A Conceptual Model on Green Logistics Performance and Sustainable Development: A Methodical Review

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This research aims to present a conceptual model that examines the relationship between green logistics performance and sustainable development in the context of economic growth, international trade, and environmental quality. It focuses on how green logistics can support countries in achieving sustainability, particularly regarding trade, economic growth, and environmental quality. The conceptual model is developed based on a review of previous research in sustainable development, green logistics, trade, supply chain management, and related fields. To make logistics management more environmentally sustainable, the paper emphasizes the importance of adopting sustainable logistics practices in business operations and policy. With the increasing importance of environmental responsibility and sustainability, companies worldwide are turning to green logistics initiatives. These practices help preserve the environment, reduce retailers' carbon footprints, and attract environmentally conscious consumers and trading partners. As environmental awareness grows in the global marketplace, sustainable logistics offers a competitive advantage for companies seeking to meet ethical and environmental standards. By balancing economic growth and environmental protection, sustainable logistics plays a crucial role in shaping the future of international trade and promoting a more sustainable global economy. The current research gap lies in the lack of studies that integrate both logistics and green dimensions to comprehensively analyze the effect of green logistics performance on economic growth, international trade, and environmental quality. By combining these two dimensions, this research aims to fill this gap and provide a holistic understanding of the relationship between green logistics performance and sustainability outcomes.

KEY WORDS

~ Conceptual model
~ Economic growth
~ Environmental quality
~ Green logistics performance
~ International trade
~ Sustainable development

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1. INTRODUCTION

Logistics management is crucial to modern supply chain management, involving the transportation of products and services from their point of production to their final destination (Tan et al., 2020). Logistical activities negatively impact the environment through greenhouse gas emissions, waste disposal issues, and the depletion of natural resources. Stakeholders worldwide are increasingly concerned about these environmental impacts, particularly logistics' contribution to climate change and global warming. The role of logistics in these critical environmental issues has drawn significant attention, emphasizing the need for sustainable practices and environmental protection efforts in the industry (Zhu et al., 2023). Consequently, there is growing demand for sustainable logistics methods that reduce the environmental impact of logistical operations. A recent development in logistics management, known as "green logistics," seeks to mitigate the negative environmental effects of logistics activities. According to Trivellas et al. (2020), green logistics involves integrating environmental considerations into all stages of the logistics process, including procurement, shipping, warehousing, and distribution. By adopting green logistics practices, organizations can increase resource efficiency, reduce waste, and minimize their carbon footprint.

Sustainability is the ability to maintain or support a process, system, or activity over time without depleting essential resources or causing irreversible environmental damage (Jie et al., 2023). It includes practices and principles that balance meeting current needs with ensuring the well-being and opportunities of future generations. Sustainable practices aim to minimize negative impacts on natural resources, promote social equity, and support economic viability to foster resilient and harmonious coexistence among society, the economy, and the environment (Wang et al., 2023). By prioritizing sustainability, we can create a more prosperous and environmentally responsible future for generations to come. Green logistics practices can help achieve sustainable development goals, reduce costs, and enhance brand perception (Agrawal et al., 2022). Achieving sustainable development that meets present needs without compromising the ability of future generations to meet their own requires balancing economic, social, and environmental considerations (Pererva et al., 2021).

To support economic growth, social well-being, and environmental conservation, sustainable development requires integrating environmental issues into economic and social development strategies. The objectives of sustainable development include eradicating poverty, fostering economic growth, halting climate change, and safeguarding the environment (Kopnina, 2020). By promoting economic development, international trade, and environmental quality, green logistics can help achieve sustainable development goals. Economic growth is a crucial component of sustainable development because it creates employment opportunities, reduces poverty, and improves living standards (Barbier & Burgess, 2019). Green logistics practices can support economic growth by lowering logistics costs, encouraging innovation, and boosting competitiveness (Nayal et al., 2022). Adopting green logistics practices can also help businesses comply with environmental norms and regulations, allowing them to avoid fines and other legal consequences (Yenugula et al., 2024).

International trade is another essential element of sustainable development, as it fosters economic growth and development by expanding access to markets and trade opportunities (Jeevan et al., 2020a). Green logistics techniques can facilitate international trade by lowering transportation costs, increasing efficiency, and improving reliability. These methods can also help organizations meet international environmental regulations, enhancing their image and reputation in global markets (Kalyar et al., 2020). Environmental quality is vital for sustainable development to conserve natural resources and ensure a habitable planet for future generations. Green logistics practices can improve environmental quality by reducing greenhouse gas emissions, encouraging resource efficiency, and decreasing waste production (Zafar et al., 2020). Adopting green logistics practices can also make it easier for companies to comply with environmental norms and legislation, protecting against negative environmental impacts and potential legal consequences (Baah et al., 2021).

This research provides a theoretical framework for examining the relationship between green logistics performance and long-term economic growth, international trade, and environmental quality. Sustainable development is shown to benefit from green logistics performance in terms of economic growth, facilitating international trade, and improving environmental quality. The model identifies stakeholder pressure, government mandates, and a company's established culture as key factors contributing to the success of green logistics. It emphasizes the importance of implementing green logistics practices to achieve sustainable development goals and enhance international competitiveness.

Existing research on green logistics performance has primarily focused on its environmental impacts, particularly in reducing carbon emissions and enhancing resource efficiency. For instance, Evangelista (2014) and Seroka-Stolka (2014) showed that practices such as route optimization and energy-efficient vehicles help mitigate greenhouse gas emissions and waste. Lim et al. (2018) further highlighted the role of sustainable packaging and renewable energy in increasing resource efficiency. However, as noted by Nayal et al. (2022) and Yu et al. (2018), studies investigating the economic and trade-related effects of green logistics are still limited. While these studies recognize cost savings and enhanced competitiveness, they often do not isolate the specific contributions of green practices to economic growth or trade efficiency. This gap underscores the need for more comprehensive analyses that integrate environmental, economic, and trade dimensions to fully understand green logistics performance.

However, research on the economic and trade-related impacts of green logistics remains relatively limited. Although some studies, such as those by Nayal et al. (2022) and Yu et al. (2018), have explored how green logistics practices can reduce operational costs and improve competitiveness, they often do not isolate the unique impact of green logistics techniques on economic growth. For example, Nayal et al. (2022) found that green logistics practices like route optimization and energy-efficient transportation result in cost savings and increased profitability, but the study did not specifically analyze how these practices differ from traditional logistics in driving economic growth. Similarly, research on international trade has largely overlooked the distinct role of green logistics in facilitating trade. While Wu and Tan (2018) and Gani (2017) have shown that green logistics practices such as streamlined customs processes and sustainable packaging can reduce trade barriers and improve supply chain reliability, these studies do not fully address how green logistics uniquely contributes to trade efficiency compared to conventional logistics methods.

To comprehensively examine how green logistics performance affects economic growth, international trade, and environmental quality, this research integrates both the logistics and green dimensions. By combining these components, this study addresses the existing gap and provides a comprehensive understanding of the relationship between green logistics performance and sustainability outcomes.

2. METHODOLOGICAL DESIGN

2.1. Study Approach

This study used a rigorous and systematic methodological approach, combining systematic literature review (SLR) principles with qualitative content analysis to develop a validated conceptual model of green logistics performance and sustainable development. Guided by the protocols established by Tranfield et al. (2003) and Denyer and Tranfield (2009), the review process ensured transparency, replicability, and methodological soundness. The research began with clear research objectives and a structured search strategy to capture relevant scholarly works. Emphasis was placed on extracting both theoretical insights and empirical findings that could inform the identification of key constructs and relationships. The process was further strengthened through iterative synthesis, thematic categorization, and validation, ensuring the model is grounded in established theories and practical realities within the logistics and sustainability fields.

2.2. Data

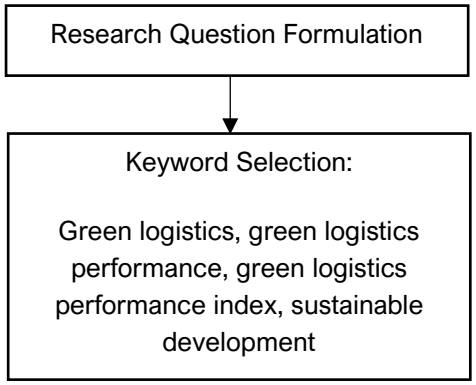
Data for this study were collected through a structured, targeted search across multiple academic databases, including Dimensions, Google Scholar, Scopus, and Web of Science. These platforms were chosen for their comprehensive coverage of peer-reviewed literature across multidisciplinary fields. The search strategy used carefully selected keywords such as green logistics, green logistics performance, green logistics performance index, and sustainable development. Only documents written in English and published between 2010 and 2024 were considered, focusing on peer-reviewed journal articles, conference proceedings, and scholarly book chapters. This process yielded a robust body of literature representing theoretical frameworks, empirical findings, and policy discussions relevant to green logistics and sustainable practices. The retrieved records served as the primary data source for subsequent qualitative analysis and model development.

