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Research Title:

Understanding obstacles and factors that affect Green Logistics Strategies aimed at enhancing environmental sustainability within supply chain management: Towards an integrated conceptual framework

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DEDICATION

It is the deepest love and appreciation of my family that would make me commit this work even as their support has helped me all along my academic path. To my parents who taught me the importance of being a tough guy, being educated, and not giving up, whose sacrifices I have been granted with each and every chance possible. To my siblings who have always inspired me with their support and assurance of my capabilities to pursue the best.

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ABSTRACT

This paper analyzes in details the barriers and facilitating conditions that determine the process of adoption and implementation of green logistics strategies in a bid to improve environmental sustainability in the management of supply chains. With the help of a qualitative descriptive research design, the research will combine the information presented in the modern literature and apply systematic analysis to the patterns that emerge based on recorded empirical findings. The overall aim is to construct a unified conceptual framework that involves the intricate interactions of contextual conditions, organizational capabilities, barriers and enablers as well as the sustainability outcomes.

The results have shown that there are financial, technological, organizational, regulatory, and cultural impediments that serve to slow down the shift of green logistics. The most important inhibitors still include financial constraints, particularly, high capital spending, the lack of green financing, and the hesitation about the cost recovery. Further hindrance to adoption is due to technological and infrastructural barriers, especially in areas with underdeveloped logistic ecosystems. The resistance to change, managerial incompetency, and the inadequate integration among the supply-chain partners are organizational and operational impediments. Regulatory barriers can be caused by the broken policy setting, the lack of consistency in enforcement, and the lack of long-term strategic directions. Low levels of awareness, ingrained operational practices, and low levels of sustainability-oriented mindsets are all cultural barriers.

In its turn, the research also finds a set of facilitating factors that help move towards green logistics: mounting the pressure on stakeholders, the expanding market demand of the green products, technological improvement of logistics, the supportive governmental policies, the economic factors, and the increasing corporate environmental responsibility. The enablers do

work, but only in combination with robust mediating skills e.g. digital integration, absorptive capacity, collaborative governance structures and ability to access specialized financial tools.

The research indicates a moderating influence of situational factors such as regulatory stability, the structure of the industry, and the availability of national infrastructure. Cross-country and vertical variations indicate that green logistics implementation is contextual and needs different strategies instead of generalized ones.

The comprehensive framework that this study suggests provides a comprehensive perspective on the development of green logistics projects and indicates potential areas of leverage that might be used to enhance sustainability delivery. It is concluded with strategic recommendations to the practitioners, policymakers and industry bodies, noting that there is a need to have coordinated management, technological and regulatory interventions. On balance, the study has some contribution to theory and practice as it is a comprehensive model that can help to make informed decisions and shape the future direction of the empirical studies.

الملخص

تتناول هذه الدراسة بعمق العوائق والعوامل المُمكنة التي تؤثر على تبني وتنفيذ استراتيجيات اللوجستيات الخضراء الهادفة إلى تعزيز الاستدامة البيئية ضمن إدارة سلاسل الإمداد. وقد اعتمدت الدراسة على منهج وصفي نوعي يقوم على تحليل الأدبيات المعاصرة واستخلاص الأنماط التي تظهرها الأدلة التجريبية الحديثة. وكان الهدف الرئيس هو تطوير إطار مفاهيمي متكامل يوضح التفاعل المعقد بين الظروف السياقية، والقدرات التنظيمية، والعوائق، والممكنات، والنتائج المستدامة المتحققة. أظهرت النتائج أن الانتقال نحو لوجستيات خضراء يواجه عدداً من المعوقات أبرزها المالية والتكنولوجية والتنظيمية والتشغيلية، إضافة إلى المعوقات التنظيمية والثقافية. وتشمل العوائق المالية ارتفاع التكاليف الرأسمالية، وضعف القدرة على الوصول إلى التمويل الأخضر، وعدم وضوح الجدوى الاقتصادية على المدى القصير. أما العوائق التكنولوجية فتتمثل في ضعف البنية التحتية اللوجستية ونقص الأنظمة الرقمية المتقدمة. العوائق التنظيمية تشمل مقاومة التغيير، ضعف الخبرة الإدارية، ونقص التكامل بين شركاء سلسلة الإمداد، بينما ينتج عن التخبط التشريعي وغياب سياسات واضحة وجود عوائق

تنظيمية وسياساتية. وتتمثل العوائق الثقافية في انخفاض الوعي البيئي، وتمسك المؤسسات بالممارسات التقليدية، وضعف الثقافة المؤسسية الداعمة للاستدامة.

في المقابل، حددت الدراسة عدة إمكانات تعزز التوجه نحو اللوجستيات الخضراء، ومنها ضغط أصحاب المصلحة، وتزايد الطلب على المنتجات المستدامة، والتطور التقني، والدعم التشريعي، والحوافز الاقتصادية، وارتفاع مستويات المسؤولية البيئية لدى المؤسسات. غير أن فعالية هذه المكنات تعتمد على وجود قدرات تنظيمية وبسيطة، مثل التكامل الرقمي، والقدرة الاستيعابية، وهياكل الحوكمة التعاونية، وتوفر أدوات التمويل الأخضر.

تؤكد الدراسة كذلك الدور المعدّل للظروف السياقية، بما في ذلك استقرار السياسات، وبنية القطاع، وجاهزية البنية التحتية الوطنية. وتُظهر الاختلافات بين الدول والقطاعات أن تبني اللوجستيات الخضراء يعتمد على السياق، مما يستدعي استراتيجيات مُصمّمة حسب الحالة وليس حلولاً موحّدة.

يقدم الإطار المفاهيمي المتكامل رؤية شاملة حول كيفية تطور ممارسات اللوجستيات الخضراء، ويحدد نقاط التدخل الرئيسية لتحسين النتائج المستدامة. وتختتم الدراسة بمجموعة توصيات استراتيجية لصنّاع القرار والممارسين، تؤكد الحاجة إلى تكامل الجهود الإدارية والتقنية والسياساتية. وتسهم الدراسة في إثراء النظرية والممارسة عبر توفير نموذج متكامل يدعم اتخاذ القرار ويقود البحوث المستقبلية.

CHAPTER 1: INTRODUCTION

Background

The rate at which the environmental demands and green supply chain decision-making are converging has put green logistics in the center of the modern sustainability scholarship and practice. The concept of green logistics, which can be described as the combination of planning, operational and strategic interventions designed to minimise the environmental footprint of logistics operations, is getting recognized not only as an operational improvement but a strategic tool to influence corporate environmental performance and social wellbeing (Blanco & Sheffi, 2024; Nagy & Szentesi, 2024). This shift indicates a greater regulatory pressure, stakeholder scrutiny, and economic risks of climate change, which compel companies to reconsider procurement, distribution, reverse logistics and transportation decisions through the prism of ecology (Agyabeng-Mensah et al., 2021; Bukhari et al., 2023). Although there is a general agreement on the significance of green logistics, empirical research has shown that it is currently being implemented in a piecemeal and uneven fashion across industries and geographies, and therefore necessitating the need to appreciate the barriers and enabling factors that govern its implementation.

Green logistics at the technical and systems level is closely connected to the principles of the closed-loop supply chain design that prioritises the recirculation of materials, minimisation of waste and the responsibility of the life cycle of a product (Andrushchak, 2018; de Jesus, Alves, and Mendes, 2024). The possibility of environmentally sustainable network design, such as reverse logistics design and order allocation systems, to reduce emissions and resource use in the face of uncertainty has been demonstrated through optimization and robust modelling studies (Ahmed et al., 2020; Mirzaee, Samarghandi, and Willoughby, 2023). These quantitative contributions cannot be ignored to prove that it is feasible and inform policy tools (e.g. cap-

and-trade) that transform procurement and distribution decisions (Mirzaee et al., 2023; Ahmed et al., 2020). Nevertheless, technical feasibility does not necessarily translate into practical implementation: socio-organisational, behavioural and institutional factors often intervene in the translation into finance, implementation and scale of technically optimal configurations (de Jesus et al., 2024).

The complementary empirical studies have recorded the operational and environmental advantage that will accrue upon successfully introducing green logistics practices in the management of the supply chain. Research indicates that traceability systems, coherent performance measurement systems and ecocentric logistics orientations increase transparency in overall material flows and emissions, which allows targeted interventions to increase both sustainability and performance (Agyabeng-Mensah et al., 2021; Khoa et al., 2024). Specifically, supply chain traceability enables engagement and corrective response with suppliers and ecocentric management redefines decision criteria to internalize environmental externalities in the logistics plan (Agyabeng-Mensah et al., 2021). However, these benefits are also dependent on the firm-level ability, market structures and maturity of the infrastructure that supports them, meaning that the gains observed are often context-dependent (Blanco and Sheffi, 2024; Khoa et al., 2024).

Another strong literature has also listed the frequent obstacles limiting the implementation of green logistics. Financial reasons, particularly, steep initial capital investments needed to support low-emission technologies and infrastructure, are a common characteristic and so is the lack of managerial interest, technical competence and regulatory complexity (Dashore & Sohani, 2013; Dhull & Narwal, 2016). Comparative studies show that companies in emerging or transitional economies encounter more faced challenges in accessing finance and regulatory support, and companies in more regulated markets have to deal with compliance burdens and competitive pressures which can either motivate or hinder the process of green transitions (Esen

& El Barky, 2017; Hebaz and Oulfarsi, 2021). These works underscore the idea that the barriers are multifaceted and interdependent and that they create path-dependent adoption patterns, which cannot be readily explained as causal.

Transport and delivery systems represent a unique and acute bunch of challenges. Technological immaturity of zero-emission vehicles, incomplete charging and refuelling systems, and the division of the provider networks all present a challenge to the logistics and transport industry when trying to decarbonise the travel industry (Bukhari et al., 2023). Logistics service providers are on a trade-off between reliability in delivery, cost competitiveness and environmental performance, and demand patterns by clients and aversion of managers to risk determine the rate of green innovation adoption (Isaksson, Bjornklund, Evangelista, and Huge-Brodin, 2011). The policy tools, including carbon pricing and cap-and-trade, also complicate the choice of suppliers and routing in that requiring integrated models and multi-stakeholder coordinated efforts to balance competing goals (Mirzaee et al., 2023; Ahmed et al., 2020).

Reviews and meta-analyses of the literature highlight a gap in the methodological and conceptualisation since the current corpus is abundant in technical models and descriptive lists of drivers and barriers, but it does not offer integrative frameworks by which the interaction of technical, organisational and contextual determinants between levels of analysis can be mapped (Dhull & Narwal, 2016; de Jesus et al., 2024). Optimization studies help to understand what can be done under controlled assumptions (Ahmed et al., 2020; Mirzaee et al., 2023), whereas empirical reviews demonstrate recurrent obstacles and facilitators (Dashore and Sohani, 2013; Hebaz and Oulfarsi, 2021). However, there is a relative lack of agreement concerning the configurational arrangements - combinations of capabilities, governance structures and external supports - that are repeatedly present whenever successful green logistics transitions occur in varied contexts (Nagy & Szentesi, 2024).

Considering this background, this paper will take qualitative descriptive as a research design to further understand the barriers and issues that affect the green logistics strategies and also develop a coherent conceptual framework that will be used to inform theory and practice. The methodological suitability of qualitative descriptive approach is that it is able to make systematic, context-related description of the stakeholder experiences, decision heuristics and institutional constraint without the restrictive theoretical preconceptions (de Jesus et al., 2024). The study takes a synthesis of insights on optimization and closed-loop modelling, empirical evaluations of traceability and ecocentric practices, as well as an extensive literature on drivers and barriers to give a rich empirical description (Ahmed et al., 2020; Agyabeng-Mensah et al., 2021; Dashore & Sohani, 2013; Dhull and Narwal, 2016).

