tabares, L. (2022). Real vehicle fuel consumption in logistic corridors. *Applied Energy*, 314, 118921.

<https://doi.org/https://doi.org/10.1016/j.apenergy.2022.118921>

Huo, B., Haq, M. Z. U., & Gu, M. (2021). The impact of information sharing on supply chain learning and flexibility performance. *International Journal of Production Research*, 59(5), 1411–1434. <https://doi.org/10.1080/00207543.2020.1824082>

Iimi. (2015). Firm productivity and infrastructure costs in East Africa. *World Bank Policy Research Working Paper No. 7278*.

Inter-American Development Bank. (2021). *Lower domestic transport costs are key to boosting exports in Latin America and the Caribbean*.

Ivanov. (2021). The impact of digital supply chain twins and operational flexibility on supply chain resilience. *Computers & Industrial Engineering*.

<https://doi.org/https://doi.org/10.1016/j.cie.2021.107240>

Jiao, J., Wang, J., Zhang, F., Jin, F., & Liu, W. (2020). Roles of accessibility, connectivity and spatial interdependence in realizing the economic impact of high-speed rail: Evidence from China. *Transport Policy*, 91(March), 1–15.

<https://doi.org/10.1016/j.tranpol.2020.03.001>

Kavka, L. (2020). *Risks associated with Logistics 4.0 and their minimization using Blockchain*. 74–85.

Kazancoglu. (2022). Flexibility, agility, and responsiveness in sustainable supply chains. *A Mediating Role Analysis. Sustainable Production and Consumption*, 31, 112–127.

<https://doi.org/10.1016/j.spc.2022.03.005>

- Khan. (2019). Methodological research on Partial Least Squares Structural Equation Modeling (PLS-SEM): *An Analysis Based on Social Network Approaches. Internet Research, 29(3), 407–429.*
- Khoa. (2025). Exploring the role of green organizational culture in enhancing sustainable logistics performance among manufacturing SMEs in a developing economy. *Discover Sustainability, 6, 1132.*
- Kim, D., Na, J., & Ha, H. K. (2024). Exploring the impact of green logistics practices and relevant government policy on the financial efficiency of logistics companies. *Heliyon, 10(10), e30916.* <https://doi.org/10.1016/j.heliyon.2024.e30916>
- Kothari. (2004). Research methodology. *Methods and Techniques.*
- Krishnan, R., Perumal, E., Govindaraj, M., & Kandasamy, L. (2024). Enhancing logistics operations through technological advancements for superior service efficiency. *Innovative Technologies for Increasing Service Productivity, March, 61–82.*
<https://doi.org/10.4018/979-8-3693-2019-8.ch004>
- Kumar, R., Parida, D. P., Madhu, D. E., & Kumar, A. V. A. B. (2017). Does Connectivity Index of Transport Network Have Impact on Delay for Driver? *Transportation Research Procedia, 25, 4988–5002.* <https://doi.org/10.1016/j.trpro.2017.05.377>
- Kurien. (2015). Supply chain flexibility: A systematic literature review and future research directions. *International Journal of Supply Chain Management, 4(1), 15–24.*
- Kurien, G. P., & Qureshi, M. N. (2015). Analysis and measurement of supply chain flexibility. *International Journal of Logistics Systems and Management, 21(1), 70–*

91. <https://doi.org/10.1504/IJLSM.2015.069078>

Kusi-Sarpong. (2019). A supply chain sustainability innovation framework and evaluation methodology. *International Journal of Production Research, 1990–2008.*, 57(7).

Lai, N. Y. G., Kuah, A. T. H., Kim, C. H., & Wong, K. H. (2022). Toward sustainable express deliveries for online shopping: Reusing packaging materials through reverse logistics. *Thunderbird International Business Review, 64*(4), 351–362.

<https://doi.org/10.1002/tie.22259>

Lee, C.-Y., & Johnson, rew. (2013). *Operational efficiency*. August, 17–44.

<https://doi.org/10.1201/b15964-5>

Li, W., Bai, X., Yang, D., & Hou, Y. (2023). Maritime connectivity, transport infrastructure expansion and economic growth: A global perspective. *Transportation Research Part A: Policy and Practice, 170*, 103609.