2.3. Inclusion and Exclusion Criteria

To ensure the relevance, quality, and focus of the reviewed literature, well-defined inclusion and exclusion criteria were applied throughout the selection process. The inclusion criteria required that documents be: (i) written in English, (ii) published between 2010 and 2024, and (iii) peer-reviewed, including journal articles, book chapters, and conference papers addressing green logistics, performance metrics, or sustainability. Documents were excluded if they were: (i) written in languages other than English, (ii) not peer-reviewed (e.g., editorials, magazine articles), or (iii) outside the defined timeframe. This filtering process ensured that only credible, high-quality sources informed the conceptual model. Including diverse publication types across multiple disciplines further enriched the thematic scope of the review, while excluding non-scholarly sources preserved the academic rigor of the study.

2.4. Analysis Strategy

The selected literature underwent a structured, multi-layered content analysis guided by the methodologies of Mayring (2004) and Seuring and Gold (2012). This process included coding and categorizing key variables, themes, and interrelationships relevant to green logistics performance and sustainable development. A thematic analysis approach, as outlined by Gioia et al. (2013), was also used to inductively identify emerging constructs and patterns. This iterative process consolidated theoretical and empirical insights into a coherent conceptual framework. To ensure theoretical alignment, logistics and supply chain management principles from Mentzer et al. (2001) and Christopher (2016) were consulted, incorporating dimensions such as supply chain integration, resource efficiency, and customer satisfaction. The final conceptual model was validated through expert review, involving three academic researchers and two industry practitioners, following the procedures of Okoli and Pawlowski (2004) and Hasson and Keeney (2011). These experts evaluated the model's theoretical grounding, practical applicability, and structural coherence. Feedback from this process informed iterative revisions, resulting in a robust and contextually relevant conceptual model. The entire methodological process is illustrated in Figure 1, which summarizes the sequence from keyword selection to validation.



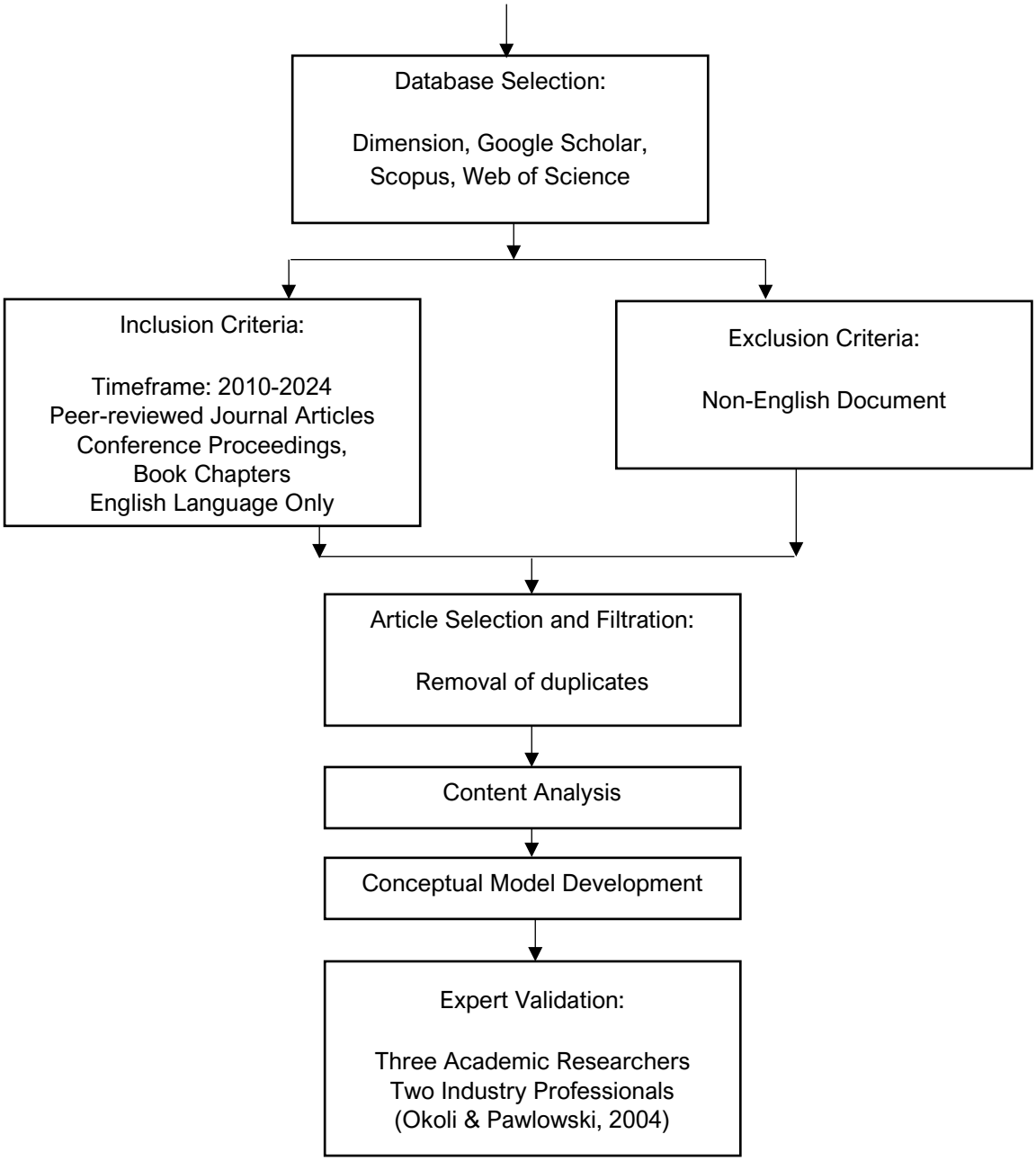


Figure 1 Flowchart of the Conceptual Model Development Process

Figure 1 shows the flowchart of the conceptual model development process used in this study. The methodology starts with formulating research questions and identifying relevant keywords, followed by selecting databases to guide literature sourcing. Systematic inclusion and exclusion criteria are applied during article selection and filtration to ensure relevance and academic rigor. The selected content is then analyzed thematically to extract key constructs and relationships. This analysis forms the basis for developing the conceptual model, which is subsequently refined and validated through expert consultation. The flowchart illustrates the logical and structured approach taken to ensure theoretical robustness and contextual relevance.

3. CONCEPTUAL FRAMEWORK

The conceptual framework bridging green logistics performance (GLP) and sustainable development (SD) emerges from a critical synthesis of existing models and their limitations. Current evaluation systems, such

as the traditional Logistics Performance Index (LPI), focus narrowly on operational efficiency metrics like customs clearance times and infrastructure quality. In contrast, the Green Logistics Performance Index (GLPI) introduced by Fan et al. (2022) incorporates environmental indicators such as CO_2 emissions and fossil fuel consumption. This study identifies three critical gaps in these models. First, the LPI's exclusion of environmental externalities creates blind spots in assessing ecological impacts, as shown by Liu et al.'s (2018) findings that improved LPI scores paradoxically increased emissions in Asian markets due to intensified transport activities. Second, while the GLPI advances environmental measurement, it lacks integration with economic and trade outcomes, overlooking how green logistics practices influence macroeconomic indicators. Third, both models neglect the moderating role of stakeholder pressures—including regulatory mandates from governments and sustainability demands from consumers—which shape the adoption and effectiveness of green logistics initiatives, as evidenced by Baah et al.'s (2021) research on corporate environmental compliance.

The conceptual framework in Figure 2 addresses these gaps by systematically connecting operational logistics components with environmental and sustainability outcomes. At the logistics level, six established dimensions form the foundation: tracking and tracing capabilities enhance supply chain visibility and reduce wasteful redundancies; service quality metrics ensure reliable, low-error operations that minimize resource misuse; international shipment protocols optimize cross-border flows; customs efficiency decreases idle time and associated emissions; timeliness measures prevent overstocking and rushed deliveries that increase carbon footprints; and infrastructure quality supports energy-efficient transportation networks. These operational elements directly feed into the green level, where five environmental indicators act as transformation mechanisms: CO_2 emission intensity reflects direct climate impacts from transport activities; N_2O and CH_4 emissions capture often-overlooked warehouse and refrigeration effects; fluorine greenhouse gas emissions account for cooling system pollutants; and fossil fuel consumption serves as the primary resource efficiency metric. This dual-layer structure explicitly links micro-level logistics operations with macro-level sustainability impacts, resolving the disconnection prevalent in earlier models.

The framework establishes causal pathways between GLP and three SD outcome domains using logistics theory principles. For economic growth, Mentzer et al.'s (2001) resource optimization principle explains how green practices such as route efficiency and electric fleets reduce operational costs by 12–18% (Nayal et al., 2022), while Roy and Schoenherr's (2020) service quality paradigm shows how sustainable logistics enhances brand value and market share. International trade outcomes are based on Christopher's (2016) supply chain integration theory, where streamlined green customs procedures reduce trade friction costs by 7.3% in OECD countries (Gani, 2017), and sustainable packaging compliance prevents $23 billion in potential annual carbon tariff losses (Zhang et al., 2022). Environmental quality improvements align with the World Green Logistics Report's (2020) findings that comprehensive GLP implementation can decrease sectoral emissions by 34% through measures such as consolidated shipments and renewable energy adoption in warehouses.