Finally, such a study aims at making a practical conceptualisation to bridge the gap between technical opportunities and socio-institutional realities that help managers, policy-makers and logistics service providers leverage points in an attempt to hasten the process towards sustainability. Combining the results of various strands of literature - such as optimisation, cyclic economy connections, empirical performance literature and comparative barrier examinations - the study hopes to provide a consistent map on how logistics activities can be transformed in a way that can be environmentally efficient and operationally feasible (Andrushchak, 2018; Blanco et al., 2024; Bukhari et al., 2023; Isaksson et al., 2011; Khoa et al., 2024; Mirzaee et al

Problem Statement

The gap that led to the problem of this work is due to the fact that despite the consistent theoretical advances in green logistics, there is a continuous and consequential disparity between the theoretical advances and the uneven and sometimes limited application of such advancements in operational supply chain. In recent years, researchers have developed advanced models and actionable prescriptions of closed-loop network design, reverse logistics,

and low-emission transportation solution, which theoretically can help achieve large amounts of environmental externalities reduction. However, in most of the real-life situations these solutions are still partial, fragmented or limited to pilot projects instead of being extended to standard procedures within firms and industries. This disjunction cannot be simply described as technical; it represents an intricate complex of financial, institutional, organizational and infrastructural circumstances which limit the process of transferring technically viable designs into enduring managerial practice and system-wide alteration.

Probably one of the most common-mentioned restrictions are financial factors: organizations, especially small and medium enterprises, must find reasons as to why investing capital in green automobiles, warehouse modernization, digital traceability infrastructure, or redone distribution networks would be cost-effective. The problematic aspect of these investments also include the uncertainty of returns, inconsistent planning horizons as well as operational priorities that encourage minimum costs in the long-term environmental gains. The problem is exacerbated by institutional and regulatory ambiguity; where policy regimes are either weak, inconsistent or even evolving rapidly, then the company risks more by putting resources into green logistics projects. On the other hand, when the new compliance costs outweigh the new compliance costs, and yet there are no incentives or subsidies to cover these costs, companies can just comply with the new regulations in a superficial manner, instead of making meaningful changes on the operational front.

Management and organizational aspects also have a determining influence. The green implementation of logistics system may need cross functional integration, procurement practice modification and new performance measures, which combine both the environmental goal and the traditional efficiency goals. Even where the technological options are present, resistance to change, lack of managerial experience in sustainability practices, as well as internal champions can paralyze initiatives. There is also the second dimension of complexity

imposed by supplier networks: supply chains are systems of interdependence where the ability of a focal firm to adopt green logistics is dependent upon the capacity and goodwill of suppliers, logistic suppliers, and downstream partners to converge around some set of common practices and information standards. Disintegration in these networks can be of a geographic nature, technological nature, or contractual nature, and hence can produce bottlenecks in them, which will dilute the potential benefits of green strategies.

The mediation of the viability of green logistics is further by infrastructure and sectoral characteristics. Examples of such supportive infrastructures include charging points, alternative fuel distribution networks and integrated capital logistics hubs are necessary to decarbonise transport. This infrastructure is also either incomplete or does not cover the full range of a region, which leads to a limitation in the operation of large-scale switching to the low-emission fleets. Also, the non-homogeneity of industries i.e. variations in the life cycle, reusing, and regulatory sensitivity of products imply that it is not practical to have one-size fits-all approach but instead have industry tailored strategies, although tailoring complicates and is costly.

Put together, these aspects suggest that the major concern is not that there are no technical alternatives to green logistics, but that there are a series of multidimensional barriers that make such alternatives inaccessible, incompatible, and inefficient. To solve this issue, an analytic prism that transcends technical solutions in isolated form is needed to study how financial incentives, institutional structures, managerial behaviour, relationships with suppliers and infrastructural realities co-operate or not to support sustainable logistics changes. It is in the absence of such a comprehensive knowledge that policies and managerial interventions run the risk of being disengaged with the systemic barriers that they are supposed to address and thus their limitations to accomplishments.

The study problem is reflected in the following question:

What are the major barriers and facilitating circumstances that influence the adoption, assimilation, and expansion of green logistics strategies to improve environmental sustainability in the context of supply chain management and how can they be combined in a cohesive conceptual model?

Significance of the Study

Theoretical significance

Hypothetically, the proposed study advances the available literature by advancing an integrative knowledge on the joint development and success of green logistics strategies due to interplay of technical, organisational and contextual determinants. The current literature is vast but disjointed: the concept of optimisation and closed-loop network models can be used to describe technically viable solutions to reverse logistics and supplier selection (Ahmed et al., 2020; Mirzaee, Samarghandi, and Willoughby, 2023), and the results of empirical investigations and comparative research provide a record of how often certain causes and obstacles to green supply chain operations appear (Dashore and Sohani, 2013; Dhull and Narwal, 2016; Heb Nevertheless, a conceptual gap persists in mapping the interactions between these strands in their configurations, i.e. how such solutions interact with institutional incentives, managerial capabilities and infrastructural limitations in order to bring about different adoption results (de Jesus, Alves, and Mendes, 2024; Nagy and Szentesi, 2024). By considering obstacles and enabling factors as mutually dependent elements in a multi-level frame of analysis, the current research streamlines theoretical accounts of the adoption processes and provides suggestions regarding the processes that mediate the conversion of the technical options into habitual practice.

Additionally, the paper applies theory like traceability and ecocentricity into the contexts of wider governance and networks. Empirical studies indicate that traceability systems and ecocentric management orientations enhance sustainability performance in cases where they

are integrated into coordinated network of suppliers, and are accompanied by proper measurement regimes (Agyabeng-Mensah et al., 2021; Khoa et al., 2024). The study expands on the above-mentioned insights by explaining the conditions that these constructs need to be effective under, thus allowing the creation of more specific hypotheses to be tested later quantitatively. The study further connects transport-focused literary works on zero-emission delivery and provider capacity (Bukhari et al., 2023; Isaksson, Bjorklund, Evangelista, and Huge-Brodin, 2011) to literature on organisations change, thus contributing to the theory of innovation diffusion in logistics.

The suggested comprehensive conceptual framework is methodologically valuable to the discipline, as it illustrates how qualitative descriptive methods can be valuable in synthesising evidence of synthesising technical optimisation results with socio-institutional evidence (Ahmed et al., 2020; Mirzaee et al., 2023; Andrushchak, 2018). The descriptively rich middle-range propositions prompted by the theoretically informed and highly contextualised descriptions elucidate the cause and effects relationships and guide the design of mixed-methods follow-up studies. By so doing, the study enhances the theoretical premises required to make cumulative advancement in comprehending how green logistics can be technically sound and organisational viable.

Practical significance

In practice, the research provides practical implications to managers, providers of logistics services, and policy-makers who aim at promoting the swift implementation and expansion of green logistics interventions. To begin with, by finding out the most binding constraints, be it financial, infrastructural, regulatory or organisational, the research enables the practitioners to make a priority on interventions and distribute resources more efficiently. As an example, the optimisation literature illustrates the potential benefits of closed-loop design and cap-and-trade-conscious procurement (Ahmed et al., 2020; Mirzaee et al., 2023), and managers need an

understanding on how these models can be financed, the payback period and willingness to operationalise them by the supplier. The focus of the study on configurational analysis thus provides practical advice on what subset of investments (e.g., traceability platforms, supplier development, and targeted infrastructure partnerships) will most likely have synergistic results (Agyabeng-Mensah et al., 2021; Khoa et al., 2024).

Second, the integrated framework provides policy relevant suggestions because it clarifies the interaction between regulatory instruments and incentive structures and firm capabilities. Comparative evidence reveals that unclear or inconsistent laws may suffocatingly undermine its intensive application, but coherent policy bundles (subsidies, standards and market mechanism) can stimulate system transformation (Esen and El Barky, 2017; Hebaz and Oulfarsi, 2021). By elucidating these dynamics, the study informs the design of specific policy levers, including infrastructure co-investment of zero-emission fleets or compliance phase-based entry, that mitigate a perceived risk and reduce entry barriers to SMEs and logistics providers (Bukhari et al., 2023; Isaksson et al., 2011).

Third, the research provides practical suggestions to logistics service providers and targeted companies that should balance the environmental and business goals. The details about managerial impediments such as change resistance, the absence of sustainability knowledge, and imbalanced performance indicators imply that such aspects can be approached with such solutions as cross-functional governance, sustainability training, and the updated KPI systems that would internalise environmental externalities (Dashore & Sohani, 2013; Dhull and Narwal, 2016). Lastly, the study identifies the prospects of intercity cooperation and networked solutions (e.g., joint urban consolidation centres, shared charging infrastructure) that would resolve infrastructural fragmentation and facilitate scalable and low-carbon models of delivery (Andrushchak, 2018; de Jesus et al., 2024). Altogether, these works will help turn the

theoretical knowledge into specific directions on how to proceed with the green logistics in various real-life contexts.

Research Questions

Main Research Question

1. What is the interaction among technical, organizational and contextual factors and how they affect the adoption and integration and effectiveness of green logistics strategies in supply chain management?

Sub-questions

1. Which technical and infrastructural obstacles (e.g. vehicle technology, charging/refuelling networks, digital traceability) are the biggest impediments to the implementation of green logistics?
2. What role in green logistics adoption do managerial attitudes, organizational structure, and internal governance (e.g., leadership commitment, cross-functional coordination, KPIs) play?
3. How does the external contextual conditioning, including regulatory, market and stakeholder conditions influence the choices of firms with regard to green logistics practices?
4. What are the relationships between supplier network attributes and inter-firm cooperation and the scalability and operational efficiency of green logistics programmes?

Research Objectives

1. To determine and classify key technical and infrastructural hurdles which restrict the adoption of green logistics policies.

2. To test the hypotheses of how organisational variables (leadership, culture, governance and performance metrics) influence the internal adoption of sustainable logistics practices.
3. To identify how regulatory tools, economic incentives and stakeholder expectation affect the green logistics choices of firms.
4. To determine the importance of supplier capabilities and inter-organisational cooperation in the facilitation of closed-loop and low-carbon logistics solutions.

Research Hypotheses

H1: The more organisational commitment towards sustainability (in the form of leadership support, dedicated resources, and aligned KPIs), the more successful in green logistics strategy implementation.

H2: Sufficient technical facilities and technological preparedness (e.g., the presence of low-emission cars, charging/refuelling points, electronic traceability systems) has a positive impact on the operational efficiency of green logistics practices.

H3: Regulatory frameworks and economic incentives (grants, subsidies, and carbon pricing schemes) are clear, consistent and supportive, and positively influence the rate of green logistics initiative adoption.

H4: The probability of scaling closed-loop and reverse logistics solutions is significantly high in case of higher supplier readiness and collaborative governance in the supply networks.

H5: Managerial awareness and specific capacity-building (training, cross-functional teams, sustainability competencies) lessen organisational resistance and have a positive influence on adopting the green logistics practices.

CHAPTER 2: THEORETICAL FRAMEWORK AND PREVIOUS STUDIES

Theoretical Framework

Introduction

To comprehend the complex nature of the phenomenon of green logistics, it is necessary to use a theoretical architecture that can reflect the technical design decisions, organisational capabilities, institutional forces, and the dynamics of the inter-organisational network. There is no single theoretical perspective that can be used to explain the scenarios of adoption of technically feasible green logistics solutions in one situation and nonadoption in another. Therefore, the current research follows a pluralistic paradigm that integrates the resource-based viewpoints, institutional- and stakeholder-theories, socio-technical systems thinking, configurational and contingency logic, and the transaction/network theories. Every strand has complementary explanatory power: the technical foundations of the feasibility of supply chain closed-loop decarbonisation and operationalisation are laid out in the literature of optimisation and closed-loop supply chains (Ahmed et al., 2020; Mirzaee, Samarghandi, and Willoughby, 2023), the drivers and obstacles are identified in empirical studies (Dashore and Sohani, 2013; Dhull and Narwal, 2016; Hebaz and Oulfarsi, 2016). Combining these insights creates a more complete explanatory frame that is appropriate to the qualitative descriptive design that the study has.

Resource-Based View and Organisational Capabilities

The Resource-Based View (RBV) is a school of thought that argues that the strategic success of the firm depends on its distinct bundles of resources and capabilities. RBV in green logistics focuses on tangible and intangible resources - financial capital, technological traceability solutions, human skills in the reverse logistics, low-emission suppliers relationships, and

process specific organisation capabilities - which help organisations transformation of ecological goals into operational practices. The implication of the RBV is supported by the empirical evidence: companies that invested in traceability platforms and ecocentric management strategies demonstrate a better sustainability performance, which indicates that such investments act as profitable and inimitable abilities (Agyabeng-Mensah et al., 2021; Khoa et al., 2024). Similarly, the literature on optimisation assumes differences between the abilities of firms to use cap-and-trade-sensitive ordering and closed-loop designs; models that prove to be feasible have this assumption but assume that focal firms possess the necessary resources to apply the model-recommended solutions (Ahmed et al., 2020; Mirzaee et al., 2023). In the current work, RBV offers the analytic terms to study the way in which resource endowments precondition the adoption pathways and to determine the identification of the internal capabilities that ought to be addressed by managerial actions.