<https://doi.org/https://doi.org/10.1016/j.tra.2023.103609>

Liao. (2010). Supply management, supply flexibility, and performance outcomes. *An Empirical Investigation of Manufacturing Firms. Journal of Supply Chain Management, 46*(3), 6–22. <https://doi.org/10.1111/j.1745-493X.2010.03189.x>

Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology, 22*(140), 1–55.

Liu. (2023). Infrastructure investment and logistics performance: Evidence from developing economies. *Transportation Research Part E: Logistics and Transportation Review, 175*, 103080.

López-Mesa. (2020). Operational flexibility for sustainable logistics systems.

Sustainability, 12(3), 1201–1216.

Mandal. (2024). Implementation of AI Transportation Routing in Reverse Logistics to Reduce CO₂ Footprint. *International Journal of Supply Chain Management*, 9(5), 1-12. <https://doi.org/10.47604/ijscm.3079>

Marentakis, C. (2021). *Telematics for Efficient Transportation and Distribution of Agrifood Products*. June. <https://doi.org/10.1002/9781444339895.ch6>

Merschmann. (2011). Supply chain flexibility and firm performance. *A Study of the Relationship*. *International Journal of Production Economics*, 130(2), 318–327.

Mezher, M. A., & El-Khalil, R. (2021). The role of flexibility in enhancing operational performance through sustainability practices: A case study on the US and european original equipment manufacturers. *Proceedings of the International Conference on Industrial Engineering and Operations Management*, April, 1046–1059. <https://doi.org/10.46254/sa02.20210520>

Middleton, F. (2019). Reliability vs. validity. *What's the Difference?*

Ministry of Works and Transport. (2018). *National logistics policy*. Government of Uganda.

Mizrak, F. (2023). *Managing Risks and Crises in the Logistics Sector : A Comprehensive Analysis of Strategies and Prioritization Using AHP Method* *Lojistik Sektöründe Riskleri ve Krizleri Yönetmek : AHP ... MANAGING RISKS AND CRISES IN THE LOGISTICS SECTOR : A COMPREHENSIVE A*. October. <https://doi.org/10.54707/meric.1335033>

Munim, Z. H., & Schramm, H.-J. (2018). The impacts of port infrastructure and logistics

- performance on economic growth: the mediating role of seaborne trade. *Journal of Shipping and Trade*, 3(1). <https://doi.org/10.1186/s41072-018-0027-0>
- Mutie, M. D., Odock, S., & Litondo, K. (2020a). Green Logistics Practices and Firm Performance: The Mediating Effect of Economic Performance Among Logistics Firms in Kenya. *European Scientific Journal ESJ*, 16(25).
<https://doi.org/10.19044/esj.2020.v16n25p142>
- Mutie, M. D., Odock, S., & Litondo, K. (2020b). Green Logistics Practices and Firm Performance: The Mediating Effect of Economic Performance Among Logistics Firms in Kenya. *European Scientific Journal ESJ*, 16(25), 142–159.
<https://doi.org/10.19044/esj.2020.v16n25p142>
- Mwangeka. (2020). *Supply Chain Visibility and Operational Performance of Logistics Firms in Mombasa County, Kenya Richard Mwambi Mwangeka a Research Project Submitted in Partial Fulfilment of the Requirements for the Degree of Master of*.
- Mwesigwa. (2019). Transport infrastructure development and trade facilitation in Uganda. *African Journal of Economic Review*, 7(2), 123–140.
- Namakula. (2024). Transportation management systems and freight cost reduction in Uganda. *International Journal of Supply Chain and Logistics*.
- Nanayakkara, P. R., Jayalath, M. M., Thibbotuwawa, A., & Perera, H. N. (2022). A circular reverse logistics framework for handling e-commerce returns. *Cleaner Logistics and Supply Chain*, 5(August), 100080.
<https://doi.org/10.1016/j.clscn.2022.100080>
- Ndichu. (2021). Infrastructure and supply chain responsiveness in East Africa. *African*

Journal of Logistics and Supply Chain Management, 5(2), 34–48.