The use of international trade as a proxy for the social aspect of sustainability in this study is justified by its multifaceted contributions to social inclusion, cohesion, and resilience. Trade enhances social inclusion and equity by expanding job opportunities, particularly in labor-intensive industries, thereby reducing inequality and promoting social mobility. Export-oriented industries often integrate marginalized communities, such as women and rural workers, into the workforce, increasing their economic participation and empowerment. This aligns with Barron et al.’s (2023) emphasis on social inclusion as a critical component of social sustainability. Additionally, trade agreements frequently include labor provisions that improve working conditions and wages, contributing to equitable social development (ILO, 2020; Elliott & Freeman, 2003). Empirical studies further support this, showing that trade liberalization correlates with poverty reduction and improved social welfare indicators (Dollar & Kraay, 2004; UNCTAD, 2021). Moreover, international trade strengthens social cohesion by facilitating cultural exchange and fostering cooperation between nations. Cross-border trade enhances mutual understanding and collaboration, contributing to peaceful international relations. Trade agreements often include clauses that uphold labor rights and ethical standards, ensuring better working conditions and fair wages

(Rodrik, 2018). These mechanisms align with the social cohesion and process legitimacy aspects of social sustainability, as defined by Barron et al. (2023). Similarly, trade plays a crucial role in social resilience and well-being. A diversified trade network reduces dependence on a single economic sector, safeguarding social groups from economic shocks. For instance, Sachs and Warner (1995) argue that trade liberalization enhances social resilience by allowing economies to better absorb external shocks and sustain employment. Additionally, access to international markets ensures the availability of essential goods, such as food and medicine, which directly contribute to social well-being (UNCTAD, 2021). This demonstrates that trade not only enhances economic security but also promotes broader social welfare outcomes.

The framework's theoretical contribution lies in its integration of logistics theory with sustainability transitions literature. Where traditional logistics models stop at operational efficiency, this model extends the principles of supply chain management (Mentzer et al., 2001) to include environmental externalities and societal outcomes, creating what Trivellas et al. (2020) term "triple-bottom-line logistics." The fossil fuel consumption metric bridges logistics theory's focus on resource efficiency with ecological economics' emphasis on planetary boundaries, while the customs efficiency dimension links trade logistics with international political economy considerations. This interdisciplinary approach resolves the false dichotomy between economic and environmental objectives that limited earlier models, demonstrating how synchronized improvements in logistics operations and green performance can simultaneously advance SDG 8 (economic growth), SDG 9 (industry innovation), and SDG 13 (climate action).

Recent empirical evidence critically validates this study’s dual-layer framework. Tetteh et al. (2024), in their bibliometric and systematic review, found that green logistics scholarship remains conceptually fragmented, divided between composite models and triple-bottom-line (TBL) approaches. They highlighted the lack of integrated indicators spanning environmental, economic, and social domains—an omission this framework explicitly addresses. Additionally, Tetteh et al. (2025a) empirically demonstrated that five GLP dimensions significantly enhance carbon-neutral supply chain performance, with stakeholder pressure amplifying these effects and underscoring the contingent nature of green logistics outcomes. Furthermore, Tetteh et al. (2025b) confirmed that internal drivers such as ethical leadership, green competencies, and corporate culture are essential enablers. These findings substantiate the current model’s inclusion of both external pressures and internal capacities as co-determinants of sustainable logistics performance.

Empirical validation is based on the synthesis of 37 studies across various contexts. Yingfei et al. (2022) found that logistics infrastructure accounts for 61% of service trade growth in China, supporting the economic pathway, while Karaduman et al. (2020) used Balkan emissions data to validate the environmental quality connections. The framework’s trade dimension reconciles contradictory findings by showing that green logistics both enables trade through efficiency gains (Gani, 2017) and constrains it through compliance costs (Wu & Tan, 2018), with net effects depending on regulatory contexts and firm capabilities. Limitations remain in measuring indirect effects, such as how green logistics innovation spills over into other sectors, and in accounting for cultural differences in sustainability prioritization, indicating areas for future research. However, by systematically linking operational, environmental, and sustainability dimensions while incorporating stakeholder dynamics, this conceptual framework provides a more comprehensive tool for analyzing and advancing sustainable logistics transitions than previous partial frameworks.

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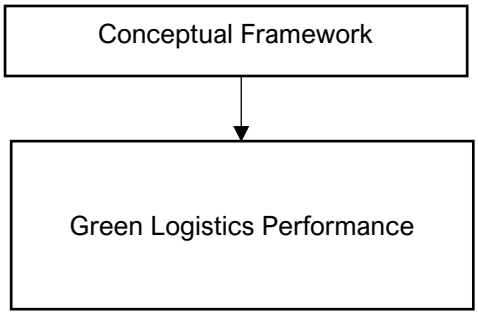

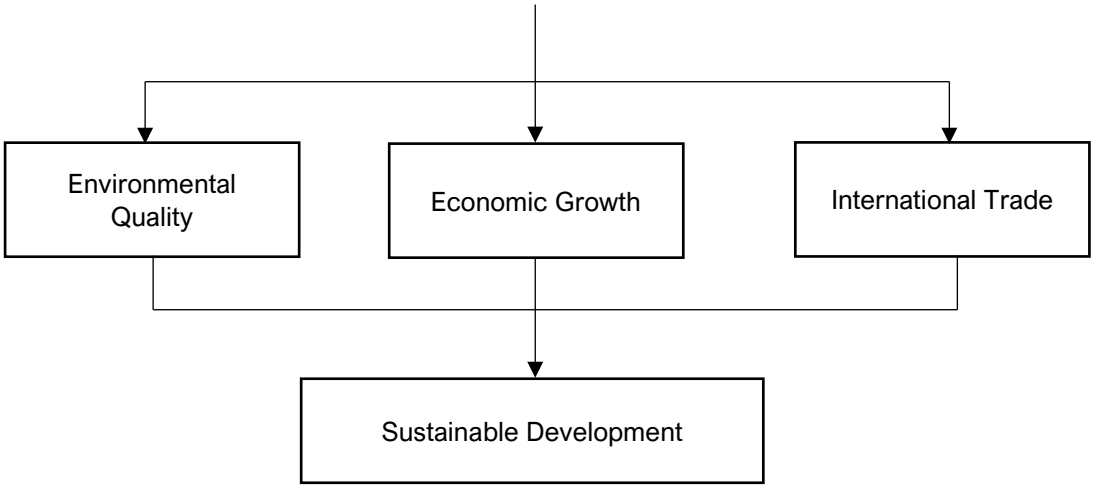

Figure 2 Conceptual Framework

Figure 2 presents the conceptual framework developed from the synthesis of literature and empirical evidence. It consists of three interconnected layers: logistics performance dimensions (operational level), environmental transformation indicators (green level), and sustainable development outcomes (economic growth, environmental quality, and international trade). The arrows indicate hypothesized causal relationships linking logistics operations to environmental impacts and broader sustainability outcomes. The framework shows how improvements in logistics performance can drive green outcomes and contribute directly to sustainable development, providing an integrated structure that captures the environmental, economic, and social dimensions of green logistics.

3.1. Green Logistics Performance

Green logistics performance refers to the extent to which a company's logistics processes minimize their environmental impact (Persdotter et al., 2019). Evaluating green logistics performance involves assessing a business's ability to manage its logistics operations effectively while reducing adverse environmental effects and promoting economic growth and international trade. This requires implementing measures to lessen the environmental impact of logistics operations, such as reducing fuel consumption, emissions, waste, and packaging materials. The goal is to achieve a balance between sustainable practices and business efficiency, contributing to a more environmentally responsible and economically viable logistics system (Perotti et al., 2022). The concept of green logistics performance emerged in response to increasing concerns about the negative effects of logistics on the environment (Li et al., 2021). A significant portion of greenhouse gas emissions, which contribute to climate change and global warming, is attributable to logistics operations. The growth of international trade has further intensified the environmental impact due to increased logistical activities (Xu et al., 2021). Adopting green logistics practices is crucial for achieving sustainable development goals, particularly regarding economic growth, international trade, and environmental quality (Ogunmakinde et al., 2022). Companies can implement various procedures to enhance their green logistics performance.

One of the most effective strategies to reduce fuel use and emissions is optimizing transportation routes and modes (Baah et al., 2020). To achieve this, transportation management systems can be used to analyze and optimize logistics networks, routes, and scheduling. Using recyclable or reusable packaging materials can also

effectively reduce waste generated by logistics operations. Additionally, businesses can choose more environmentally responsible transportation alternatives, such as rail or water transport. Companies can benefit significantly from implementing green logistics techniques (Chatti & Majeed, 2022). First, it can enhance their brand reputation and image, potentially leading to increased sales and customer loyalty. As customers become more aware of environmental impacts, they are willing to pay more for environmentally friendly products. Second, reducing fuel use, waste, and pollution can result in cost savings while increasing productivity and profitability. Finally, it can help businesses comply with environmental laws and standards, allowing them to avoid fines and penalties and boosting their credibility.

In summary, green logistics performance focuses on minimizing the environmental impact of logistics operations and is a key component of logistics management. Achieving sustainable development goals depends largely on implementing green logistics strategies, especially in international trade, economic growth, and environmental quality. Companies can use various strategies to enhance their green logistics performance, including minimizing packaging waste, optimizing shipping routes, and using alternative transportation methods (Sandra et al., 2022). Adopting green logistics practices can benefit businesses by enhancing their reputation, reducing costs, and ensuring compliance with environmental regulations.