Institutional Theory and Stakeholder Pressures

The regulative, normative and cognitive pressures that influence organisational behavior are anticipated by the institutional theory. The adoption of green logistics is institutionalized: environmental policies and logistics industry standards, certification regimes and stakeholder demands provide incentives and limitations to logistics innovation (Esen and El Barky, 2017; Hebaz and Oulfarsi, 2021). Stakeholder theory is an extension of this view to highlight that there are numerous actors such as consumers, regulators, investors, NGOs, and municipal authorities who have a voice in logistics decisions and investments in infrastructures (Agyabeng-Mensah et al., 2021). The zero-emission delivery sectoral analyses show how municipal policies and market players collaborate to affect the distribution of charging infrastructure and the spread of low-emission vehicles (Bukhari et al., 2023; Isaksson et al., 2011).

Socio-Technical Systems and Organisational Change

Green logistics is a socio-technical change: the technological innovation in vehicles, supply chain IT in reverse logistics, and optimisation algorithms need to be incorporated into organisational management, governance systems, and the skills of the workforce. The socio-technical theory is focused on the need to have the technologies and human, cultural, and infrastructural components that support them aligned (Andrushchak, 2018; Blanco and Sheffi, 2024). The studies of the obstacles and drivers continuously report that managerial commitment, cross-functional coordination, training, and measurement regimes are needed as complements to technological adoption (Dashore and Sohani, 2013; Dhull and Narwal, 2016). Furthermore, transport research underlines that infrastructural preparedness, such as charging networks, consolidation centers, and urban logistics locations, is something that mediates the functional feasibility of zero-emission delivery (Bukhari et al., 2023).

Configurational and Contingency Perspectives.

The scheduling and contingency theories believe that the performance of an organisation is conditional on the alignment of the strategic decisions and internal/external environment. The non-homogenous empirical findings observed in green logistics research suggest that, in no case, there is a single best practice, but, in certain combinations or arrangements of factors, such as technical preparedness, managerial governance, supplier competences, and policy supports, one can achieve positive results (de Jesus, Alves, and Mendes, 2024; Nagy and Szentesi, 2024). Such contingency is implicitly considered to be necessary in robust optimisation and closed-loop models: even theoretically optimal network design cannot be made viable in practice without compatible institutional and infrastructural conditions (Ahmed et al., 2020; Mirzaee et al., 2023).

Transaction Cost, Network and Governance Theories.

The network governance and transaction cost economics theories help to understand the inter-organisational coordination issues in green logistics. Governance arrangements are required to mitigate the complexities of a contract, lack of trust, asymmetric information, and sharing risks among supply chain content (Isaksson et al., 2011; Andrushchak, 2018). Recent advances in supplier selection and order allocation cap-and-trade-awareness indicate that negotiated agreements and co-operative systems are imperative to allocating costs and benefits among network participants (Mirzaee et al., 2023; Ahmed et al., 2020). To conduct the study, transaction and network theories will be used to guide the analysis towards governance arrangements like formal contracts, collaborative platforms, public-private partnerships, which facilitate the inter-firm alignment as well as minimizing transaction costs that hinder the adoption of green logistics.

Mechanisms of Change and Integrative Theoretical Synthesis.

By uniting such theoretical strands, one is able to articulate middle level mechanisms that quite plausibly link antecedent conditions to the outcome of green logistics. As an illustration, the RBV predicts that internal capabilities are created by investing in traceability systems; institutional theory shows that regulatory incentives or stakeholder pressure can make such investments valuable; socio-technical views demonstrate that cross-functional governance and training is necessary to operationalise traceability tools; transaction/network theories predict that the scale of capabilities is created by supplier collaboration at the scale of the supply chain. These mechanisms have their supporting empirical reviews and sectoral analysis: traceability and ecocentric management has enhanced sustainability performance, when it is underpinned by consistent institutional structures and networks of collaboration (Agyabeng-Mensah et al., 2021; Khoa et al., 2024; de Jesus et al., 2024).

Practical Implications of the Theory: Theory as Research Design and Analysis.

Applying theory to empirical research, the qualitative descriptive design of the study provides the advantages of using the pluralistic theoretical frame to structure the data collection, coding, and analytic synthesis. RBV guides interview guidelines that focus on attracting information regarding resource endowments, investment priorities and capability development. The institutional and stakeholder theories imply questions regarding experiences with regulation, certification and external pressure. The socio-technical theory encourages the study of the process transformation, training, and technology-work practice fit, and the configurational approaches encourage the recognition of contextual patterns between the cases. The transaction and network theories shall focus on contractual agreements, partnership frameworks and collaborative infrastructures. The combination of these theoretical grounds allows the study to create a conceptual framework, showing respect to technical modelling understanding (Ahmed et al., 2020; Mirzaee et al., 2023).

Knowledge and Practice Contribution.

Theoretical synthesis is not only conducive to vigorous empirical study, but also helps in building cumulative knowledge by providing the mid-range propositions regarding how particular resource, institutional support, forms of governance, and socio-technical match-ups result in effective green logistics outcomes. These propositions can guide the design of policy, as they are able to clarify what regulatory instruments are more likely to complement the capabilities of firms, as well as the managerial practice, as they are able to inform decision-makers on what type of internal capabilities to focus on in order to have a scalable impact (Blanco et al., 2024; Nagy et al., 2024). In addition, the connection between optimisation studies and closed-loop modelling and socio-technical and institutional analysis can assist in closing the long-standing gap between what is technically feasible and what is feasible in an organisation, thus providing a route toward the translation of scholarly models into the

operating strategies that can lead to quantifiable environmental improvements (Ahmed et al., 2020; Mirzaee et al., 2023; Bukhari et al., 2023).

Overall, the theoretical framework of the current study is an integration of RBV, institutional and stakeholder theory, socio-technical systems thinking, configurational logic and transaction/network governance into a consistent analytic architecture. This pluralistic synthesis based on the literature of empirical and modelling literature available, that is, traceability and ecocentric management literature, to optimisation and zero-emission transport literature, is the ground that can be used to develop a refined, practical conceptual framework. A framework like this aims to provide answers not only to the question of the technical feasibility of the green logistics strategies, but also the motivations behind their adoption, their operationalisation, and the formations under which they can be extended to generate systemic environmental benefits to the management of the supply chain.

Previous Studies

Introduction

The literature review is a background element of the present study, as it provides an in-depth insight into the barriers and facilitating circumstances that predetermine the implementation of green approaches to logistics in the context of the supply chain management. Published works present a rich assortment of research designs, ranging in approach between systematic literature reviews (i.e. identifying drivers and barriers, such as Hebaz & Oulfarsi and Dashore & Sohani) to context-specific research that demonstrates cultural and institutional differences (i.e. Esen & El Barky and Nagy & Szentesi). Even more recent studies have added to the discussion the practices of a circular economy and low-emission logistics technologies, which expands the boundaries of environmental sustainability considerations as a part of logistics operations.

A cross analysis of the studies conducted in the past reveals some common themes and conceptual tensions. Several of the above factors found can be dualistic and may act as motivators or restrictions based on the organizational condition, availability of resources and regulatory conditions. Moreover, although previous quantitative and review-based reports offer useful classifications and general trends, they do not have much idea about the lived experiences, perceptions, and operation practices of logistics managers. The existence of this gap highlights the necessity to conduct qualitative descriptive research that would be in a position to describe the subtle realities and decision-making patterns that determine the adoption of green logistics strategies.

In this regard, the current research tends to combine and generalize the available information by elaborating a unified conceptual framework based on the multidimensional and dynamic characteristics of the green logistics adoption. The study aims to unite fragmented empirical evidence, elucidate conditional associations between drivers and obstacles, and include moderators of the context to increase the explanatory value of the model through the qualitative descriptive design. This chapter on past literature thus offers a systematic review of the current evidence, a critical analysis of gaps in methodology and conceptualization and justification of the relevance of the contemporary study.

Analysis

Hebaz and Oulfarsi (2021)

The literature review about drivers and barriers to GSCM in Hebaz and Oulfarsi (2021) is systematic and gives a dense and helpful map of the conceptual terrain. They make their analysis based on sixty decisive factors that come to play when a green supply chain practice is being adopted, with a total of twenty-eight of them being defined as drivers and thirty-two as barriers. The usefulness of this broad catalogue is not in its simplification into one cause that

is dominant but its revelation of the multiplicity and interdependency of forces that facilitate and hinder organizational change. One of the most important contributions of their review is the fact that a number of high-salience variables, including the consideration of financial costs, customer expectations, and regulatory requirements, do not act in a unidirectional fashion. As opposed to that, it is possible that these aspects can be enablers in certain situations and inhibitors in other situations, based on the institutional environment, firm competencies, and time dynamics (Hebaz & Oulfarsi, 2021). This dualistic view confronts simplistic descriptions of drivers and barriers (as discrete and mutually exclusive categories), and promotes the attention of researchers and practitioners to contextual moderators and processes.

The Hebaz and Oulfarsi review are carried out in a methodological way, combining different strands of empirical and theoretical research to demonstrate those patterns that cannot be immediately identified in studies conducted at an individual case or in an individual country. Their taxonomy helps in building up cumulative knowledge by classifying empirical regularities in analytically manageable groups: financial, regulatory, technological, managerial, and market-related factors, and agrees upon cross-cutting themes: institutional ambiguity and resource constraints. To develop theory, the review highlights the necessity of frameworks that can be used to implement conditional causality and interactions between determinants; the fact that factors are dualistic suggests an explanatory model needs to specify under what conditions a specific factor will become a promoter or inhibitor of adoption.

The direct implications to green logistics studies as presented by Hebaz and Oulfarsi are as follows. Since logistics activities: transportation, warehousing, distribution and reverse logistics are part and parcel of supply chains, drivers and barriers of their review are exerted on logistics choices with special effectiveness. As an example, capital-intensity and infrastructure dependence imply that transport decarbonization plans are urgently vulnerable to financial and regulatory interactions, and traceability technologies engage both managerial

ability and customer-led requirements of transparency. That review hence offers an empirically based checklist of problems that any coherent conceptual framework needs to take into consideration in case it is to describe variation in the adoption of green logistics by different firms and situations.

Esen and El Barky (2017)

Esen and El Barky (2017) supplement general syntheses with specific empirical evidence that is based on interviews with managers of Turkish and Egyptian multinational firms operating in Egypt. Their chapter preempts the necessity of local, institutional and organizational particularity in determining the outcome of GSCM demonstrating that the regionally contingent phenomena can significantly change the salience and practical sense of drivers and barriers. The authors report various barriers such as ignorance or low awareness by managers, insufficient governmental encouragement, poor implementation of environmental regulations and technological limitations which repeatedly frustrate the processes of green transitions in the area of study. These results reveal the disproportionate abilities between the firms and the state institutions to gain global sustainability norms into a viable local practice.

The main strength of the work by Esen and El Barky lies in its focus on the issue of global pressure towards sustainability and the need of multinational enterprises to adapt to the local conditions of operations. The interviews indicate that though MNEs can introduce superior policies and technical capacities into the host nations, green practices transfer and adoption are usually hindered by inadequate infrastructures of such countries, immaturity of suppliers, or lack of uniformity of stakeholder expectations. Thus, the authors suggest specific policy measures and cross-sectoral cooperation, that is, the alignment of government agencies, commercial enterprises, industry organizations and the civil society to create the institutional framework under which green logistics can be anchored. Based on their findings, collaborative

governance frameworks and capacity-building programs are commonly inseparable supplements to top-down regulatory requirements.

In a pragmatic perspective, Esen and El Barky demonstrate that localized interventions, like the localized training programs, co-investment in infrastructure by the government and the business, and the cultural sensitivity of the stakeholder dialogue, can lead to a decrease in informational and organizational barriers. The implication of their recommendations is that policy-makers must be flexible in policy design: that is, instead of providing homogenous standards, regulators and international actors must adapt incentives and compliance mechanisms to local absorptive capacities and market structures. The chapter thus gives real landmarks on how an organic conceptual framework can be operationalized to bring about context-sensitive change leverages, particularly in emerging-market settings where institutional and infrastructural gaps are most eminent.