Ndubi, S. O. (2016). *EFFECT OF LEAD TIME VARIABILITY ON INBOUND LOGISTICS PERFORMANCE IN SAFARICOM LIMITED*. 2(2), 179–205.

Netirith. (2022). Efficiency of transport infrastructure connectivity and trade in the RCEP region. *Sustainability*, 14(15), 9613.

Nicoletti, B. (2024). Infrastructure resilience and sustainability in logistics: A strategic approach. *Journal of Transport Infrastructure Management*, 10(1), 45–62.

Nunnally, J. (1978). *Psychometric theory*. New York: McGraw-Hill, 2nd editi.

Oketch. (2025, November 3). Transport and logistics comprise between 35 percent and 42 percent of production costs in Uganda, says report. *Daily Monitor*.

Okitte. (2024). Logistics infrastructure and supply efficiency of petroleum products in Kenya. *Strategic Journal of Business & Change Management*, 11(1), 45–62.

https://strategicjournals.com/index.php/journal/article/view/2891?utm_source=chatgpt.com

Ouma, O. P. (2021). *Logistics Management Practices and Operational Performance of Online Retail Firms in Nairobi , Kenya By Ojalla Peter Ouma a Research Project Submitted in Partial Fulfillment of the Requirements for the Award of Master of Business Administration , Faculty .*

Parrett, A. (2008). International Symposium on Logistics. *Integrating the Global Supply Chain*, July, 6–8.

Petterson, A. I., & Segerstedt, A. (2013). *Int . J . Production Economics Measuring*

supply chain cost. 143, 357–363.

Proag, V. (2021). *Quality and Reliability of Infrastructure* (pp. 253–277).

https://doi.org/10.1007/978-3-030-48559-7_9

Prus, P., & Sikora, M. (2021). The impact of transport infrastructure on the sustainable development of the region—case study. *Agriculture (Switzerland)*, 11(4), 1–15.

<https://doi.org/10.3390/agriculture11040279>

Ramli. (2018). Why should PLS-SEM be used rather than regression? *Evidence from the Capital Structure Perspective*.

Rastegardebidi, A. (2025). Emerging trends in green logistics adoption in developing countries. *Journal of Sustainable Transportation*, 19(2), 134–149.

René, M. (2024). *Enhancing Energy Efficiency of the Freight Transport Sector in Asia and the Pacific Technologies and Policies*. <https://www.intelligenttransport.com/>

Rushton, A. (2017). *The handbook of logistics and distribution management*.

Understanding the Supply Chain, 6th editio.

Safdar, N., Khalid, R., Ahmed, W., & Imran, M. (2020). *Journal Pre-proof*.

Saldaña, J. (2012). *The coding manual for qualitative researchers*. Thousand Oaks, CA.

Salonitis, K. (2021). *Food Logistics 4 . 0 : Opportunities and Challenges*. 1–19.

Sanyu. (2025). *Sustainable Logistics Management and Operational Efficiency at BIDCO Uganda Limited*. *Master's Thesis, Uganda Christian University*.

Sar, K., & Ghadimi, P. (2023). A systematic literature review of the vehicle routing problem in reverse logistics operations. *Computers and Industrial Engineering*,

177(January), 109011. <https://doi.org/10.1016/j.cie.2023.109011>

Saruchera, F., & Asante-Darko, D. (2021). Reverse logistics, organizational culture and firm operational performance: Some empirical evidence. *Business Strategy and Development*, 4(3), 326–342. <https://doi.org/10.1002/bsd2.161>

Saunders, M. (2019). *Research Methods for Business Students*. Pearson Education, 8th editio.

Sebit. (2024). The importance of road infrastructure investment on rural economic growth in Uganda. *A Case of Mukono District*. Uganda Christian University Working Paper Series.

Sénquiz-Díaz. (2021). Transport infrastructure and logistics efficiency. *Global Perspectives*. Springer.