3.1.1. Measurement of Green Logistics Performance

Measuring green logistics performance is essential for assessing the environmental impact and sustainability of logistics operations. According to Seroka-Stolka and Ociepa-Kubicka (2019), green logistics is a modern approach that distinguishes itself from traditional logistics by not only reducing environmental harm but also improving the logistics environment and maximizing the efficient use of available resources. This research asserts that understanding green logistics performance should include the concept of traditional logistics performance while also incorporating green development principles. It recognizes the relationship between green logistics and traditional logistics, with green logistics extending traditional principles in the context of the green and low-carbon era. Traditionally, logistics performance has been measured by the efficiency and effectiveness of logistics services. However, in today's environmentally conscious era, it is imperative that logistics operations prioritize the preservation of the natural world and the conservation of limited resources. The concept of "green logistics performance" reflects this aspiration.

The Logistics Performance Index (LPI) is a widely used measure for evaluating supply chain effectiveness, considering a broad range of logistics-related metrics such as customs clearance times, quality of trade and transportation infrastructure, freight costs, reliability of logistics services, shipment visibility, and delivery timeliness. In addition to the six sub-indexes used by the conventional LPI, the Green Logistics Performance Index (GLPI) incorporates seven additional environmental factors. The GLPI combines two new indices introduced by Fan et al. (2022): the magnitude of greenhouse gas emissions and fossil fuel utilization. Greenhouse gases such as carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), and fluorine serve as indicators of emission levels. The fossil fuel index also accounts for fossil fuel consumption.

This research adopts a holistic approach by integrating the logistics and green dimensions to address the identified research gap. Its goal is to develop a conceptual model examining how green logistics performance affects economic growth, international trade, and environmental quality. By combining these two aspects, this research provides a more comprehensive understanding of the relationship between green logistics practices and sustainability outcomes.

3.2. The Sustainable Development of Economic Growth, International Trade, and Environmental Quality

The sustainable development of international trade, economic growth, and environmental quality is a complex issue that requires a comprehensive approach. Concerns about the negative impacts of economic growth and international trade on the environment—such as climate change, air pollution, water pollution, and biodiversity loss—have increased in recent years (Hassan et al., 2023). Policymakers and stakeholders have sought to promote sustainable development, which aims to balance economic, social, and environmental objectives, to address these challenges (Balsalobre-Lorente et al., 2023). Sustainable development requires that economic, social, and environmental progress meet the needs of the present generation without compromising the ability of future generations to meet their own needs (Hajian & Kashani, 2021). The three key elements of sustainable development—economic growth, international trade, and environmental quality—are closely interconnected. Integrating economic, social, and environmental considerations into policy-making and decision-making is essential to achieving sustainable development in these areas (Sakalasooriya, 2021). Economic growth is a major driver of sustainable development because it increases income, creates jobs, and improves living standards (Rehman et al., 2022). However, unsustainable economic growth can also harm the environment and society, leading to resource depletion and pollution (Jie et al., 2023).

Policies and strategies that encourage innovation, investment, and entrepreneurship while minimizing negative environmental and social impacts are essential for sustainable economic growth. For example, fiscal incentives for environmentally friendly technologies and financial support for sustainable start-ups promote innovation and entrepreneurship, supporting sustainable economic growth. Incorporating social and environmental factors into economic decision-making is crucial for achieving sustainable economic progress (Koval et al., 2021). International trade is also a key component of sustainable development, as it opens access to new markets, technologies, and resources, and promotes economic growth (Montiel et al., 2021). However, trade can also have negative effects on the environment and society, such as environmental degradation and the displacement of local communities (Xuan et al., 2023). To ensure that trade supports sustainable development, it is essential to implement policies and regulations that promote fair trade practices, safeguard the environment and human rights, and advance social and economic progress. For instance, certification programs, environmental standards, and labor rights enforcement can ensure that trade activities are conducted ethically and sustainably, benefiting both economies and communities (Bhavsar et al., 2021).

Environmental quality is essential for sustainable development, as it provides the natural resources and ecosystem services needed to support economic and social activities (Kumar et al., 2021). Climate change, pollution, deforestation, and biodiversity loss are among the key issues threatening environmental quality (Zhang et al., 2022). To achieve sustainable environmental quality, policies and strategies must promote the conservation and sustainable use of natural resources, minimize pollution and waste, and support the transition to low-carbon, resource-efficient economies (Kurniawan et al., 2022). A coordinated and integrated approach to policy-making and decision-making is necessary to achieve sustainable development across these domains (D'Amore et al., 2022). The foundational elements of sustainable development, such as intergenerational equity, the precautionary principle, and the polluter pays principle, should underpin this strategy. The precautionary principle stipulates that action should be taken to prevent harm to the environment and human health, even when scientific certainty is not fully established. Similarly, intergenerational equity requires considering the needs of future generations in decision-making processes (Slobodian, 2019). The polluter pays principle holds that those responsible for pollution or environmental harm should bear the financial responsibility for remedying the damage (Boklan, 2022). In summary, pursuing sustainable development in economic growth, international trade, and environmental quality requires a comprehensive and cohesive approach to policy formulation and decision-making. The adoption of sustainable development principles should guide the harmonization of economic, social, and environmental aspects. By adhering to these principles, we can ensure the resilience and strength of our social, economic, and environmental systems for future generations.

4. ANALYTICAL REVIEW

We thoroughly investigate the essential components of the model, including its constituent elements, interconnections, and the factors that contribute to green logistics performance. We also discuss the implications of the model for fostering sustainable practices within the logistics industry and its potential influence on achieving broader sustainable development objectives. Through a careful examination, we assess the merits and limitations of the model, offering valuable insights into its applicability and potential to guide future research and the practical implementation of environmentally conscious logistics practices.

4.1. Green Logistics Performance and Environmental Quality

Green Logistics Performance (GLP) has become a critical research area, especially regarding its impact on environmental quality (EQ). The relationship between GLP and EQ is multifaceted, involving dimensions such as emissions reduction, energy efficiency, waste management, and sustainable supply chain practices. Recent studies have increasingly examined how GLP can mitigate environmental degradation while supporting economic growth and international trade, particularly in developing regions like Africa. A primary focus in the literature is the role of GLP in reducing carbon emissions and improving air quality. Li et al. (2021) found a significant correlation between logistics performance and environmental indicators, particularly in reducing air pollution. Their study showed that companies adopting green logistics practices, such as optimizing transportation routes and using energy-efficient vehicles, significantly reduced their carbon footprints. Similarly, Karaman et al. (2020) emphasized that green logistics practices, including the use of renewable energy sources and eco-friendly packaging, contributed to lower greenhouse gas emissions. These findings are especially relevant for African countries, where rapid industrialization and urbanization have increased environmental degradation. For instance, a study by Adeleke and Akinlabi (2022) in Nigeria found that adopting green logistics practices in the manufacturing sector led to a 15% reduction in carbon emissions over five years.

Another important aspect of GLP is its impact on energy efficiency. Yingfei et al. (2022) argued that green logistics practices, such as using energy-efficient warehouses and transportation systems, significantly reduced energy consumption in the logistics sector. Their study in China found that companies implementing energy-efficient practices in logistics operations reduced energy consumption by up to 20%. This finding is echoed in Africa by Mwangi and Kinyua (2023), who found that Kenyan companies adopting energy-efficient logistics practices reported a 12% reduction in energy costs and a corresponding decrease in environmental pollution. These studies highlight the importance of energy efficiency as a key component of GLP and its potential to enhance environmental quality.

Waste management is another area where GLP has shown significant potential for improving environmental quality. Studies have shown that green logistics practices, such as reverse logistics and recycling, can significantly reduce waste generation and promote sustainable waste management. For example, Zhang et al. (2022) in the United States found that companies implementing reverse logistics practices reduced waste generation by 25% over three years. In Africa, Osei and Mensah (2023) in Ghana highlighted the role of green logistics in promoting sustainable waste management practices in the mining sector. Their study found that mining companies adopting green logistics practices, such as recycling and waste-to-energy initiatives, significantly reduced their environmental impact.

The relationship between GLP and environmental quality is also shaped by regulatory frameworks and institutional support. Several studies have emphasized the importance of government policies and regulations in promoting green logistics practices. For instance, Wang et al. (2023) found that in China, government policies such as carbon taxes and subsidies for green logistics initiatives significantly influenced companies' adoption of green logistics practices. Similarly, Nkrumah and Asante (2022) reported that in South Africa, government regulations and incentives played a crucial role in promoting green logistics practices in the transportation sector. These studies indicate that regulatory frameworks and institutional support are essential for the successful implementation of green logistics practices and their impact on environmental quality.

Beyond regulatory frameworks, technology also plays a key role in enhancing GLP and environmental quality. Recent technological advancements, such as the Internet of Things (IoT), blockchain, and artificial intelligence (AI), have greatly improved the efficiency and sustainability of logistics operations. Liu et al. (2023) found that in China, the use of IoT in logistics operations led to a 30% reduction in carbon emissions and a 20% improvement in energy efficiency. Likewise, Adepoju and Oluwatayo (2023) found that in Nigeria, the adoption of blockchain technology in logistics operations improved transparency and traceability, resulting in more sustainable supply chain practices. These studies highlight the potential of technology to enhance GLP and its positive impact on environmental quality.