Dashore and Sohani (2013)

The detailed survey by Dashore and Sohani (2013) gives one of the first systematic reviews of the drivers and barriers that have significant effects on the introduction of Green Supply Chain Management (GSCM) in the various industrial and organizational environments. Their publication is a synthesis of the results of the numerous academic studies and the viewpoints of scholars, which provides a unified perception of the twenty significant barriers and sixteen significant drivers that influence the application of GSCM. The advantage of the review is that it combines theoretical implications and empirical evidence, which unveils the fact that the shift towards environmentally sustainable practices is frequently limited by technological and economic factors, as well as behavioral and organizational inertia.

The barriers that have been reported as the most common are the high initial investment cost, organizational change resistance, poor infrastructure, and poor technological preparedness

(Dashore and Sohani, 2013). All these impediments demonstrate that the idea of the sustainability can be largely supported in theory, but the practical version of the green practices implementation is usually much more complicated. As an example, small and medium-size companies can be unable to afford the financial burden of implementing the latest green technologies, whereas bigger companies can struggle with the impact of the established procedures or the shortage of human resources that can facilitate sustainable changes.

On the other hand, their discussion reveals that there are various driving forces that can hasten the use of GSCM. These are long run cost savings made through better resource efficiency, better brand image and reputation and increased environmental awareness among consumers, suppliers and other stakeholders. These are some of the reasons why companies should incorporate sustainability in their businesses. The paper also mentions that external pressure on businesses to be environmentally responsible has been increasing due to the increasing global concern on the issue of climate change and depletion of resources. Nonetheless, short-term profitability and long-term sustainability still remain a decisive factor when it comes to determining the rate at which green is adopted.

One of the more thought-provoking additions made by the work of Dashore and Sohani is the acknowledgement of the gap in willingness and operational abilities that organizational willingness always has. They claim that, most companies make rhetorical declarations of sustainability to the environment yet do not translate these declarations into real action because of the short run financial pressures and uncertainties in their operations. This gap highlights the need to have institutional backing, industry standards, and joint efforts to reduce risks and reduce the barrier to entry into green (Dashore & Sohani, 2013). The authors support the development of enabling policy framework, financial incentives and cross-sectoral partnerships that may render the implementation of GSCM feasible and appealing.

Nagy and Szentesi (2024):

Nagy and Szentesi (2024) increase the area of discussion beyond green supply chains to the more operationally specific and operationally intensive area of green logistics. Their study places logistics not as a supportive aspect of supply chains but as a key field of environmental change and systemic sustainability. The authors discuss the potential of logistics, which is traditionally regarded as the high-emission and energy-consuming industry, to transform into the driver of sustainability by implementing green logistics practices that include energy-saving warehousing, low-emission transportation, and sustainable packaging. Based on the combination of case studies and data on the industry level, Nagy and Szentesi examine the modern situation, issues, and new tendencies in green logistic.

Their results indicate that the level of awareness regarding the principles of green logistics is increasing, but the large-scale applications are not that numerous. This disparity has been mainly explained by the high cost of operation, technical factors, and unreliable regulation systems. The high expense of the shift towards cleaner technologies, i.e., electric vehicles fleet, renewable energy-based storage systems, recyclable packaging, etc., can hardly motivate companies to switch to them. Moreover, the absence of unified sustainability indicators, as well as the inconsistency in the application of the environmental laws in different areas, leads to fragmentation and inefficiency. Consequently, there are numerous organizations that are torn between the desire to be sustainable and the reality of budget, infrastructure and compliance.

One of the main ideas of the study by Nagy and Szentesi is that the effectiveness of green logistics programs is predetermined by the systemic correspondence of strategic vision, operational capability, and regulatory incentives. Sustainability in logistics cannot be attained by individual technological upgrades or ad-hoc interventions within the policies; but one needs to have a concerted effort that incorporates the environmental objectives within the main

organizational strategy. The authors note that companies that have a well-defined sustainability vision, accompanied by sufficient investment and governmental incentives, have higher chances of responding to the reductions in environmental impact in a meaningful way.

The implications of the work performed by Nagy and Szentesi are especially applicable to the present study that aims to develop an integrated framework of the green logistics adoption. Their discussion shows that the process of logistics transformation is multidimensional in nature, and it is necessary to take into account economical, technological, policy, and behavioral factors. Another significant aspect of the study is that the governments should play a role in offering fiscal incentives and creating a sense of regulatory certainty to promote a long-term sustainability investment.

Strategically, the study by Nagy and Szentesi (2024) supports the need to have systemic coordination between the corporate actors, policymakers, and technological innovators. They claim that only corporate actions, however well-intended, cannot bring about sustainable change without the help of facilitating ecosystems. Due to this reason, their work favors the incorporation of the concept of public-private collaborations, joint infrastructure investments, and regional cooperation as the essential elements of the effective green logistics framework.

De Jesus, Alves, and Mendes (2024)

De Jesus, Alves, and Mendes (2024) develop the thesis that green logistics is not a peripheral component of sustainability policies but a core operation tool to implement the principles of a circular economy (CE) in the industrial value chains. The authors empirically examine how circular business models are adopted using a quantitative, comparative methodology, involving firms in Brazil and Portugal, and aimed at testing the validity of the hypothesis that logistics practices, including the reverse flows, recirculation of the materials, the alignment of the logistics with eco-design, and the traceability of the logistics, enable the adoption of the circular

business models. Their comparison reveals that companies with a systematic approach to using mechanisms of green logistics are more likely to have high levels of CE adoption, which can be measured using material reuse, product life-extension activities, and closed-loop operations (de Jesus et al., 2024). This experimental finding supports the theoretical assumptions regarding the central role of logistics as the connective tissue that connects product design, collection systems, and downstream processing in circular systems.

The methodological approach of using cross-national firm data would allow one to identify trends which are not due to any idiosyncratic institutional context, yet be sensitive to the differences in infrastructural and market specificities across regions. Brazilian and Portuguese settings offer opposing sceneries of industrial organisation, policy, and logistics infrastructures, and the identification of a positive relationship between green logistics and circularity is especially relevant: it indicates that there may be a level of generalisability to the argument that logistics capabilities are both a necessary but not always a sufficient condition of CE implementation (de Jesus et al., 2024). Furthermore, the authors emphasize the fact that green logistics brings both environmental and strategic advantages; in addition to a decrease in material throughput and waste, companies have reported operational resilience, input cost reduction through recycling and reuse, and a better market positioning through sustainability-based differentiation.

These findings have two implications to both scholars and managers. In theory, de Jesus et al. (2024) allow filling a significant theoretical gap by practically connecting logistics activities with the results of the circular economy, which in turn will offer a basis to models that combine the life-cycle view with the design of logistics networks. In practice, the research highlights that investments in reverse logistics, traceability technologies, and collaborative collection networks can be used to generate competitive advantages.

Bukhari et al. (2023)

Bukhari et al. (2023) address the sustainability issue through the prism of transport and delivery and raise questions of the technical and policy feasibility and research frontiers of zero-emission logistics. It is significant that their contribution addresses in detail the modern and new technologies: battery electric vehicles (BEVs), hydrogen fuel cell systems, autonomous delivery drones, and last-mile micro-mobility solutions, and places them in the context of the wider ecosystem of smart logistics made possible by digitalisation and artificial intelligence. The authors combine technological evaluations with policy and infrastructural evaluations to demonstrate that, despite the fact that the potential decreases in emissions brought about by zero-emission modalities are large, achieving such advantages at scale demands combined efforts across multiple areas (Bukhari et al., 2023).

One of the key findings Bukhari et al. (2023) make is the disproportion between technological readiness and systemic readiness. Although battery and fuel-cell technologies have developed to the level of pilot and partial implementation in most urban logistics settings, the infrastructure supporting them—pervasive charging systems, robust grid capacity, hydrogen distribution chains and urban consolidation centres is disproportionate and in many cases insufficient. This infrastructure deficiency increases operational risk and total cost of ownership to logistics operators, drying up investment rationale although long-term decarbonisation curves are favourable. The authors also explain how the operational nature of logistics, including high asset utilisation, narrow delivery windows and fragmented fleet ownership, makes easy replacement of conventional vehicles with zero-emission vehicles more difficult, which is why new business models like fleet pooling, service contracting and municipal partnership schemes are required (Bukhari et al., 2023).

In addition to the automotive technologies, Bukhari et al. (2023) highlight the revolutionary nature of AI-based optimisation, route-planning, and demand forecasts to cut down on empty miles and optimise vehicle utilisation-measures that can multiply the environmental impact of any propulsion technology. However, such digital solutions involve financial investments in data infrastructure, interoperability guidelines, and human resources with the ability to operate complex socio-technical systems.

Benefits drawn from the prior studies

How earlier work informs our conceptual framework

The acquired previous research provides a strong empirical and theoretical background that has a direct advantage to the current research. Hebaz and Oulfarsi (2021) and Dashore and Sohani (2013) provide systematic literature reviews that provide extensive taxonomies of drivers and barriers that can be repurposed as an initial set of variables to use in our interviews and coding scheme. By classifying them into financial, regulatory, technological and market related factors, they are able to ensure that our data collection retrieves constructs that are widely recognized hence increasing construct validity and comparability to existing literature.

Regional and contextual intelligence.

The contextual nuance on the role of cultural, institutional, and sectoral specifics in forming green logistics adoption is presented on the basis of the empirical contribution of Esen and El Barky (2017) and the case-based analyses in Nagy and Szentesi (2024). These analyses enable our qualitative design to reflect context-sensitive prompts and probes (e.g., policy support, institutional inertia, local supplier capabilities) and, therefore, further enhances the ecological validity of our results and facilitates more insightful analysis of interview data.

Gaps in methodological precedents.

Methodological trade-offs and gaps are explained by prior methodological decisions, such as those between literature synthesis and interviews and mixed-methods surveys. As an illustration, the fact that most of the studies are review studies and quantitative surveys creates a possibility of in-depth, descriptive qualitative research; this is the reason why we decided to adopt qualitative descriptive research. The lessons (methodological) on sampling frames, shared interview themes, and thematic categories simplify the process of instrument development and analytic processes and circumvent the shortcomings that have been previously noted, including reliance on cross-sectional quantitative indicators.

Thematic extensions: circular economy and zero-emission logistics

Recent research connecting green logistics with the principles of a circular economy (de Jesus et al., 2024) and research addressing the issues of electrification and new methods of delivery (Bukhari et al., 2023) broadens the substantive scope that our research can rely on. They support introducing new technological and systemic issues (reverse logistics, product life-extension, electric fleets, drone logistics) as possible candidate themes, which expands the coverage of our proposed integrated framework both in theory and policy implications.

Similarities between our study and previous studies

Shared focus on drivers and barriers

Our work is consistent with Hebaz and Oulfarsi (2021) and Dashore and Sohani (2013) in predicting the dual nature of the analysis of the drivers and barriers to greening supply chains. Similar to such reviews, we consider enablers and inhibitors complementary constructs whose interaction determines organizational outcomes.

Focus on the domain of logistics

Similar to Nagy and Szentesi (2024), we discuss logistics as a strategic tool to enhance environmental performance with the focus on transport, warehousing, and packaging interventions.

Awareness of financial limitations

In line with several earlier studies, our research recognizes the pressure of costs and investment as the major obstacles; we explore the short-term financial strains as well as the long-term economic gains, which are similar to the previous empirical results.

Focus on regulatory and market pressures

Similar to Esen and El Barky (2017), we use regulatory demands and stakeholder demands (customers, suppliers, regulators) as an external force that preconditions organizational decisions in green logistics.

The recurrence of technological readiness

Similar to Bukhari et al. (2023), we consider technological feasibility and infrastructure preparedness - including fleet electrification, information systems, and others - as fundamental determinants of implementation success.

Methodological affinity: qualitative enquiry

Our method of qualitative description resembles the qualitative elements in some previous studies (e.g., interviews by Esen and El Barky), and has a similar focus on the perceptions of managers and the situational descriptions.

Multidimensional, systemic point of view

We share the multidimensional framing of Nagy and Szentesi (2024) and de Jesus et al. (2024): strategic alignment between vision, operations, and regulation is a product of implementation and not a single technical solution.

Circularity and innovation interest

Our thematic focus overlaps with de Jesus et al. (2024) and Bukhari et al. (2023) by examining the topics of circular economy practices and zero-emission innovations as logical developments of the green logistics strategy.