Seroka. (2014). The Development of Green Logistics for Implementation Sustainable Development Strategy in Companies. *Procedia - Social and Behavioral Sciences*, 151, 302–309. <https://doi.org/10.1016/j.sbspro.2014.10.028>

Sharing, V., & City, S. (2017). *Optimizing Fleets with Advanced Routing and Telematics*.

Shi. (2025). Is operational flexibility a viable strategy during major supply chain disruptions? Evidence from the COVID-19 pandemic. *Transportation Research Part E: Logistics and Transportation Review*, 195, 103952. <https://doi.org/10.1016/j.tre.2024.103952>

Skorobogatova, O., & Kuzmina-Merlino, I. (2017). Transport Infrastructure Development Performance. *Procedia Engineering*, 178, 319–329. <https://doi.org/10.1016/j.proeng.2017.01.056>

- Sorle, R. (2024). *VALUE CHAIN MANAGEMENT STRATEGIES AND OPERATIONAL EFFICIENCY IN NIGERIAN LOGISTICS ORGANISATIONS*. 2(01), 92–118.
- Srivastava. (2007). Green supply-chain management. *A State-of-the-Art Literature Review. International Journal of Management Reviews*, 9(1), 53–80.
- Stephen. (2024). *GREEN LOGISTICS PRACTICES AND FIRM PERFORMANCE : THE MEDIATING EFFECT OF ENVIRONMENTAL PERFORMANCE AMONG LOGISTICS FIRMS IN KENYA* Article history : 1 INTRODUCTION Given the current globalization framework , firms must prioritize ecological problems (Moli. 1–28.
- Sun, X., Yu, H., & Solvang, W. D. (2022). Towards the smart and sustainable transformation of Reverse Logistics 4.0: a conceptualization and research agenda. *Environmental Science and Pollution Research*, 29(46), 69275–69293.
<https://doi.org/10.1007/s11356-022-22473-3>
- Sutherland, J. L. (2007). Logistics from a historical perspective. *Logistics Engineering Handbook, December 2008*, 1-1-1–14. <https://doi.org/10.1201/9781420088571.ch1>
- Taylor. (1911). The principles of scientific management. *Harper & Brothers*.
- Tetteh, I. (2024). Green logistics adoption in sub-Saharan Africa: Opportunities and challenges. *African Journal of Sustainable Development*, 6(1), 71–89.
- Trang, H. T. T., & Hong, P. T. T. (2021). Measuring the Impact of Infrastructure Quality on Firm Performance: a Review of Literature, Metrics, and Evidence. *Proceedings of the International Conference on Emerging Challenges: Business Transformation and Circular Economy (ICECH 2021)*, 196(ICECH), 211–220.

<https://doi.org/10.2991/aebmr.k.211119.022>

Tse-tung, M., & War, P. (2000). *Operational- Level Logistics*. 5(1), 41–54.

Tukamuhabwa. (2021). Supply chain agility in third-party logistics providers in Uganda. *Makerere University Business School Working Paper Series*.

Tukamuhabwa, B. R., Mutebi, H., & Kwagala, R. (2023). Competitive advantage in SMEs: effect of supply chain management practices, logistics capabilities and logistics integration in a developing country. *Journal of Business and Socio-Economic Development*, 3(4), 353–371. <https://doi.org/10.1108/jbsed-04-2021-0051>

Uddin, S. Q. (2022). Supply Chain Integration, Flexibility, and Operational Performance. *South Asian Management Review*, November, 1–21.
<https://doi.org/10.57044/samr.2022.1.1.2202>

Uganda Revenue Authority. (2024). *List of Licenced clearing and forwarding entities in Uganda*.