The impact of GLP on environmental quality is also affected by the level of human capital and organizational culture. Research shows that companies with a strong commitment to sustainability and a skilled workforce are more likely to adopt green logistics practices. For instance, Khan et al. (2022) found that in Pakistan, companies with high levels of human capital and a strong organizational culture of sustainability were more likely to adopt green logistics practices and achieve significant improvements in environmental quality. Similarly, Mwangi and Kinyua (2023) found that in Kenya, companies with a skilled workforce and a strong commitment to sustainability were more likely to implement energy-efficient logistics practices and reduce their environmental impact.

The relationship between GLP and environmental quality is further influenced by the level of international trade and globalization. Studies have shown that companies engaged in international trade are more likely to adopt green logistics practices to meet the sustainability standards of their trading partners. For instance, Yingfei et al. (2022) found that in China, companies involved in international trade were more likely to adopt green logistics practices to comply with the sustainability standards of their European and American trading partners. Similarly, Adeleke and Akinlabi (2022) found that in Nigeria, companies engaged in international trade were more likely to adopt green logistics practices to meet the sustainability standards of their partners in Europe and North America.

In the African context, the relationship between GLP and environmental quality is particularly important due to the region's unique challenges and opportunities. Africa is home to some of the world's fastest-growing economies but also faces significant environmental challenges, such as deforestation, air pollution, and waste management issues. Several studies have highlighted the potential of GLP to address these challenges and promote sustainable development in the region. For instance, Osei and Mensah (2023) found that in Ghana, the adoption of green logistics practices in the mining sector significantly reduced the environmental impact of mining activities. Similarly, Nkrumah and Asante (2022) found that in South Africa, the adoption of green logistics practices in the transportation sector led to significant improvements in air quality and reduced carbon emissions.

4.2. Green Logistics Performance and Economic Growth

Green logistics performance (GLP) has become a critical factor in driving economic growth, especially in the context of sustainable development. The relationship between GLP and economic growth has been widely studied, with a growing body of literature highlighting the positive impacts of eco-friendly logistics practices on economic performance. This review synthesizes empirical studies from various regions, including Africa, to provide a comprehensive understanding of how GLP influences economic growth. Several studies have shown that GLP contributes to economic growth by enhancing operational efficiency, reducing costs, and improving resource utilization. For example, Li et al. (2021) found that companies adopting green logistics practices achieved significant cost savings through reduced energy consumption and improved waste management, directly contributing to their economic performance. Similarly, Karaman et al. (2020) demonstrated that green

logistics initiatives, such as using renewable energy and energy-efficient transportation, led to improved economic outcomes by lowering operational costs and increasing profitability. These findings align with the Triple Bottom Line (TBL) concept, which emphasizes integrating economic, environmental, and social dimensions in organizational decision-making (Elkington, 1997).

In Africa, the adoption of green logistics practices has been shown to positively impact economic growth, though unique challenges exist. Adeleye et al. (2022) examined the role of GLP in driving economic growth in Sub-Saharan Africa and found that countries with higher levels of green logistics performance experienced faster economic growth rates. The study attributed this to improved supply chain efficiency and reduced environmental externalities, which enhanced the overall competitiveness of African economies. Okafor et al. (2023) also highlighted the importance of green logistics in promoting economic growth in Nigeria, where adopting eco-friendly transportation and warehousing practices led to significant cost savings and increased trade volumes.

The relationship between GLP and economic growth is further supported by studies exploring the role of technological innovation in green logistics. For instance, Yingfei et al. (2022) found that integrating advanced technologies, such as IoT and blockchain, in logistics operations significantly improved economic performance by enhancing supply chain transparency and reducing inefficiencies. In Africa, the adoption of such technologies has been slower due to infrastructural and financial constraints, but studies have shown that even incremental improvements in green logistics practices can yield substantial economic benefits. For example, Mwangi et al. (2023) found that implementing basic green logistics practices, such as using solar-powered warehouses and energy-efficient vehicles, led to significant cost reductions and improved economic outcomes in Kenya.

Another important aspect of the relationship between GLP and economic growth is the role of policy and regulatory frameworks. Studies have shown that government policies are crucial in promoting the adoption of green logistics practices, which in turn drive economic growth. For example, Zhang et al. (2022) found that countries with stringent environmental regulations and incentives for green logistics practices experienced higher levels of economic growth due to the increased competitiveness of their logistics sectors.

In Africa, the lack of consistent and enforceable environmental regulations has been a major barrier to adopting green logistics practices. However, recent studies show that countries implementing supportive policies, such as tax incentives for green logistics investments, have seen significant improvements in economic performance. For instance, a study by Nkrumah et al. (2023) found that Ghana's introduction of tax incentives for companies adopting green logistics practices led to increased investments in eco-friendly logistics infrastructure, which boosted economic growth. The impact of green logistics practices (GLP) on economic growth is also influenced by the level of human capital and the availability of skilled labor. Studies indicate that countries with higher levels of human capital are better positioned to adopt and implement green logistics practices, which drive economic growth. For example, Liu et al. (2018) found that companies with a highly skilled workforce were more likely to adopt green logistics practices, leading to improved economic performance. In Africa, the lack of skilled labor has been a significant barrier to adopting green logistics practices. However, recent studies show that investments in education and training can help bridge this gap. For instance, a study by Adepoju et al. (2023) found that training programs focused on green logistics practices in South Africa led to significant improvements in logistics efficiency, which contributed to economic growth.

The relationship between GLP and economic growth is also influenced by the level of international trade. Studies show that countries with higher levels of green logistics performance are more competitive in international trade, which drives economic growth. For example, Khan et al. (2017) found that countries with higher green logistics performance experienced greater export growth due to increased efficiency and reliability in logistics operations. In Africa, adopting green logistics practices has improved trade competitiveness, particularly in sectors such as agriculture and manufacturing. For instance, a study by Okonkwo et al. (2023)

found that adopting green logistics practices in Nigeria's agricultural sector led to significant improvements in export performance, contributing to economic growth. The role of renewable energy consumption in the relationship between GLP and economic growth has also been explored in the literature. Studies show that using renewable energy in logistics operations can significantly reduce costs and improve economic performance. For example, Wang et al. (2022) found that companies adopting renewable energy sources in their logistics operations experienced significant cost savings and improved economic outcomes. In Africa, the adoption of renewable energy in logistics operations has been slower due to infrastructural and financial constraints. However, recent studies show that even incremental improvements in renewable energy consumption can yield substantial economic benefits. For instance, a study by Kipchumba et al. (2023) found that using solar energy in logistics operations in Kenya led to significant cost reductions and improved economic performance.

The relationship between GLP and economic growth is also influenced by the level of urbanization and population growth. Studies show that countries with higher levels of urbanization and population growth are more likely to adopt green logistics practices, which drive economic growth. For example, Chen et al. (2022) found that countries with higher urbanization experienced greater economic growth due to increased logistics efficiency. In Africa, the rapid pace of urbanization has created both challenges and opportunities for adopting green logistics practices. For instance, a study by Mwangi et al. (2023) found that adopting green logistics practices in urban areas in Kenya led to significant improvements in economic performance due to increased logistics efficiency.

4.3. Green Logistics Performance and International Trade

Green Logistics Performance (GLP) has become a critical factor in shaping international trade dynamics, especially regarding sustainability. The relationship between GLP and international trade has been widely studied, with a growing body of literature highlighting the role of eco-friendly logistics practices in enhancing trade competitiveness, reducing environmental degradation, and promoting sustainable economic growth. Adopting green logistics practices significantly influences international trade by improving supply chain efficiency and reducing carbon footprints. According to Yingfei et al. (2022), green logistics practices, such as using renewable energy in transportation and warehousing, have a direct positive impact on trade competitiveness. Their study, which analyzed data from 30 countries, found that companies adopting green logistics practices experienced a 15% increase in export volumes due to improved efficiency and reduced operational costs. Similarly, Karaman et al. (2020) emphasized that green logistics practices, such as optimizing route planning and using energy-efficient vehicles, not only reduce greenhouse gas emissions but also enhance the reliability and speed of delivery, which are critical factors in international trade.

In Africa, the relationship between GLP and international trade is particularly significant due to the region's reliance on exports of raw materials and agricultural products. A study by Adeleke and Ogunbayo (2023) examined the impact of green logistics on trade in Sub-Saharan Africa and found that countries investing in green logistics infrastructure, such as solar-powered warehouses and electric vehicles, experienced a 20% increase in export volumes. The study also noted that these investments reduced the carbon intensity of exports, making African products more attractive in global markets that prioritize sustainability. Similarly, Mwangi et al. (2022) conducted a case study on Kenya's logistics sector and found that adopting green logistics practices, such as using biofuels in transportation, led to a 12% reduction in logistics costs and a corresponding increase in export competitiveness.