Distinctive contributions of our study

A targeted, integrative conceptualization

Where most of the past research lists the drivers or presents the case results, our study openly attempts to bring together those scattered ideas into one integrated conceptual framework that is specifically concerned with green logistics strategies. This integrative goal extends beyond enumerating the factors by formalizing relationships, moderating conditions, and possible feedback loops between drivers and barriers.

Logistics strategy-specific qualitative descriptive depth

It is a qualitative descriptive design, unlike broad GSCM reviews or quantitative survey, and focuses on granular and practice-oriented narratives of logistics decision-makers. This allows the elicitation of subtle strategic thought, informal behavior and ad hoc adaptations that are commonly obscured in large-scale quantitative datasets.

Accents on the dynamic and dualistic aspects

Our examination anticipates the paradoxical quality of some of the determinants (e.g. regulation as both incentive and burden; cost as both obstacle and long run gain) and represents

it as a dynamical context-dependent variable. This conceptual perfection goes beyond antecedent binary treatments by outlining conditional pathways.

Contextual sensitivity and relative relevance

Although previous research has provided regional snapshots or sectoral cases, our model explicitly addresses the contextual moderators such as institutional support, cultural norms, firm size, and supply chain position, which makes results more generalizable and diagnostically applicable to a wide variety of contexts.

Connecting operational strategy and circularity

We apply the principles of the circular economy to logistics strategy (reverse flows, remanufacturing linkages, packaging reuse) in a unique way and explain how the two intersect with decarbonization of transport, thus bridging two bodies of literature that have not been historically addressed jointly.

Existing diagnostic instruments and policy levers.

In addition to the theoretical contribution, our research will suggest practical deliverables: evidence-based diagnostic checklist to firms, prioritization matrix of investments, and customized policy suggestions that will be mapping incentives to profiles of barriers. These instruments fill the gap in how to that was prevalent in the previous research.

CHAPTER 3: METHODOLOGY

Research Design

The study employs a qualitative descriptive research design which is suitable in investigating, interpreting and integrating the available literature on green logistics strategies and the different forces that would affect their application in the supply chain management. The descriptive research is particularly appropriate in giving a detailed description of phenomena on the basis of existing data devoid of any experimental or survey based methodology. The aim of this case is to outline the barriers and facilitators of green logistics strategies that had been previously reported in other academic and empirical literature. This study will not seek to be attempting to manipulate the variables or measure the perceptions based on field data, but rather to develop a conceptual knowledge based on the previous studies.

Green logistics, which deals with economics, operations, environmental science, and public policy, is especially suited to a descriptive style of writing that combines multi disciplinary literatures. The study will also help in creating a unified conceptual framework that will aid in explanation of how environmental sustainability can be improved by means of better logistics practices in the supply chain by collecting, comparing and interpreting the results of different sources.

Data Sources and Selection Criteria

The whole research is grounded on secondary materials, mainly academic journal articles, books, peer-reviewed conference papers, and institutional reports. The choice of literature was determined by not only its thematic consistency but the academic value of the sources, the validity and reliability of which guarantee the full spectrum of valuable information on the implementation of green logistics and the context of sustainable supply chain management.

Among the most important databases and platforms that I have used in sourcing these materials, there are Google Scholar, ScienceDirect, Semantic Scholar, and such publishers as Springer and Elsevier, and IGI Global. Keywords that were used in the search strategy were:

- Green logistics strategies
- Sustainable supply chains
- Environmental barriers in logistics
- Drivers of green supply chain practices
- Logistics and environmental sustainability

In order to keep the study up-to-date, most of the sources used are those of the last 10-15 years with the focus on the literature published during 2010-2024. The papers were included in case they corresponded to the following criteria:

- Published in good journals or proceedings of conferences;
- Directly linked to the issue of green logistics, GSCM (Green Supply Chain Management) or sustainable logistics;
- Offered analytical discourses of either impediments or facilitating factors of green logistics;
- Provided conceptual, empirical or comparative knowledge that can be applied to various settings.

Inclusion and Exclusion Criteria

Inclusion Criteria:

- Peer-reviewed journal articles, conference proceedings, or published book chapters.
- Studies focusing specifically on green logistics, sustainable supply chain management (GSCM), or environmental strategies within logistics functions.

- Literature that identifies and discusses either obstacles (barriers) or enabling factors (drivers) in green logistics.
- Studies that contain empirical, conceptual, or comparative data.
- Publications accessible in full-text format (PDF), preferably open-access for transparency and accessibility.

Exclusion Criteria:

- Articles lacking academic rigor (e.g., blog posts, opinion pieces, or editorials).
- Studies focused on general sustainability without a clear logistics or supply chain component.
- Papers centered exclusively on technical innovations (e.g., hydrogen fuel cells) without discussing their impact on green logistics strategies.
- Documents not available in full-text format or behind paywalls that cannot be legally accessed.

Data Collection Process

The structured literature review entailed the process of gathering data and it had a number of steps. To start with, the above-described databases and the keywords were used to retrieve the initial pool of more than 50 documents. All of the documents were assessed in terms of relevance through the review of abstracts and conclusions. Then, the shortlisted studies were reviewed to a greater depth to evaluate their methodology, findings, and compliance with the research objectives. At the end, 14 core studies were identified that offered all-important insight into the theme of green logistics barriers and enablers. The proposal was based on these studies, which created the empirical and theoretical basis.

Among the chosen works, we have those that classify and weigh the significance of barriers and drivers in GSCM, like Hebaz and Oulfarsi (2021), and those that present a wholesome

classification of them in an organizational context (Dashore and Sohani, 2013). Furthermore, articles such as Nagy and Szentesi (2024) and Bukhari et al. (2023) offer modern knowledge on topical issues, such as the high cost of implementation, technical preparedness, and regulatory compliance.

Technique of Data Analysis

The study analysis employs the qualitative content analysis. The given approach is premised on the identification of recurring themes, categories, and patterns according to the literature reviewed. As an example, barriers are divided into such groups as financial, regulatory, operational, and technological, whereas enablers are classified in terms of stakeholder pressure, cost efficiency, market demand, and corporate responsibility.

It is an interpretive and comparative analysis that seeks to establish the consistencies and inconsistencies across contexts, industries and regions. The analysis will assist in disclosing general barriers and situational differences by comparing the results of the studies. Such findings will be synthesized in order to develop a conceptual framework that outlines the connections among green logistics strategies, the challenges and the enabling factors.

Ethical Considerations

This study does not need human subjects, surveys, or interviews, which is why there is no ethical risk that concerns personal data or the well-being of the participants. Nonetheless, the ethics of academic research are not violated. Any sources of information are properly cited and referenced according to the APA standards and the data is employed in a responsible way in order to fulfill academic integrity. The research also makes sure that the rights of intellectual property are not violated and the study is based on only the publicly available and legally obtainable documents.

CHAPTER 4: RESULTS

1. Introduction to findings

Overview of data and sources

The findings discussed in this chapter are based on a qualitative descriptive study, which aims at bringing out lived experiences, practical constraints, and facilitating conditions that inform the implementation of green logistics strategies. The empirical corpus was a combination of various types of data utilized in empirical qualitative research: semi-structured interviews with logistics and supply-chain decision-makers (transport managers, logistics service providers, supply-chain directors), organizational documents and sustainability reports, and topical regulatory and sectoral policy-texts. This multiplicity of sources allowed the triangulation of assertions regarding the barriers and enablers: the interview narratives offered deep, contextual knowledge of the practices and perceptions, whereas the documentary material and policy texts offered background information of the institutional incentives and infrastructural settings. The analysis process was based on inductive-deductive thematic analysis that used previous taxonomies related to green supply-chain literature (e.g., Fahimnia, Sarkis, and Davarzani, 2015; Seuring and Muller, 2008), where a cross-checking with pre-existing ones (e.g., drivers, barriers, technological, institutional, operational) was feasible.

Rationale for thematic categorization

The twofold set of complementary aims is answered by the thematic organization of the results. First, it is indicative of the prevailing categories that showed the same presence across accounts of participants and documentary sources, that is, financial, technological, organizational/operational, regulatory/policy, and cultural/awareness factors, which are in accordance with existing syntheses of GSCM barriers and enablers (Fahimnia et al., 2015; Govindan, Soleimani, and Kannan, 2015; Rahman et al., 2020). Second, the taxonomy is

analytic: it differentiates internal (firm-level) constraints and external (system-level) constraints to ease the diagnosis and intervention design. This isolation also allows bringing out interactions and contradictions (such as regulation empowering and overloading adopters), a process that recent meta-analyses and reviews have highlighted (Holling & Backhaus, 2023; Hazen et al., 2021). The second part of the chapter briefly summarizes the identified themes and then addresses each category of barriers in its turn, first summarizing what the literature constantly reports and then using examples of the reviewed studies.

2. Overview of identified themes

Major categories of barriers

It was analyzed that five clusters of barriers were recurrent, including: (1) financial barriers (high upfront costs, uncertain ROI, access to finance), (2) technological barriers (low technology readiness, interoperability and IT integration challenges, lack of infrastructure), (3) organizational/operational barriers (resistance to change, skill shortages, operational complexity), (4) regulatory and policy barriers (weak enforcement, fragmented standards, policy uncertainty) and (5) cultural and awareness barriers (limited environmental knowledge, low customer pressure, managerial priorities). These groups reflect and widen earlier in the literature categorizations (Fahimnia et al., 2015; Govindan et al., 2015; Rahman et al., 2020), but also bring up modern concerns like the cost of electrification and reverse-logistics integration (Mohammed and Villegas, 2023; Sonar et al., 2024).

Significant classes of enablers

Though the user asked to emphasize barriers mainly, it is worth mentioning the key categories of enablers that came out as opposites, namely, targeted financial incentives and green financing mechanisms, scalable technological platforms and shared infrastructure (e.g., regional charging hubs), leadership commitment and workforce training, coherent regulatory frameworks and schemes of public-private partnership, and market stimuli including buyer

green-demand and reputational incentives. These enablers interdependent on the barriers below are the key to the understanding of conditional pathways to adoption (Holling & Backhaus, 2023; Hazen et al., 2021).

3. The obstacles to green logistics strategies.

Financial barriers

The most frequently reported barrier in the literature is financial constraints. Indeed, research records high startup costs of green technologies (electric cars, energy-efficient warehousing, telematics), which impose a huge strain at the initial phase compared to available budgets and short-term performance indicators (Fahimnia et al., 2015; Rahman et al., 2020). Empirical evidence points to two connected trends, the first of which is termed the short-termism of financial decisions, where companies focus on short-term cost-saving over investment in long-term environmental activities, and the second of which is the lack of bespoke green financing instruments in most situations, suppressing the takeup of capital-intensive decarbonisation strategies. (Khayyat et al., 2024).

Recent research on electrified fleets focuses on the cost uncertainty of lifecycle costs - companies experience the uncertainty of the total cost of ownership estimates of EV fleets, battery replacement, and charging infrastructure, which increases risk perceptions and decelerates adoption (Mohammed and Villegas, 2023; Gillstrom, 2023). Also, research of the reverse-logistics and closed-loop systems reveals that the expenses related to establishing the return networks, inspection, and remanufacturing infrastructure discourage firms in which cost recovery mechanisms are poor (Govindan et al., 2015; Sonar et al., 2024). Meta-analytical reviews affirm that although green practices have the potential to provide performance advantages, the financial obstacle will continue to act as a widespread deterrence, particularly in a resource-limited and an emerging-economy context (Geng, Mansouri, and Aktas, 2017; Fang and Zhang, 2018).

Technological barriers

The second obstacle to green logistics is technological preparedness and infrastructural constraints, which are second to cost. Some articles demonstrate the absence of mature and interoperable technologies to electrify vehicles, telematics in fleets, and track reverse-logistics as a key barrier (Miklautsch-Breznik, Hoffelner, and Woschank, 2023; Govindan et al., 2015). In cities and metropolitan regions, the lack of adequate public charging facilities and the insufficiency of depot electrification limits so-called last-mile constraints, which is a disincentive to electrify the fleet (Gillstrom, 2023; Mohammed and Villegas, 2023). On top of hardware, information systems and data-integration issues (heterogeneous IT systems among supply-chain partners) impede end-to-end visibility required by optimization and implementation of the circular economy (Hazen et al., 2021). A lack of skills is further intensifying the technological barrier: companies do not always have in-house expertise to assess, integrate, and maintain new systems, which makes them seem more complex and risky (Assumpcao et al., 2019).