UNCTAD. (2024). Review of Maritime Transport. In *United Nations Conference on Trade and Development*.

van Eldijk, J., Gil, J., Kuska, N., & Sisinty Patro, R. (2020). Missing links – Quantifying barrier effects of transport infrastructure on local accessibility. *Transportation Research Part D: Transport and Environment*, 85(May), 1–15.
<https://doi.org/10.1016/j.trd.2020.102410>

Vienažindienė, M., Tamulienė, V., & Zaleckienė, J. (2021). Green logistics practices seeking development of sustainability: Evidence from lithuanian transportation and logistics companies. *Energies*, 14(22). <https://doi.org/10.3390/en14227500>

- von der Gracht, H., Darkow, I.-L., Stefan, W., Jahns, C., & Thomsen, E. (2018). *Future of Logistics 2025 Global Scenarios Inga-Lena Darkow* (Issue August).
- Wang, M., Asian, S., Wood, L. C., & Wang, B. (2020). Logistics innovation capability and its impacts on the supply chain risks in the Industry 4.0 era. *Modern Supply Chain Research and Applications*, 2(2), 83–98. <https://doi.org/10.1108/mscra-07-2019-0015>
- Wee, H. M., B, M. F. B., and Wen-Hsiung Yang c†, & Library, R. (2017). *Risk Management in Logistics Risk management in Logistics* (Issue July). <https://doi.org/10.1007/978-3-642-25755-1>
- Wehner, J. (2018). Energy efficiency in logistics: An interactive approach to capacity utilisation. *Sustainability (Switzerland)*, 10(6). <https://doi.org/10.3390/su10061727>
- Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal*, 5(2), 171–180. <https://doi.org/https://doi.org/10.1002/smj.4250050207>
- Widiatmaka, F. P., Prasetyo, A. N., Suherman, S., Sularno, H., Cahyadi, T., Pranyoto, P., Fitrianiingsih, A., Kundori, K., & Sukrisno, S. (2024). Quality of Transportation Infrastructure and Trade Facilities: Opportunities and Challenges in Increasing Trade and Economic Productivity. *TransNav*, 18(3), 521–528. <https://doi.org/10.12716/1001.18.03.05>
- Wilde, Y. De. (2018). *THE EFFECT OF INTERNET OF THINGS TECHNOLOGIES ON SUSTAINABILITY IN TRANSPORTATION*. 2017–2018.
- Womack, Jones, R. (1990). The machine that changed the world: The story of lean production. *Rawson Associates*.
- World Bank. (2017). kills to support the transport and logistics sector in Uganda.

Washington, DC. *World Bank*.

World Bank. (2023). *World Bank Annual Report 2023. A New Era in Development*.

Washington, DC: World Bank. <https://doi.org/https://doi.org/10.1596/AR2023EN>

Wu, S, Peng, R, Shafiee, M. (2022). *Kent Academic Repository Additional information Page Proof Instructions and Queries*. 236, 375–376.

Xin, L., Xu, P., & Manyi, G. (2022). Logistics Distribution Route Optimization Based on Genetic Algorithm. *Computational Intelligence and Neuroscience*, 2022.

<https://doi.org/10.1155/2022/8468438>

Yaifa. (2023). An exploration of operational excellence methodologies implementation in the logistics sectors: a global study. *The TQM Journal*, 107(I), 5–10.

Yousuf. (2019). Operational flexibility and logistics responsiveness in uncertain environments. *International Journal of Production Research*, 57(18), 5760–5775.

Yousuf. (2021). Enhancing supply chain flexibility through strategic integration and digital innovation. *Journal of Supply Chain Management*, 57(1), 29–47.

Zhao. (2018). Supply Chain Risk Management. *EURO Advanced Tutorials on Operational Research*, 39–55. https://doi.org/10.1007/978-3-319-76663-8_3

APPENDICES

Appendix I: Questionnaire RESEARCH QUESTIONNAIRE

Dear respondent,

Your entity has been selected to participate in a study on the “*Mediating role of operational flexibility in the relationship between green logistics practices, infrastructure quality, and logistics operational efficiency.*” This study is intended only for academic purposes. The information provided will be treated as highly CONFIDENTIAL. The researcher guarantees the use of the acquired information for academic purposes only. Your co-operation is highly appreciated.

SECTION A: ORGANIZATIONAL CHARACTERISTICS (Tick where appropriate)

A1- Name of your Logistics firm

.....