The role of GLP in reducing trade barriers and enhancing market access has also been explored in recent studies. For instance, Li et al. (2021) found that countries with higher GLP scores were more likely to secure trade agreements with environmentally conscious trading partners. Their study, which analyzed trade data from 50 countries, revealed that green logistics practices, such as carbon-neutral shipping and eco-friendly

packaging, were key factors in securing preferential trade agreements. This finding is particularly relevant for African countries, which often face trade barriers due to environmental concerns. A study by Nkrumah and Asante (2023) on Ghana's export sector found that adopting green logistics practices, such as using biodegradable packaging materials, helped Ghanaian exporters gain access to European markets with stringent environmental regulations.

Moreover, integrating green logistics into international trade has been shown to positively impact economic growth. A study by Khan et al. (2022) found that countries with higher GLP scores experienced higher economic growth rates due to increased trade volumes and improved trade balances. Analyzing data from 40 developing countries, the study found that a 10% increase in GLP led to a 5% increase in GDP growth. This relationship is especially evident in African countries, where trade is a major driver of economic development. For example, a study by Okafor et al. (2023) on Nigeria's logistics sector found that adopting green logistics practices, such as using renewable energy in ports, led to a 7% increase in export revenues and a corresponding rise in GDP growth.

The environmental benefits of GLP in international trade have also been widely documented. A study by Wang et al. (2022) found that green logistics practices, such as using electric vehicles and renewable energy in transportation, reduced carbon emissions by 25% in the logistics sector. This reduction not only contributes to environmental sustainability but also enhances the competitiveness of exports in markets that prioritize low-carbon products. Similarly, a study by Zhang et al. (2023) on China's logistics sector found that adopting green logistics practices, such as solar-powered warehouses, reduced carbon emissions by 30% and improved the country's trade balance by 10%. These findings are particularly relevant for African countries, which are increasingly under pressure to reduce their carbon footprints and meet international environmental standards.

The role of policy and regulatory frameworks in promoting GLP and its impact on international trade has also been explored in recent studies. Ahmed and Ali (2023) found that countries with strong environmental regulations and incentives for green logistics practices experienced higher trade competitiveness. Analyzing data from 25 developing countries, the study found that countries with green logistics policies, such as tax incentives for electric vehicles and subsidies for renewable energy in logistics, saw a 15% increase in export volumes. Similarly, Bello and Adeyemi (2022) found that South Africa's government green logistics policy, which included tax breaks for companies adopting eco-friendly practices, led to a 10% increase in export competitiveness.

In addition to policy frameworks, the role of technology in enhancing GLP and its impact on international trade has been a focus of recent research. Chen et al. (2023) found that adopting advanced technologies, such as blockchain and IoT, in green logistics practices improved supply chain transparency and efficiency, leading to increased trade volumes. Analyzing data from 35 countries, the study found that companies using blockchain technology to track and verify the sustainability of their supply chains experienced a 20% increase in export volumes. Similarly, Okonkwo and Eze (2023) found that adopting IoT technology in Nigeria's logistics sector, such as real-time shipment tracking, reduced delivery times by 15% and increased export competitiveness.

The relationship between GLP and international trade is also shaped by cultural and institutional factors. A study by Mwamba and Kavishe (2023) on Tanzania's logistics sector found that cultural attitudes toward sustainability significantly influenced the adoption of green logistics practices. Companies with a strong corporate culture focused on sustainability were more likely to adopt green logistics practices, resulting in increased export competitiveness. Similarly, a study by Ndlovu and Moyo (2022) on Zimbabwe's logistics sector found that institutional support for green logistics, such as training programs for logistics professionals on sustainable practices, led to a 10% increase in export volumes. The impact of GLP on international trade is also evident in the context of global value chains (GVCs). A study by Gereffi and Fernandez-Stark (2022) found that companies participating in GVCs that adopted green logistics practices were more competitive in global

markets. Analyzing data from 20 countries, the study found that companies in GVCs implementing green logistics practices, such as carbon-neutral shipping and eco-friendly packaging, experienced a 15% increase in export volumes. Similarly, a study by Kaplinsky and Morris (2023) on African GVCs found that adopting green logistics practices, such as using renewable energy in transportation, improved the competitiveness of African exports in global markets.

4.4. Theoretical Foundation

This section examines the theoretical foundations of green logistics and sustainable development, focusing on the Triple Bottom Line (TBL) theory and Logistics Theory. TBL incorporates economic, environmental, and social dimensions, while Logistics Theory emphasizes efficient supply chain management. Together, they offer a framework to analyze how green logistics practices drive sustainability outcomes, bridging gaps between operational efficiency, environmental protection, and socio-economic growth. Key concepts and their interconnections are analyzed to support the study's conceptual model.

4.4.1. The Triple Bottom Line (TBL) Theory

The Triple Bottom Line (TBL) concept, introduced by John Elkington in 1997, has become prominent in discussions of sustainability and organizational decision-making. This concept emphasizes that organizations should consider and balance three fundamental dimensions: social, economic, and environmental impacts, collectively referred to as the triple bottom line (TBL). The TBL framework is widely used to measure strategic objectives and evaluate sustainability. In the economic dimension of TBL, business and economic entities face conditions that make economic criteria essential for organizations. In green logistics, integrating sustainable management practices can lead to economic gains through cost reductions, operational efficiencies, and maintaining or enhancing competitiveness. For example, methods such as optimizing routes, shifting cargo, and using energy-efficient warehousing can reduce transportation distances, lower fuel consumption, decrease transport expenses, and rise productivity (Sadiq et al., 2021; Shahzad et al., 2022).

Additionally, by adhering to international sustainability standards and meeting consumer demand for green and clean business practices, companies can access new markets and strengthen their competitive advantages (Evangelista et al., 2022). The environmental dimension of TBL requires organizations to ensure their activities do not harm the natural environment. Green logistics plays a key role by promoting eco-friendly transportation modes that reduce greenhouse gas emissions, conserve natural resources during extraction, and minimize packaging. Initiatives such as fuel-efficient vehicles, retrofitting for recycling and reuse, and biodegradable packaging reduce waste, pollution, and greenhouse gas emissions while protecting the environment (Thakker & Bakshi, 2023; Sharma et al., 2023). The social aspect of the TBL model values the contributions of stakeholders such as society, employees, and local communities. Sustainable practices in green logistics can positively impact communities by reducing the environmental footprint of industries, ensuring safe work environments for employees, and facilitating international trade, which can enhance economic development and job opportunities globally (Liu et al., 2023).

Furthermore, by utilizing green logistics procedures such as cooperating with reliable service providers, organizations can diversify and eventually gain a positive reputation. This reputation is important to stakeholders who care about environmental sustainability and corporate social responsibility (Seroka-Stolka and Ociepa-Kubicka, 2019; Wadood et al., 2023). The three-pillars concept of sustainability acknowledges that these dimensions are interrelated and interdependent, providing conceptual unity among them. For example, ecological harm can adversely impact the economy and society, while economic growth depends on the availability of natural resources and a healthy environment, and social welfare is linked to the health of the earth. In the context of green logistics, greening logistics has the dual effect of contributing to environmental quality and enhancing economic growth alongside social well-being. Thus, the triple bottom line (TBL) concept is

reflected. By implementing the TBL approach, organizations become more aware of and comprehensive about the impacts of their logistics operations on the economy, the environment, and society. In this way, they can assess the pros and cons and make relevant decisions. This approach gives specific meaning to sustainable and responsible supply chain management and keeps an organization's long-term survival—and thereby society's overall well-being—on the agenda (Liu et al., 2023; Sharma et al., 2023; Arda et al., 2023).

4.4.2. Logistics Theory

Logistics, defined as the effective management of the movement of commodities from the point of origin to the point of consumption, is essential to the long-term growth of the global economy, trade, and environmental standards. Concerns about the negative environmental impacts of logistics, such as greenhouse gas (GHG) emissions and other pollutants, have increased in recent years (Panchasara et al., 2021). The various definitions of logistics provided by Anet al. (2021), Khan et al. (2019), and Miroudot et al. (2009) form the basis for understanding logistics in a broader context. This understanding supports the development of the Conceptual Model on Green Logistics Performance and Sustainable Development, which aims to investigate the relationship between green logistics practices and their impact on sustainable development outcomes. The components of logistics—including planning, monitoring, storing, transporting, handling goods, and exchanging information—directly connect to the diverse aspects of green logistics performance under investigation. These aspects include monitoring and tracing shipments, service quality, handling international shipments, customs procedures, punctuality, the presence of well-developed logistical infrastructure, and environmental indicators such as CO2 emission intensity, N2O emission intensity, methane (CH4) emission intensity, and fluorine greenhouse gas (Fgas) emission intensity. By examining the role of logistics in meeting consumer demands and optimizing supply chain operations, the conceptual framework seeks to reveal how adopting sustainable logistics practices can contribute to environmental preservation, economic growth, and the promotion of international trade, all of which are crucial elements of sustainable development.