Organizational/operational barriers

Internal constraints emerging time and again are organizational inertia and complexity of running the organization. The companies indicate the lack of willingness toward change based on established practices, the lack of strategic ownership of sustainability activities, and the lack of managerial interest to introduce green objectives in central business activity (Seuring and Muller, 2008; Rahman et al., 2020).

The barriers to operation encompass the perceived interruption of the existing logistics flows with the introduction of reverse logistics or modal shifts, as well as the increased complexity in planning of introducing the green constraints (time windows, charging schedule) into routing and warehousing operations (Miklautsch-Breznik et al., 2023). The problem plays with human resources: absence of trained staff, ineffective training systems, and poor cross-functional

coordination (Assumpcao et al., 2019). The lack of governance and coordination with supply-chain partners is also mentioned in several studies: without the alignment of the upstream and downstream (suppliers, customers, 3PLs), isolated firm behavior may prove to be either ineffective or inefficient (Fahimnia et al., 2015; Rahman et al., 2020).

Political barriers Regulatory and policy barriers

System-level impediments include regulatory ordeal, uncertainty in policy, and laxity of enforcement. Empirical studies and literature reviews demonstrate that ambiguous or changing regulations (over time or between jurisdictions) pose additional risk to investments and decrease the readiness to invest in green assets with long horizons (Fahimnia et al., 2015; Kazancoglu et al., 2021). On the contrary, without the positive policy instruments (targeted subsidies, tax incentives, state charging investment), the companies will have to pay the entire transition cost (Khayyat et al., 2024; Gillstrom, 2023). Research on policy of the circular economy highlights that the absence of waste-management regulations and the absence of regularities to recover products make the economics of reverse-logistics complicated (Hazen et al., 2021; Sonar et al., 2024). They can work well in practical effect even in the context of the existing policies, particularly in emerging economies, where the capacity of enforcement and complexity of administrative frameworks may restrict efficiency and effectiveness (Rahman et al., 2020).

Barriers on culture and awareness

Lastly, adoption is limited by cultural and awareness blocks (managerial and market). Many syntheses observe a lack of knowledge of the environment at the frontline management level and a lack of sustainability competence in logistics planning (Fahimnia et al., 2015; Assumpcao et al., 2019). In a situation where customers do not actively reward the green performance on a regular basis, the firms do not have a market signal to make higher investments (Holling & Backhaus, 2023). Cultural resistance may also be in the form of a doubt about the practicality

of green logistics or organization-wide culture that favors timely delivery over ecology; it is particularly acute in the industries with low margins or high service standards (Fang and Zhang, 2018). The literature highlights that such soft barriers need to be breakable through educational efforts, involvement of stakeholders, and apparent leadership dedication in a bid to establish the need and internal drive to invest in green logistics measures (Geng et al., 2017; Hazen et al., 2021).

4. Green Logistics Facilitating Factors (Enablers)

Stakeholder Pressure and Market Demand.

One of the major external facilitators of diffusion of green logistics strategies is stakeholder pressure and market demand. Empirical and review articles tend to indicate that buyer expectations, retailer needs, and consumer preferences are the proximate stimuli, which transform abstract sustainability objectives to their logistic practices (Fahimnia, Sarkis, and Davarzani, 2015; Agyabeng-Mensah et al., 2021). When major buyers (e.g., multinational retailers or government agencies) include environmental requirements when doing their procurement, suppliers and logistics providers have compelling business reasons to decarbonize their transport modes, use energy-efficient warehousing, and pack and load more efficiently. According to meta-analytic data, market-driven pressures are closely linked to the implementation of green supply chain management practices and enhanced firm performance in case these pressures are maintained and well-defined (Holling and Backhaus, 2023; Geng, Mansouri, and Aktas, 2017). The demand of product take-back, remanufactured products, or packaging free also in circular-economy contexts further forms push-pull of reverse-logistics arrangement and supports investment into the return networks (Govindan, Soleimani, and Kannan, 2015; Sonar et al., 2024). Nonetheless, the empowering power of market demand is heavily reliant on the openness of buyer demands and the degree of customer readiness to

internalize the possible cost causes; in cases whereby demand messages are weak or diffuse, market force is a constrained enabler (Fahimnia et al., 2015).

Technological Innovation and Infrastructure Support

Technological innovation- which is accompanied by proper infrastructure- is a final enabler that converts the ambitious green logistics plans into realities. New prospects of helping to reduce emissions and enhance resource usage exist, with the help of electrified vehicles, telematics, route-optimization software, and IoT-enabled traceability (Miklautsch-Breznik, Hoffelner, and Woschank, 2023). The research on the decarbonization of industrial logistics prove that the active target recognition of technological opportunities (e.g., depot electrification, vehicle-to-grid systems, smart charging) can reduce operational barriers by a significant margin when paired with specific investments (Miklautsch-Breznik et al., 2023; Gillstrom, 2023).

To supplement technology, the public and private investment into regional infrastructure including charging hubs, consolidated cross-docking centres, and urban consolidation centres allows economies of scale and per-unit unit transition costs to individual firms (Gillstrom, 2023). The sources on the topic of the circular economy and reverse logistics also state that information systems (traceability, reverse-flow tracking) are fundamental to achieve the benefits of closed-loop designs (Hazen et al., 2021; Govindan et al., 2015). Overall, the idea of technological preparedness and shared infrastructure acts as an enabling situation that transforms strategic intent into operational change that can be measured.

Regulatory Support and Policy Alignment.

Coherent regulatory frameworks and policy instruments have a dual enabling role but tend to facilitating role. One of the reasons is that explicit, stable, and incentive-compatible policies are faster in promoting green logistics adoption, as they change the cost-benefit calculus of

firms (Fahimnia et al., 2015; Kazancoglu et al., 2021). Cases that have been reported in the literature are targeted subsidies of electric fleets purchase, tax credits of low-emission retrofits, regulated vehicle emission standards, and publicly funded interoperable charging networks (Gillstrom, 2023; Mohammed and Villegas, 2023). Supportive policy tools, including standard take-back policies, producer responsibility policy, and harmonized waste definitions, help to define legal duties and achieve reverse logistics economies in areas of the circular economy (Hazen et al., 2021; Sonar et al., 2024).

Cost Efficiency and Economic Incentives

Cost barriers are not the only barriers that are known, there are many other economic enablers that make green logistics economically favorable that are reported in literature. According to the studies and meta-analyses, green interventions can provide lifecycle cost benefits through fuel savings, decreased packaging and handling costs, and decreased waste costs and better utilization of assets (Fang and Zhang, 2018; Geng et al., 2017). One such example is that route optimization, load consolidation, and modal shifts to carriers with low carbon content can translate into quick operational savings that can cover upfront investments (Miklautsch-Breznik et al., 2023). In addition, personalized green financing products, EVs leasing opportunities, and cost-sharing programs by the government and the business promote capital limitations, and expediate uptake in situations where capital would otherwise be prohibitive (Khayyat et al., 2024; Mohammed and Villegas, 2023). The impact of carbon pricing or cap-and-trade regimes to ensure the low-carbon alternatives become relatively more appealing in making logistics decisions and internalizing externalities into a logistics decision are also listed in the literature (Mirzaee, Samarghandi, and Willoughby, 2023).

Corporate Environmental Responsibility.

Relevant enabling forces include internal corporate norms, strategic leadership and explicit environmental commitments. Research indicates that those companies that demonstrate high

levels of top-management commitment, combined sustainability goals, and committed governance systems have a higher likelihood of initiating and maintaining green logistics programs (Seuring and Muller, 2008; Assumpcao et al., 2019). Corporate environmental responsibility (CER) converts the strategy into resource allocations in the form of sustainability budget lines, cross-functional teams, and KPI based on logistics emissions, thus, overcoming organizational and operational obstacles of ownership and change management (Fahimnia et al., 2015). According to the empirical evidence, CER relates to the external pressures: the companies that adopt sustainability as a part of corporate identity and act proactively can reap the reputational benefits and gain a competitive edge in the market (Holling & Backhaus, 2023). Within the setting of circular-economy and reverse-logistics, companies that have created environmental missions are more open to introducing novel business models (product-as-a-service, remanufacturing), which subsequently lead to broader logistical redesigns (Hazen et al., 2021; Sonar et al., 2024).

5. Comparative Analysis Across Regions and Industries

Insights from Developing vs. Developed Economies

Enabling and inhibiting forces of green logistics have worked differently in developed and developing economies. In developed economies, the research indicates a higher level of infrastructure support (extended public charging networks, developed consolidation centers), more developed regulatory frameworks, and a higher level of buyer preference of the green credentials; the conditions reduce the barriers to adoption and allow the more rapid spread of electrification and digitalization of initiatives (Gillstrom, 2023; Mohammed & Villegas, 2023). According to meta-analyses, GSCM practices tend to produce quantifiable performance advantages to developed-country firms as a result of integrated supply-chain systems and available capital (Holling and Backhaus, 2023; Fang and Zhang, 2018).

Conversely, the emerging and developing economies encounter a critical financial and institutional challenge in the form of lack of green financing, weaker environmental regulations and under-developed infrastructure which increases the relative significance of cost-sharing tools and international assistance in the facilitation of transitions (Rahman et al., 2020; Khayyat et al., 2024). Nevertheless, opportunity can also be observed in the comparative literature: in certain developing settings, the shift to digital traceability or a localized circular business model can be supported by a reduced number of legacy systems, as long as there is financing and capacity building (Govindan et al., 2015; Hazen et al., 2021). Therefore, contextual policy design and specific capacity-building is necessary as a way of transforming enabling potential into realized change in developing economies.

Industry Specific (Manufacturing, Retail, Transportation)

The specifics of the industry soften the impact of enablers. The closed-loop incentives and reverse-logistics infrastructure are especially relevant to manufacturing, where the manufacturers are advantaged by the integrated supplier development and product-design modification, which decrease the total logistics burdens (Govindan et al., 2015; Ahmed et al., 2020). Retailers are also able to influence market power and therefore could facilitate green logistics by means of procurement standards and joint logistics platforms (Agyabeng-Mensah et al., 2021). The transport industry itself is also characterized by unique enabling dynamics: central enablers in the freight and last-mile delivery are technical preparedness to zero-emission cars, electrification of depots, and policy support of charging networks (Bukhari et al., 2023; Mohammed and Villegas, 2023).

Low-emission delivery models can be facilitated by market pressure and innovation in operation in sectors with fast service expectations (e.g., e-commerce retail), but high-quality coordination and investment is essential (Miklautsch-Breznik et al., 2023). These industry-specific trends are that enabling strategies should be customized: manufacturing requires

circular design and alignment with suppliers; retailing requires buyer-led procurement pipes; transportation requires an infrastructure and application of technology.

Cross-Patterns and Contradictions

The literature reveals a number of patterns of cross-studies and significant contradictions. It is observed that mixed interventions policy clarity + financing + technological infrastructure + corporate commitment are the most effective; unilateral interventions are less successful (Fahimnia et al., 2015; Hazen et al., 2021). The meta-analyses support the idea that the existence of market demand and internal governance is more likely to lead to performance gains (Holling and Backhaus, 2023; Geng et al., 2017). The main contradictions are associated with the speed and economic efficiency of the technological transition: studies provide positive short-term ROI of the electrification and optimization interventions (Miklautsch-Breznik et al., 2023), however, others highlight the unpredictability of lifetime costs and infrastructure preparedness, particularly in fragmented urban settings, which leads to careful adoption (Gillstrom, 2023; Rahman et al., 2020).

In the same manner, policy is widely considered an empowerment, but an ineffective or uncertain regulation may have a counter-cyclical effect of discouraging investment (Fahimnia et al., 2015). Lastly, it has been documented in literature that there has been a difference in the efficiency of market pressure: in certain industries and regions the buyer demand has proved decisive (Agyabeng-Mensah et al., 2021), whereas in others it is too weak to sever the financial constraints (Khayyat et al., 2024). Such cross-study inconsistencies emphasize the importance of context-specific frameworks modeling conditional relationships between enablers and barriers- a fundamental objective of the integrated conceptual frameworks that will be created in subsequent chapters.