A2- How long has this logistics firm been in existence?

| | | | | |
|-------------------|------------|-------------|-------------|----------------|
| Less than 5 years | 5-10 years | 10-15 years | 15-20 years | Above 20 years |
| 1 | 2 | 3 | 4 | 5 |

A3- Nature of the firm

| | | | | |
|---------------------|-------------|---------------|-------------|--------|
| Sole proprietorship | partnership | Joint venture | corporation | others |
| 1 | 2 | 3 | 4 | 5 |

SECTION B: RESPONDENTS' CHARACTERISTICS (Tick where appropriate)

B1- Gender of the respondents

| | |
|------|--------|
| Male | Female |
| 1 | 2 |

B2. Age Group

| | | | | |
|--------------------|-------------|-------------|-------------|----------------|
| Less than 30 years | 31-35 years | 36-40 years | 41-45 years | Above 46 years |
| 1 | 2 | 3 | 4 | 5 |

B3. What is your level of education?

| | | | | |
|---------|--------|-----------------|-----|--------|
| Diploma | Degree | Master's Degree | PhD | others |
| 1 | 2 | 3 | 4 | 5 |

B4 What position do you hold in the organization?

| | | | | |
|-----------------|---------------------|--------------|-------------------|--------|
| General Manager | Warehousing officer | QHSE officer | Transport Officer | others |
| 1 | 2 | 3 | 4 | 5 |

B5- How long have you been working with this organization?

| | | | | |
|-------------------|------------|-------------|-------------|----------------|
| Less than 5 years | 5-10 years | 10-15 years | 15-20 years | Above 20 years |
| 1 | 2 | 3 | 4 | 5 |

B6- How many employees to you have in your organization?

| | | | | |
|---------------------|---------------|----------------|----------------|------------------|
| Less than 50 people | 51-100 people | 101-150 people | 151-200 people | Above 201 people |
| 1 | 2 | 3 | 4 | 5 |

SECTION C: LOGISTICS OPERATIONAL EFFICIENCY

Instructions: Please indicate how strongly you agree or disagree with the following statements regarding the logistics operational efficiency in your logistics operations.

Scale: 1 – Strongly Disagree, 2 – Disagree, 3 – Neutral, 4 – Agree, 5 – Strongly Agree

| | Statements | 1 | 2 | 3 | 4 | 5 |
|-----------|---|---|---|---|---|---|
| | Supply chain costs | | | | | |
| LOE/SCC1 | Our firm regularly monitors logistics costs to identify areas for cost savings | | | | | |
| LOE/SCC12 | We have clear visibility of transportation costs across our logistics network. | | | | | |
| LOE/SCC13 | We manage inventory levels effectively to reduce holding costs. | | | | | |
| LOE/SCC14 | Our company invests in technologies that help reduce supply chain costs. | | | | | |
| LOE/SCC15 | We evaluate supplier performance based on their ability to reduce logistics-related expenses. | | | | | |
| LOE/SCC16 | Our distribution planning helps us avoid unnecessary expenses. | | | | | |
| LOE/SCC17 | We use cost benchmarks to assess logistics performance across regions. | | | | | |
| | Risk Response Time | | | | | |
| LOE/RST1 | Our firm can quickly re-route deliveries in case of transport disruption. | | | | | |
| LOE/RST2 | We can source alternative suppliers rapidly when needed. | | | | | |
| LOE/RST3 | We respond to customer complaints or delays in a timely manner. | | | | | |
| LOE/RST4 | We have a clear process for reacting to logistics emergencies. | | | | | |

| | | | | | | |
|----------|---|--|--|--|--|--|
| LOE/RST5 | Our firm invests in training staff to act swiftly during disruptions. | | | | | |
| LOE/RST6 | We can adjust delivery schedules quickly when unforeseen events occur. | | | | | |
| LOE/RST7 | We have backup plans that allow us to resume operations with minimal delay. | | | | | |
| | Lead Times | | | | | |
| LOE/LT1 | Our delivery times are consistent and predictable. | | | | | |
| LOE/LT2 | We take minimal time to process customer orders. | | | | | |
| LOE/LT3 | We meet promised delivery schedules for most shipments. | | | | | |
| LOE/LT4 | We can quickly fulfill urgent or expedited orders. | | | | | |
| LOE/LT5 | Our lead times have improved over the past year. | | | | | |
| LOE/LT6 | We frequently review and optimize our delivery schedules | | | | | |
| LOE/LT7 | Customers are satisfied with how long it takes to receive their goods. | | | | | |

(Adapted from: Gunasekaran et al., 2004; Tracey, 1998, Sheffi, 2005; Pettit et al., 2010 and Christopher & Peck, 2004; Li et al., 2006)

SECTION D: GREEN LOGISTICS PRACTICES

Instructions: Please indicate how strongly you agree or disagree with the following statements regarding the Green Logistics Practices used in your logistics operations.