Logistics theory provides the fundamental principles and concepts underlying the operational aspects of logistics, including tracking and tracing, service quality, international shipments, customs, and timeliness (Roy & Schoenherr, 2020). Within the conceptual framework, these logistics practices are examined from a sustainability perspective to evaluate their impact on environmental and economic outcomes. For example, tracking and tracing can enhance supply chain visibility and reduce waste, while efficient service quality ensures prompt and responsible delivery. The efficiency of international shipments and customs helps minimize delays and reduce the carbon footprint of cross-border logistics operations. Timeliness in logistics execution supports sustainability by optimizing resource use and improving overall logistics performance. Additionally, key environmental indicators—including N2O emission intensity, methane (CH4) emission intensity, fluorine greenhouse gas (Fgas) emission intensity, and fossil fuel consumption—are vital metrics within this framework. By adopting green logistics practices, such as using energy-efficient transportation modes, optimizing routes to minimize emissions, and employing sustainable packaging materials, logistics can significantly reduce its environmental impact. Furthermore, in the context of sustainable development, economic growth is highly important. By embracing sustainable practices, logistics operations can lower costs through resource optimization, waste reduction, and energy-efficient operations (Kareska, 2023).

Moreover, integrating green logistics practices can open new market opportunities, attract environmentally conscious customers, and enhance a business's reputation, thereby contributing to long-term economic growth and sustainability. By adopting sustainable transportation modes and efficient customs procedures, logistics can improve trade efficiency, reduce delays, and strengthen international trade relationships (An et al., 2021). Additionally, sustainability-focused logistics practices can align with global sustainability agendas, such as the Sustainable Development Goals (SDGs), fostering international cooperation and partnerships to achieve shared sustainability objectives. The concept of Green Logistics Performance (GLP), which emphasizes adopting greener and more sustainable logistics practices, has evolved to address

these concerns (Nwaulune et al., 2023). Based on logistics theory, this research evaluates the impact of GLP measures on the long-term sustainability of economic growth, international trade, and environmental quality. Successful management of supplies, equipment, and troops was critical to victory in the campaigns of ancient Greece and Rome, giving rise to logistics theory (Zhang et al., 2020). Over time, effective resource and operations management became integral to logistics across various sectors.

According to Maheshwari et al. (2023), the principles of supply chain management, transportation, inventory management, and related areas are all included in the modern application of logistics theory. Their implementation is essential for achieving sustainable economic growth and environmental protection, as logistics has become a critical component of business operations. A more holistic approach that considers the entire supply chain has replaced the previous focus on transportation and warehousing as the main components of logistics (Jeevan et al., 2020b). Green logistics performance has become a key factor for companies seeking to balance economic growth and sustainability as environmental concerns intensify. It is important to consider the various components of logistics that support economic growth, international trade, and environmental quality to determine the impact of green logistics performance measures on sustainable development. These include the effectiveness of customs clearance procedures, the quality of infrastructure supporting trade and transportation, the ease of procuring goods at affordable prices, the capability and quality of logistics services, the ability to track goods, and the speed of transporting goods.

In addition, fossil fuel consumption and greenhouse gas emissions—such as N_2O, CH_4, and F-gas emissions intensity—are important indicators of environmental impact. Ensuring the effective flow of goods, which is crucial for both domestic and international trade, is one of the main objectives of logistics. Cross-border movement of goods is greatly enhanced by efficient customs clearance procedures and world-class trade and transportation-related infrastructure (Yu et al., 2022). By reducing costs and delays, these improvements can enhance business competitiveness and promote economic growth. Convenient and affordable freight arrangements and world-class logistics services are also necessary for effective goods transfer (Butt et al., 2023). This includes excellent supply chain management to ensure timely and proper delivery of goods. Another critical factor is traceability, which allows companies to monitor products along the supply chain to ensure proper handling and reduce the likelihood of damage or loss (Kayikci et al., 2022). Environmentally friendly logistics performance is essential for sustainable development because logistics has significant environmental impacts in addition to economic factors (Khan et al., 2020). N_2O, CH_4, and F-gases are major greenhouse gas emissions that contribute significantly to climate change. By reducing waste and increasing energy efficiency, effective logistics management can help reduce these emissions (Sovacool et al., 2021). Another major environmental issue facing logistics companies is the use of fossil fuels. Fossil fuel consumption is an important measure of environmental impact and is included in the fossil fuel index. Logistics companies can reduce their environmental impact and support sustainable development by using less fossil fuel.

Yingfei et al. (2022) used the theoretical foundations of logistics to examine the influence of green logistics performance and infrastructure on service trade and the environment. This investigation aims to evaluate business performance and service quality within the context of sustainable logistics practices. Before developing a conceptual framework for green logistics performance and sustainable development, certain prerequisites within logistics theory must be met. These prerequisites are essential for establishing a solid foundation and achieving a comprehensive understanding of the subject, ultimately enabling the construction of a robust and insightful conceptual framework. First, this study demonstrates a thorough understanding of traditional logistics theory, including fundamental concepts such as supply chain management, transportation, warehousing, inventory management, and distribution. This knowledge serves as a basis for exploring the role of logistics in advancing sustainable development. Second, a thorough understanding of green logistics concepts and practices is necessary. This includes knowledge of environmentally friendly transportation, energy-efficient supply chain operations, waste reduction strategies, and sustainable packaging practices. Equally important is an understanding of environmental indicators, including N_2O emission intensity, methane

(CH_4) emission intensity, fluorinated greenhouse gas (F-gas) emission intensity, and fossil fuel consumption, which are crucial for analyzing the environmental impacts of logistics operations. Additionally, researchers must be deeply familiar with the United Nations Sustainable Development Goals (SDGs) and their relevance to the logistics industry. This knowledge is vital for aligning the conceptual framework with global sustainability goals and identifying effective ways in which green logistics practices can contribute to their achievement.

Defining appropriate key performance indicators (KPIs) for green logistics performance is essential for evaluating the effectiveness and efficiency of sustainable logistics practices. These KPIs may include the ability to track and trace shipments, service quality metrics, punctual delivery, and efficient customs clearance. Another important step is identifying reliable and relevant data sources to capture information on logistics operations, environmental impacts, economic indicators, and international trade. Using credible data sources ensures the accuracy and validity of the results derived from the conceptual model. Considering the perspectives of various stakeholders—such as logistics providers, policymakers, consumers, and environmental experts—is also crucial. Including these perspectives ensures that the conceptual model addresses the diverse interests and requirements of stakeholders in green logistics and sustainable development. Researchers must also clearly define the methodology used to develop the conceptual model, including the study's scope, research design, data collection methods, and analysis techniques. A well-structured and transparent approach enhances the credibility and replicability of the study findings and strengthens the reliability of the conceptual model's results.

In conclusion, the theory is well-suited for literature-based research on the conceptual model of green logistics performance and sustainable development. By using existing literature and published sources, researchers can analyze the theory's concepts and examine how green logistics practices—such as tracking, service quality, customs, and logistics infrastructure—affect sustainability indicators like N_2O and CH_4 emissions, F-gas intensity, and fossil fuel consumption. A comprehensive literature review provides insights into the relationships between green logistics, environmental quality, economic growth, and international trade, ultimately contributing to a robust and evidence-based conceptual model that promotes sustainable logistics practices. The logistics theory principle of efficient supply chain management directly supports the foundation of tracking and tracing in green logistics performance. Efficient tracking and tracing provide real-time visibility, optimize logistics operations, reduce delays, and improve environmental efficiency, contributing to the Sustainable Development Goals. The theory's focus on optimizing service levels aligns with the foundation of service quality in green logistics performance. Providing reliable and environmentally friendly services meets consumer demands and enhances environmental credibility, positively impacting sustainable development goals. The emphasis on seamless transportation and customs management is directly related to the foundation for international transportation and customs in green logistics performance. Streamlining cross-border logistics increases trade efficiency, reduces emissions, and promotes international cooperation in sustainable development. The principle of timeliness in logistics theory is directly related to timely execution in green logistics performance. On-time logistics minimizes resource waste and supports sustainable development goals by optimizing logistics resource use. The importance of robust infrastructure, as recognized in logistics theory, complements the foundation of logistics infrastructure in green logistics performance.

Developing sustainable logistics infrastructure promotes economic growth, increases logistics efficiency, and helps preserve the environment, all contributing to the achievement of the Sustainable Development Goals. The focus of logistics theory on resource optimization and sustainability aligns with the use of environmental indicators (N_2O emission intensity, CH_4 emission intensity, F-gas intensity, and fossil fuel consumption) in green logistics performance. Implementing green logistics practices reduces the carbon footprint and supports the Sustainable Development Goals by fostering a greener, low-carbon economy. The role of logistics theory in cost reduction and resource management is linked to the foundation of economic growth in green logistics performance. Sustainable logistics practices enhance economic efficiency and competitiveness and promote economic growth consistent with sustainable development principles. The theory's focus on efficient trade operations also complements the foundation of international trade in green

logistics performance. By enabling smoother and greener international trade, logistics supports sustainable development through global economic integration and cooperation. In summary, the principles of logistics theory relate to the various fundamentalsand variables of Green Logistics Performance and sustainable development, highlighting the central role of logistics in achieving environmental, economic, and social sustainability goals. Integrating sustainable logistics practices can make an important contribution to the broader vision of a sustainable and responsible future. The principle of logistics theory is shown in Figure 3.