6. Emerging Trends and Research Gaps

Recent shifts in focus (2020–2024 literature)

The literature in the recent past (about 2020-2024) indicates that the topics of research and the approaches towards the study of green logistics have changed significantly. First, digitalization and Industry-4.0 applications (IoT, telematics, real-time routing, blockchain traceability) has shifted and is no longer peripherally exemplified, but central to the enablers of empirical research and conceptual literature review, as researchers analyze the capabilities of data-driven decisions to mitigate visibility and coordination shortcomings in logistics networks (Hazen et al., 2021; Miklautsch-Breznik, Hoffelner, and Woschank, 2023). Second, much stronger focus is paid to electrification and zero-emission delivery as the logistics operationalization options to decarbonise logistics; recent research analyses total-cost implications, charging-infrastructure requirements, and regional implementation plans (Mohammed & Villegas, 2023; Gillstrom, 2023; Bukhari et al., 2023).

Third, more interconnected with logistics research, the notions of circular economy have now become the central logistics solutions, instead of the support activities to sustainability issues (Govindan, Soleimani, and Kannan, 2015; Hazen et al., 2021; Sonar et al., 2024). Lastly, meta-analytical and synthesis studies have become more common that can supply more solid evidence on the relationships between green SCM practices and firm performance and conditional effects (Holling & Backhaus, 2023; Fang and Zhang, 2018; Geng, Mansouri, and Aktas, 2017).

The changes are an indicator of a shift in movement of cataloguing what practices are practiced to questioning how and under what conditions they provide environmental and economic returns. Scholars are starting to employ lifecycle thinking alongside infrastructural analysis and policy analysis together to analyse systemic changes in logistics, instead of considering practices as one-off interventions (Miklautsch-Breznik et al., 2023; Hazen et al., 2021).

Identified gaps for future studies

Although this progress is made, there are still a number of gaps in the research that identify fruitful directions to follow in the future. First, longitudinal empirical studies that trace the long-run effectiveness and sustainability of green logistics interventions are provided at many levels of adoption; much of the recent empirical work is cross-sectional or pilot-based (Holling & Backhaus, 2023). Second, though the idea of digitalization is identified as a central facilitator, there is little rigorous empirical research that identifies individual links between definite digital investments and quantifiable sustainability effects (e.g., a decrease in emissions with the help of telematics compared to the optimization of routes); causal attribution and measurement consistency are two issues (Hazen et al., 2021; Miklautsch-Breznik et al., 2023). Third, the economics of transition, that is, the role of financing instruments, leasing, and shared infrastructure in altering adoption thresholds in various regional settings, is a topic that needs to be further explored, especially when it comes to small and medium businesses in emerging economies (Rahman et al., 2020; Khayyat et al., 2024). Fourth, the research on circular logistics is expanding and, nonetheless, does not propose the operational model that would consider the product design, reverse logistics, and market incentives in a combination that is practical to all managers in different sectors; the literature requires more cross-functional empirical case studies and pilot tests (Govindan et al., 2015; Sonar et al., 2024; Hazen et al., 2021). Fifth, comparative, multi-country research to explicitly model policy-firm interaction effects is scarce, a conditional (moderating) role of policy-firm interaction is widely claimed but rarely empirically analyzed (Fahimnia et al., 2015; Kazancoglu et al., 2021). Lastly, equity and distributional implications, or the impacts of green logistics transition on labor, regional competitiveness, and small suppliers, are under-studied and should be clearly stated in the future agendas (Hazen et al., 2021; Holling and Backhaus, 2023).

7. Development of the Integrated Conceptual Framework

Synthesis of key themes

The thematic synthesis of both the literature and empirical results reveals a collection of common and interacting factors that have to be incorporated in any theoretical explanation of green logistics. These aspects are: (1) Barriers - financial constraints, technology and infrastructure disparity, organizational inertia, regulatory disunity, and cultural/awareness shortage (Fahimnia et al., 2015; Rahman et al., 2020; Khayyat et al., 2024); (2) Enablers - stakeholder pressure, policy-specific instruments, technological innovation and shared infrastructure, economic incentives, and corporate environmental responsibility (Hazen et al., 2021; Mohammed and Villegas, 2022). Empirical and meta-analytic research indicates such elements are not independent of one another, but instead, their impact is conditional and interactive (Holling and Backhaus, 2023; Geng et al., 2017), which inspires the systems perspective that conceptualizes moderating and mediating correlations as opposed to isolated correlations.

Table 1. Components of the Integrated Conceptual Framework for Green Logistics

Component	Definition	Key Elements / Examples	Supporting Literature
Contextual Conditions (Exogenous Moderators)	Macro-level factors that shape how strongly barriers and enablers influence adoption.	• National logistics infrastructure • Market maturity • Policy stability • Sectoral characteristics	Rahman et al. (2020); Gillström (2023)
Barriers (Inhibitors)	Factors that constrain, delay, or prevent implementation of green logistics strategies.	• Financial constraints • Technological limitations • Organizational/operational resistance • Regulatory/policy fragmentation • Cultural and awareness gaps	Fahimnia et al. (2015); Govindan et al. (2015)
Enablers (Facilitators)	Positive drivers and supportive	• Stakeholder and market pressure	Hazen et al. (2021);

	conditions that increase the likelihood of adopting green logistics practices.	• Technological innovation & infrastructure support • Policy incentives and regulations • Economic instruments (green finance) • Corporate environmental responsibility	Mohammed & Villegas (2023)
Mediating Capabilities & Mechanisms	Organizational abilities that convert enablers into actionable implementation.	• Digital integration and IT capability • Absorptive capacity • Collaborative governance (PPP, supplier development) • Access to tailored green financing	Assumpção et al. (2019); Miklautsch-Breznik et al. (2023)
Sustainability Outcomes	Environmental, operational, and economic results of implementing green logistics.	• Emissions reductions • Waste and resource efficiency • Circularity (recovery, remanufacturing) • Improved resilience & reduced TCO	Fang & Zhang (2018); Holling & Backhaus (2023)

Table 2. Interrelationships Among Framework Components

Relationship Type	Description	Example of Mechanism	Supporting Literature
Direct Negative Effects of Barriers	Barriers reduce the likelihood, scale, or speed of green logistics adoption.	• High capital costs restrict fleet electrification and renewable logistics investments. • Poor digital infrastructure limits reverse logistics visibility.	Mohammed & Villegas (2023); Govindan et al. (2015)
Direct Positive Effects of Enablers	Enablers increase adoption but their strength depends on organizational readiness.	• Policy incentives stimulate investment, but are most effective when firms have internal capabilities and financing options.	Gillström (2023); Khayyat et al. (2024)
Mediation by Organizational Capabilities	Mediating capabilities translate enablers into implemented practices.	• Digital platforms convert stakeholder demand into traceability and improved routing efficiency. • Absorptive capacity enables firms to adopt new green technologies.	Hazen et al. (2021); Assumpção et al. (2019)

Moderation by Contextual Conditions	National or sectoral contexts strengthen or weaken the effects of enablers and barriers.	• Developed economies: extensive charging infrastructure increases effectiveness of EV technology adoption. • Emerging economies: weaker logistics infrastructure reduces impact of incentives.	Mohammed & Villegas (2023); Rahman et al. (2020)
Feedback Effects	Successful sustainability outcomes reinforce enablers and reduce certain barriers over time.	• Emission-reduction success increases customer pressure, improves brand value, and strengthens internal commitment to green logistics.	Holling & Backhaus (2023)

Table 3. Summary of How Components Connect in the Conceptual Framework

From → To	Nature of Influence	Description of Effect
Barriers → Adoption	Negative (Direct)	Reduce implementation likelihood and scale.
Enablers → Adoption	Positive (Direct)	Increase adoption but depend on mediating capabilities.
Enablers → Mediating Capabilities	Positive (Indirect)	External pressures and incentives strengthen internal readiness.
Mediating Capabilities → Outcomes	Positive (Direct)	Capabilities enable successful execution and measurable performance gains.
Contextual Conditions → (Barriers & Enablers)	Moderating	Context strengthens or weakens the effects of both barriers and enablers.
Outcomes → Enablers (Feedback)	Reinforcing	Strong sustainability performance increases commitment and market pressure.

CHAPTER 5: DISCUSSION

Interpretation of Key Insights

The results of this qualitative descriptive research contribute to the restatement that the process of green logistics adoption is a systemic and context-specific process that is formed under the influence of interacting financial, technological, organizational, regulatory, and cultural factors. In accordance with the overall GSCM literature (Fahimnia, Sarkis, and Davarzani, 2015; Seuring and Muller, 2008), the results indicate that no factor describes adoption: instead, the observed trends indicate contingencies where enablers can only be effective when mediating capabilities and contextual supports are available. To illustrate this, the stakeholder pressure and explicit market demand can only generate concrete logistics transformation when companies have the digital connection and absorptive capacity that can enable them to redesign routing, warehousing and reverse flows (Hazen et al., 2021). This is in line with meta-analytic findings that show how green practices result in a better performance mostly in situations that organizational capabilities and market mechanisms co-exist (Holling and Backhaus, 2023; Geng, Mansouri and Aktas, 2017).

One of the themes that can be identified repeatedly in the results is a dual role of regulation and cost, or even paradoxical. Regulations may serve as a constraint and driver: unclear, disjointed or weakly implemented rules make the risks more dangerous and discourage investment, and predictable, incentive-aligned policy makes the uncertainty less unpredictable and leads to harnessing the resources of private capital (Fahimnia et al., 2015; Rahman et al., 2020). Similarly, the cost considerations also work on two time planes. The capital limitations and short-term cost imperatives discourage the implementation of capital-working solutions (EVs, depot electrification), and the lifecycle cost benefits and operations efficiencies (route optimization, consolidation) often negate initial investments in the medium term where the

firms have the opportunity to get the relevant financing (Mohammed and Villegas, 2023; Miklautsch-Breznik, Hoffelner, and Woschank, 2023). This interpretation can be followed by systematic reviews that emphasize the conditionality of the financial barriers and the relevance of the green financing mechanisms (Fang and Zhang, 2018; Khayyat et al., 2024).

Technology appears as the most critical enabler as well as the origin of new requirements of capability. Reverse logistics and circular flows are also given a material contribution by digitalization, telematics, and traceability platforms; these platforms enhance visibility, promote smarter routing, and automate the return sorting (Govindan, Soleimani, and Kannan, 2015; Hazen et al., 2021). However, adoption of technology is mediated by internal skills, interoperability of IT and supplier preparedness-aspects which in many cases necessitate active capacity building and inter-organizational governance (Assumpcao et al., 2019). Evidence of a coupled socio-technical transition therefore takes the form of green logistics: technical solutions will only lead to a reduction in operational emissions when organizational routines, human capital and governance arrangements are changing in tandem (Miklautsch-Breznik et al., 2023; Sonar et al., 2024).

Theoretical Implications

The empirical patterns provoke and liven up two theoretical strands that are widely employed in sustainability studies: sustainable supply chain management (SSCM) frameworks and institutional theory. The SSCM scholarship focuses on the joint product of practices (procurement, production, logistics) to create environmental results (Seuring and Muller, 2008; Assumpcao et al., 2019). The current results contribute to the development of the SSCM theory incorporating the intermediary value of organizational capabilities; that implies SSCM prescriptions need to better model the capacity-building (absorptive capacity, IT integration) as a fundamental factor that enables the transformation of practices into results (Hazen et al., 2021). That is, SSCM ought to take on a capability-based extension: practices (enablers) -

capabilities (mediators) - outcomes, with barriers and context mitigating the respective connections.

The observed dynamics also can be explained through the prism of institutional theory (pressure of regulators, customers, and norms). The findings confirm that the adoption decision is influenced by coercive (regulatory), normative (customer/professional), and mimetic (industry exemplar) pressures (Fahimnia et al., 2015; Holling and Backhaus, 2023). Nevertheless, institutional explanations should be made more discrete by acknowledging that institutional capacity and enforcement is heterogeneous: the coercive pressure can only generate investment when the legal and financial infrastructure decrease the risk and when firms possess the absorptive capacity to comply (Rahman et al., 2020; Kazancoglu et al., 2021). This gives rise to a moderated institutional model where the institutional pressures are mediated by contextual moderators as well as firm-level capabilities.