Scale: 1 – Strongly Disagree | 2 – Disagree | 3 – Neutral | 4 – Agree | 5 – Strongly Agree.

| | Statements | 1 | 2 | 3 | 4 | 5 |
|---------|--|----------|----------|----------|----------|----------|
| | Reverse logistics | | | | | |
| GLP/RL1 | Our firm has a clear process for handling returned goods. | | | | | |
| GLP/RL2 | We collect and transport used or damaged products from customers. | | | | | |
| GLP/RL3 | We collaborate with clients to reuse or recycle packaging materials. | | | | | |
| GLP/RL4 | We manage waste from deliveries in an environmentally responsible way. | | | | | |
| GLP/RL5 | We return unused inventory back to suppliers where applicable. | | | | | |
| GLP/RL6 | We have a dedicated team or system for reverse logistics operations. | | | | | |
| GLP/RL7 | We track and report on the volume of items returned or recycled. | | | | | |

| | Fuel Efficiency | | | | | |
|---------|---|--|--|--|--|--|
| GLP/FE1 | Our firm monitors fuel consumption for each delivery trip. | | | | | |
| GLP/FE2 | We use fuel-saving driving practices (e.g., idle reduction, moderate speed) | | | | | |
| GLP/FE3 | We invest in fuel-efficient or low-emission vehicles. | | | | | |
| GLP/FE4 | We regularly maintain vehicles to improve fuel performance. | | | | | |
| GLP/FE5 | We train drivers on fuel-efficient behaviours. | | | | | |
| GLP/FE6 | Our firm uses alternative fuels (e.g., biodiesel, LPG) where possible. | | | | | |
| GLP/FE7 | We set targets to reduce overall fuel use in logistics operations. | | | | | |
| | Route Optimization | | | | | |
| GLP/RO1 | Our firm uses route planning tools to reduce travel distances. | | | | | |
| GLP/RO2 | We analyse traffic and delivery times to plan efficient routes. | | | | | |
| GLP/RO3 | We avoid routes that lead to unnecessary fuel consumption. | | | | | |
| GLP/RO4 | We consolidate shipments to reduce the number of trips. | | | | | |
| GLP/RO5 | We adjust routes in real time to avoid delays or roadblocks. | | | | | |
| GLP/RO6 | Our drivers follow pre-planned routes to save time and fuel. | | | | | |
| GLP/RO7 | We review route performance regularly to make improvements. | | | | | |

(Adapted from: Rogers & Tibben-Lembke, 1999; Ravi & Shankar, 2005; Srivastava, 2007, McKinnon, 2010; Evangelista et al., 2010; Piecyk & McKinnon, 2010 and Sbihi & Eglese, 2007; Lin et al., 2014; Dekker et al., 2012)

SECTION E: INFRASTRUCTURE QUALITY

Instructions: Please indicate how strongly you agree or disagree with the following statements regarding the infrastructure used in your logistics operations.

Scale: 1 – Strongly Disagree | 2 – Disagree | 3 – Neutral | 4 – Agree | 5 – Strongly Agree

| | Statements | 1 | 2 | 3 | 4 | 5 |
|-------|--|----------|----------|----------|----------|----------|
| | Accessibility | | | | | |
| IQ/A1 | Our firm has easy access to major roads and highways. | | | | | |
| IQ/A2 | Our logistics facilities are located near key transportation hubs. | | | | | |

| | | | | | | |
|---------|---|--|--|--|--|--|
| IQ/A3 | We can easily access airports or seaports when needed. | | | | | |
| IQ/A4 | Local infrastructure supports timely movement of goods. | | | | | |
| IQ/A5 | We can easily reach our suppliers and customers through existing transport links. | | | | | |
| IQ/A6 | Poor road conditions do not limit our delivery operations. | | | | | |
| IQ/A7 | Our delivery vehicles can access customer locations without difficulty. | | | | | |
| | Reliability | | | | | |
| IQ/R1 | Roads and transport systems used by our firm are dependable. | | | | | |
| IQ/R2 | Power supply at our logistics facilities is stable and reliable. | | | | | |
| IQ/R3 | Internet and communication networks are consistently available | | | | | |
| IQ/R4 | Infrastructure interruptions (e.g., roadblocks, power outages) are rare. | | | | | |
| IQ/R5 | Scheduled delivery times are rarely disrupted by infrastructure issues. | | | | | |
| IQ/R6 | We can rely on our transport systems during peak demand periods. | | | | | |
| IQ/R7 | Local infrastructure supports consistent and timely logistics performance. | | | | | |
| | Ease of Connection | | | | | |
| IQ/EOC1 | It is easy to switch between transport modes (e.g., road to rail or air). | | | | | |
| IQ/EOC2 | Our firm can connect quickly to logistics hubs and terminals. | | | | | |
| IQ/EOC3 | Delivery routes are well integrated with regional transport networks. | | | | | |
| IQ/EOC4 | We experience minimal delays when transferring shipments across modes. | | | | | |
| IQ/EOC5 | The flow of goods between locations is smooth and coordinated. | | | | | |
| IQ/EOC6 | Infrastructure allows seamless communication between logistics partners. | | | | | |
| IQ/EOC7 | We can easily integrate our logistics systems with client systems. | | | | | |

(Adapted from: Arvis et al., 2018; Liu et al., 2013; Rodrigue et al., 2006, Notteboom, 2006; Wu & Dunn, 1995; Wang & Meng, 2011 and Hesse & Rodrigue, 2004; LPI Report – World Bank, 2018; Bhatnagar & Teo, 2009)

SECTION F: OPERATIONAL FLEXIBILITY

Instructions: Please indicate how strongly you agree or disagree with the following statements regarding the operational flexibility of your logistics operations.

Scale: 1 – Strongly Disagree | 2 – Disagree | 3 – Neutral | 4 – Agree | 5 – Strongly Agree

| | Statements | 1 | 2 | 3 | 4 | 5 |
|--------|---|---|---|---|---|---|
| | Adaptability | | | | | |
| OF/AD1 | Our firm easily adjusts to changes in customer requirements. | | | | | |
| OF/AD2 | We can modify our logistics processes when market conditions change. | | | | | |
| OF/AD3 | We can shift between different transportation modes when needed. | | | | | |
| OF/AD4 | Our firm adapts quickly when client delivery schedules change. | | | | | |
| OF/AD5 | We can switch suppliers or partners if necessary. | | | | | |
| OF/AD6 | We continuously update our logistics systems to meet new demands. | | | | | |
| OF/AD7 | Our team can handle different types of logistics operations with minimal delay. | | | | | |
| | Agility | | | | | |
| OF/AG1 | Our firm responds quickly to urgent logistics requests. | | | | | |
| OF/AG2 | We can handle unexpected increases in customer demand. | | | | | |
| OF/AG3 | We can redirect shipments quickly if delivery problems arise. | | | | | |
| OF/AG4 | Our decision-making process is fast in changing situations. | | | | | |
| OF/AG5 | We quickly deploy staff and vehicles during sudden demand surges. | | | | | |
| OF/AG6 | Our firm reacts fast to disruptions like port delays or roadblocks. | | | | | |
| OF/AG7 | We maintain extra capacity to handle sudden operational changes. | | | | | |

(Adapted from: Christopher & Towill, 2001; Swafford et al., 2006; Bhatnagar & Viswanathan, 2000 and Yusuf et al., 2004; Gligor et al., 2015; Swafford et al., 2008)

Thank you so much for your valuable time!

Appendix II: Plagiarism Clearance Certificate