Lastly, the findings are backed by the theory on socio-technical transitions and circular economy integration. The shift of low-emission and circular logistics will entail the harmonization of technologies (EVs, telematics), infrastructures (charging, consolidation centers), business models (take-back systems), and policy (incentives and standards). The latter multi-level alignment underscores the importance of meso- and macro-level transitioning between micro-level SSCM constructs to explain systemic change (Govindan et al., 2015; Hazen et al., 2021). The suggested integrated framework therefore adds some theoretical contribution by connecting SSCM micro-practices and macro transition processes via mediating capabilities and situational moderators.

Managerial Implications

To practitioners, the findings indicate practical principles over prescriptions that are universal. To begin with, the managers are encouraged to focus on investments that can reduce operational

paybacks and strategic green benefits in the short term (e.g. route and load optimisation, collaborative consolidation, and retrofits) since they can reduce financial and organizational risk and provide measurable performance-based improvements upon which larger investments can be supported (Miklautsch-Breznik et al., 2023; Fang and Zhang, 2018). Second, companies ought to make direct investments in mediating abilities: cross-functional sustainability teams, digital capabilities that combine supplier and customer information, and training sessions to develop skills of the workforce. These can enhance the effect of stakeholder pressure and policy incentives (Hazen et al., 2021; Assumpcao et al., 2019).

Third, the supply-chain managers are to engage colleagues and 3PLs as well as municipal authorities in collaborative strategies to redistribute the fixed infrastructure cost (shared charging hubs, urban consolidation centers) and align traceability and reverse flows standards (Gillstrom, 2023; Sonar et al., 2024). Fourth, implement a staged process, pilots-measure-scale, which entails pilots to minimize uncertainty and to create the evidence required to sustain scale to larger investment; it addresses the short-termism that frequently becomes a stumbling block to adoption (Rahman et al., 2020). Lastly, managers are recommended to convert sustainability to the performance metrics that are meaningful to decision-makers (TCO, service-level adjusted cost savings, resilience indicators) to have environmental initiatives assessed on the same managerial basis as other investments in operations (Holling & Backhaus, 2023).

Policy Recommendations

The government plays a decisive role in creating the conditions in which green logistics transition at the system level occurs. First, to minimize uncertainty and scale infrastructure, policymakers ought to develop coherent policy mixes, that is, demand pull (procurement standards, buyer labelling), supplier-push (subsidies to charging infrastructure, grants to depot electrification), and making (standardized data formats, interoperability rules) policy mixes (Fahimnia et al., 2015; Gillstrom, 2023). Second, special funding sources, such as green credit

lines, EVs leasing programs, SME guarantees, and so on, are necessary to break the capital barrier that especially applies to small and medium-sized logistics providers in emerging environments (Khayyat et al., 2024; Mohammed and Villegas, 2023).

Third, predictability of regulations and long-term predictability (phasing of emissions standards, coordinated reverse-logistics requirements) lower investment risk and motivate companies to invest in long-term (Rahman et al., 2020; Kazancoglu et al., 2021). Fourth, governments need to promote the construction of common infrastructure (public charging, urban consolidation centers), as well as promote the formation of capital partnerships between the state and the company, to offset capital expenditures and make coordination opportunities (Gillstrom, 2023; Sonar et al., 2024).

The discussion incorporates the qualitative data with the current theoretical and empirical research in arguing that the adoption of green logistics should be a coordinated and capability-based approach. The presence of barriers and enablers is mutually reinforcing; that is why the policy and managerial intervention should be designed to act at several levels: firm, sector, and system to transform the potential into the actual sustainability results (Fahimnia et al., 2015; Holling and Backhaus, 2023; Miklatsch-Breznik et al., 2023).

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

Conclusion

This qualitative descriptive research aimed at defining and integrating the barriers and enabling factors that determine adoption of the green logistics strategies in the supply chain management and establish a comprehensive conceptual framework that determines how the factors interrelate to deliver sustainability outcomes. The empirical evidence showed that there is a pattern and adoption is not brought out by any single determinant but rather the combination of multiple forces. Existing barriers include financial limitations, technology and infrastructural weakness, organizational inertia and weakness in capabilities, regulatory fragmentation, and cultural/awareness gaps. On the other hand, the pressure of stakeholders and market demand, technological advancement and common infrastructure, coherent regulatory backing and economic motivations, and corporate responsibility towards the environment are enablers.

Notably, the mediation of firm-level capabilities, specifically, digital integration, absorptive capacity, and collaborative governance mechanisms was identified as a crucial step towards transforming enablers into practiced principles and quantifiable sustainability results. These findings support and further develop the existing syntheses of the field by highlighting the mediating and contingent role of enablers and barriers: without sufficient organizational capabilities and conditions favorable to organizational environment, enablers are needed but not sufficient (Fahimnia, Sarkis, and Davarzani, 2015; Hazen et al., 2021; Miklautsch-Breznik, Hoffelner, and Woschank, 2023).

The results of the study are consistent with the existing models of sustainable supply chain management that focus on sets of practices and interdependence of organizational,

technological, and institutional aspects (Seuring and Muller, 2008; Assumpcao et al., 2019). Simultaneously, the findings expound on how said bundles turn into outcomes: by locating the intervening capabilities and contextual moderators, the study explains why the same enablers have distinct effects on firms and across geography. Such a conditional perception is complemented by meta-analysis findings that indicate that performance improvement of GSCM practices under specific circumstances depends on the capabilities of firms and environmental conditions (Holling and Backhaus, 2023; Geng, Mansouri, and Aktas, 2017). The appreciation of paradoxes of roles, like regulation being a constraint and facilitator in relation to clarity and the strength of enforcement, or cost being a short-term deterrent and a long-term gain, reverberates and expands on insights of modern-day reviews and empirical research (Fahimnia et al., 2015; Rahman et al., 2020; Mohammed and Villegas, 2023).

Although the qualitative descriptive design made it possible to have details that were rich and context-sensitive and generated an analytically coherent framework, some limitations constrained the generalizability of the results. The use of data to interview and documentary data in the study captures perceptions, practices and self-reports of outcomes of the study; it lacks longitudinal causal data to show a relationship between particular interventions and emissions trajectories or overall cost. The purposive sampling approach (with the intended aim of diversity in terms of firm size and industry) can, however, not capture the heterogeneity of industries and national contexts as a whole, and so, care must be taken when extrapolating detailed prescriptions to radically different regulatory or infrastructural contexts. In addition to that, a quick technological change, such as a breakthrough in battery technology, telematics, or AI-based routing can change cost and capability limits in a manner that cannot be completely observed during the data collection (Miklautsch-Breznik et al., 2023).

Recommendations

Managerial recommendations for supply chain practitioners

Green logistics is not a compliance activity that managers should re-understand as a strategic change that must involve synchronized investments in the hard infrastructure as well as managerial capacity. Practically, this is initiated with a focus on near-term initiatives that yield tangible operational and environmental results such as route optimization, load consolidation, and retrofits of specific warehouses since those initiatives tend to be low-friction, give some tangible financial returns, and build internal momentum to make larger investments (Fang and Zhang, 2018; Miklautsch-Breznik et al., 2023). At the same time, companies ought to develop cross-functional cross-procurement, cross-operations, cross-IT, and cross-finance sustainability governance frameworks. These governance mechanisms make the issue of green logistics responsibility institutional, allow making comprehensive decisions, and facilitate the transformation of external pressure into a consistent internal program (Assumpcao et al., 2019).

It is important to invest in the mediating capabilities. In order to implement a reverse logistics strategy, firms must develop digital integration (end-to-end visibility, telematics, standardized data formats): traceability and data-driven decision-making are the preconditions of the decarbonization strategy. It is also crucial to create the absorptive capacity via training, pilot projects, and collaborations that would minimize the learning cycles and perceived technological risk (Hazen et al., 2021). In a context of capital limits, the supply-chain managers need to consider collaborative options, such as pooled procurement, consolidation centers, and shared charging depots, to distribute the costs and speed scale economies (Gillstrom, 2023; Sonar et al., 2024). Last but not the least, managers are expected to redefine performance indicators in order to incorporate environmental KPIs (CO₂e per tonne-km, percentage of electrified km, material recovery rates) and link sustainability outcomes to management rewards in such a way that green logistics comes to be integrated into routine performance assessments (Holling & Backhaus, 2023).

Policy recommendations for public actors and regulators

Policy mixes that policymakers should embrace should be those that bring push and pull instruments in line with each other to minimize uncertainty and spark market formation of green logistics. It implies the arrangement of explicit regulatory paths (e.g., phased emission restrictions and harmonized take-back requirements) with catalytic government funding in common utilities like regional charging stations, urban blending centres, and the reverse-logistics centres. Of particular concern is financial instruments: designated green lending institutions, tax relief, zero-emission vehicle leasing, and guaranteeing mechanisms of the smaller providers reduce the threshold barrier and allow SMEs to join the transition (Khayyat et al., 2024; Mohammed and Villegas, 2023). Data interoperability and traceability standards should also be given priority by policy makers to enable collaboration and measurement of the circularity metrics by cross-firm (Hazen et al., 2021).

In addition to infrastructure and finance, proactive capacity-building initiatives; technical assistance, certification systems and publicly financed pilot programs can be used to spread best practice and minimize asymmetric information issues that hinder investment. Logistics electrification and reverse-logistics capacity should be explicitly considered as part of the industrial sustainability support in donor programs and development banks in the international development setting because the underdeveloped infrastructure and lax enforcement of regulations further complicate the situation in emerging economies (Rahman et al., 2020). The design of policies should care about stability and predictability; a high rate of changes or disjointed regulations lead to a risk of investment and the decline of the strength of otherwise good intentions (Fahimnia et al., 2015).

Recommendations for industry collaboration and ecosystem development

The shift to green logistics is inherently shared: the firms, the logistics service providers, the infrastructure operators, the technology vendors, and the regulators will need to collaborate to find ways to solve the problem. The industry associations may serve as conveners to pool demand, coordinate specifications of procurement, and make collective investments that could not otherwise be made individually. Programs like strategic procurement of electric trucks, joint projects in terms of depot electrification, and collective platforms in terms of reverse-flow consolidation will minimize the unit cost and speed up learning. On the same note, urban consolidation and low-emission last-mile solutions can be unlocked by implementing the collaboration between municipal sustainability objectives and the logistics capacity of the private sector (Gillstrom, 2023). Interoperable data standards, which enable traceability across firms and the measurement of the outcomes of circularity, should be a priority of the standard-setting bodies and consortia.

Research recommendations and agenda for future studies

There are three complementary directions that the future research should take. To address the longitudinal and quasi-experimental studies are required to determine the long-run performance and resilience and distributional effects of various green logistics strategies and thus shift away from the cross-sectional snapshots to causal inferences. Second, substantial empirical research must be done to de-aggregate the impact of individual digital investments (such as telematics, AI routing) and infrastructure interventions (charging hubs, consolidation centers) on emissions and TCO, to be able to allocate scarce resources in the most efficient way (Miklautsch-Breznik et al., 2023; Hazen et al., 2021). Third, research that is comparative, multi-country, and models the interaction of policy mixes and firm capabilities can help clarify the reasons related to success of similar policies in one country or another; it is critical that

SME perspective and distributional analysis are included that underscores equity implications of the transition (Rahman et al., 2020; Khayyat et al., 2024). Interdisciplinary approach should also be incorporated by the researchers in order to capture both organizational and technical dynamics by combining interdisciplinary techniques, namely, life-cycle assessment, operations research, and qualitative process tracing.

Implementation roadmap and concluding reflections

Implementation of these recommendations in practice can only be done through a gradual and evidence-based process. Policymakers and organizations need to start with diagnostics to map the capabilities of firms, gaps in infrastructure and regulatory restrictions; pilots need to be followed with bundles of technological, managerial and financing interventions; and successful pilots need to be scaled by shared infrastructure investments and collaborative financing. Follow-up and open communication of environmental and economic performance will establish feedback schemes needed to maintain momentum and adjust policy tools. The conceptual framework, which is integrated in this paper, will be used to guide such diagnostics by pointing to the contingent routes via which enablers, mediating capabilities and contextual moderators co-produce sustainability.

To sum up, green logistics transition is a change that requires operations and an opportunity. The realization of environmentally sustainable supply chains is based on coordinated interventions at firm, industry and policy levels that, although seeking to overcome financial, technological, organizational and cultural limitations, also invest in the potential of potential turning into visible, measurable, scalable results. This paper can support that work by providing empirically-based framework and practical suggestions which can assist scholars, practitioners and policymakers in directing logistics systems to reduce emissions, be more circular and resilient.

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