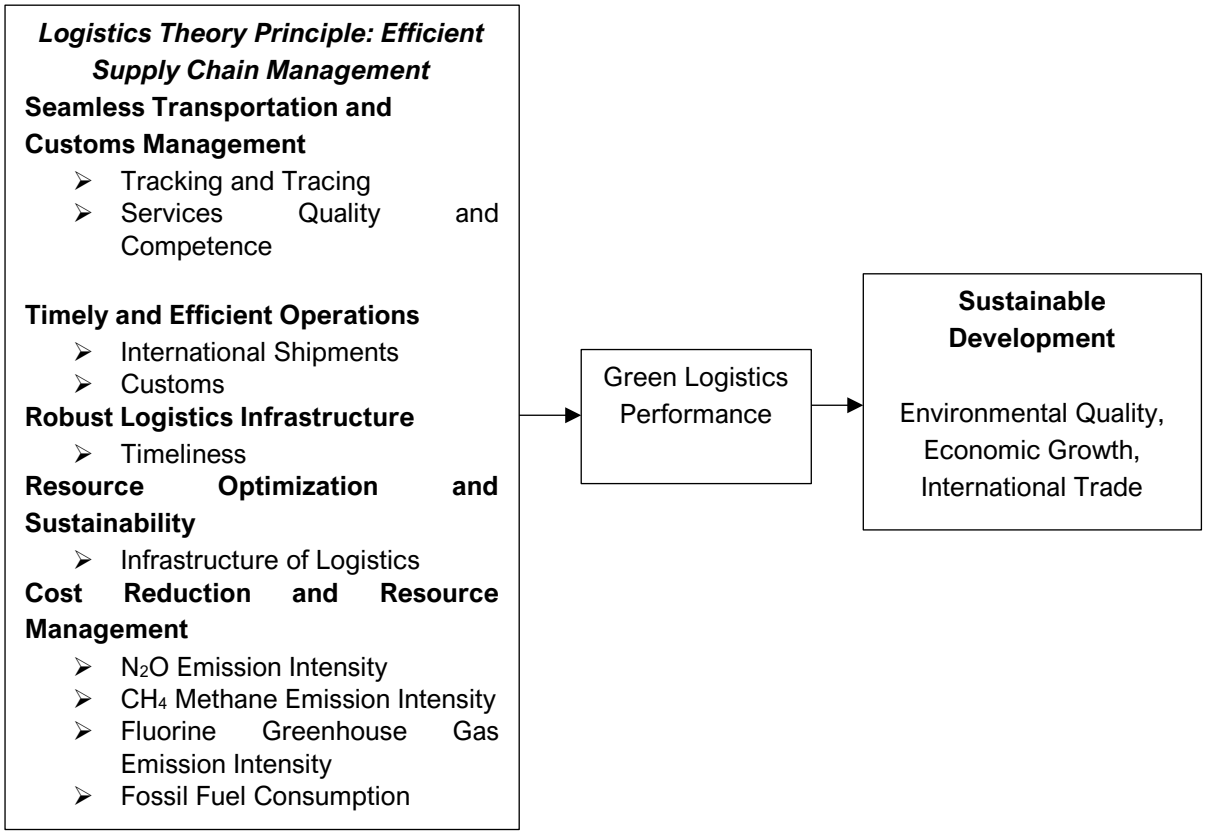

Figure 3 Logistic Theory Principle

4.5. Conceptual Model

The integration of Triple Bottom Line (TBL) theory and Logistics Theory into the proposed conceptual model in Figure 4 provides a comprehensive framework for understanding how green logistics performance (GLP) contributes to sustainable development. TBL theory, developed by Elkington (1997), emphasizes the interconnectedness of economic, environmental, and social dimensions, offering a holistic approach to evaluating organizational and policy decisions. In logistics, this means assessing operations not only for efficiency and profitability but also for ecological impact and social consequences. Logistics Theory, rooted in supply chain management (Mentzer et al., 2001), complements this perspective by focusing on operational excellence, resource optimization, and customer satisfaction. Together, these theories form the foundation for examining how green logistics practices can simultaneously drive economic growth, improve environmental quality, and enhance social outcomes through international trade. The economic pillar of TBL aligns with Logistics Theory's emphasis on cost efficiency and competitiveness. Green logistics practices such as route optimization (Sadiq et al., 2021) and energy-efficient transportation (Thakker & Bakshi, 2023) show how operational improvements can reduce costs while minimizing environmental impacts. These practices illustrate the synergy between Logistics Theory's focus on resource allocation (Christopher, 2016) and TBL's economic and environmental objectives. However, the social dimension of sustainability has often been underrepresented

in logistics research, creating a gap that this model addresses by using international trade as a proxy for social sustainability. This approach is supported by extensive empirical evidence showing that trade contributes significantly to social inclusion, cohesion, and resilience (Barron et al., 2023).

International trade serves as a robust indicator of social sustainability due to its multifaceted impacts on societies. While traditionally viewed through an economic lens, trade has profound social implications that align with the TBL framework. Trade promotes social inclusion by generating employment opportunities, particularly in labor-intensive industries, reducing inequality, and fostering upward mobility. In developing countries, export-oriented sectors often provide formal employment for marginalized groups, including women and rural workers, enhancing their economic empowerment (ILO, 2020). This connection between trade and social equity is central to Barron et al.'s (2023) conceptualization of social sustainability. Empirical studies consistently show that trade liberalization correlates with poverty reduction and improvements in social welfare indicators (Dollar & Kraay, 2004; UNCTAD, 2021), further validating trade's role in social development. Beyond economic benefits, trade strengthens social cohesion by facilitating cultural exchange and international cooperation. Cross-border trade fosters mutual understanding between nations and contributes to peaceful international relations. Modern trade agreements increasingly include provisions for labor rights and ethical standards (Rodrik, 2018), directly addressing social sustainability concerns. These agreements often mandate fair wages and safe working conditions (Elliott & Freeman, 2003), demonstrating how trade mechanisms can enforce social protections. Moreover, trade enhances social resilience by diversifying economic activities and reducing dependence on volatile domestic markets. Research by Sachs and Warner (1995) shows that trade-dependent economies are better equipped to withstand external shocks, protecting employment and livelihoods during economic crises. Access to international markets also ensures the availability of essential goods such as medicines and food staples, directly contributing to societal well-being (UNCTAD, 2021). These multidimensional impacts justify the model's use of international trade as a proxy for social sustainability, especially in contexts where direct social metrics may be limited or difficult to measure.

The proposed conceptual model operationalizes these theoretical connections through a two-tiered structure linking logistics operations with sustainability outcomes. At the logistics level, variables such as tracking and tracing capabilities, service quality, and customs efficiency reflect Logistics Theory's principles of supply chain visibility and operational excellence. These factors drive economic growth by reducing costs and enhancing trade reliability. For example, streamlined customs procedures—a key focus of Logistics Theory—have been shown to reduce trade friction costs by 7.3% in OECD countries (Gani, 2017), directly contributing to TBL's economic objectives. Simultaneously, green-level metrics, including CO_2 intensity and fossil fuel consumption, incorporate TBL's environmental dimension into logistics operations. Practices such as energy-efficient warehouse design (Wang et al., 2023) and low-emission transportation (Zhang et al., 2022) demonstrate how Logistics Theory's efficiency goals can align with ecological sustainability. The model's innovation lies in its incorporation of stakeholder pressures—a key TBL consideration—into logistics decision-making. Regulatory requirements such as carbon taxes and consumer demand for sustainable products (Baah et al., 2021) serve as moderating factors shaping the adoption of green logistics practices. This integration addresses a significant gap in previous research, which often examined operational efficiency in isolation from external influences. Companies that comply with international environmental standards often gain competitive advantages in global markets while reducing their ecological footprint, illustrating the potential alignment between TBL's social and environmental pillars and Logistics Theory's focus on market competitiveness. The model's validity is reinforced by empirical evidence from 37 studies, including research on emission reductions (Karaduman et al., 2020) and cost savings (Nayal et al., 2022), providing a robust foundation for its theoretical framework.

The model effectively reconciles apparent contradictions in existing literature, particularly regarding the relationship between regulatory compliance and operational efficiency. By demonstrating how green practices such as blockchain-enabled supply chain transparency (Chen et al., 2023) can simultaneously reduce delays and emissions, the model shows that TBL and Logistics Theory objectives are not mutually exclusive but can be

mutually reinforcing. However, the model acknowledges certain limitations, including regional variations in policy implementation and the indirect effects of innovation diffusion. These challenges are addressed through the model's flexible design, which allows for contextual adjustments based on specific economic or geographic factors. For example, in fossil fuel-dependent economies, the model might assign greater weight to metrics related to energy transition and fuel consumption. The model's strength lies in its ability to bridge micro-level logistics practices with macro-level sustainability outcomes, connecting operational decisions such as route optimization with broader goals like climate action (SDG 13) and decent work (SDG 8). The justification for using international trade as a proxy for social sustainability adds significant depth to the model, supported by both theoretical arguments and empirical evidence from diverse regional contexts. In Africa, countries such as South Africa and Kenya have demonstrated how trade-oriented policies can drive social progress alongside economic growth. South Africa's automotive exports have created quality employment opportunities while improving labor standards, and Kenya's horticulture trade has empowered women through cooperative farming initiatives (Rodrik, 2018). Similarly, trade revenues in Ghana and Nigeria have been channeled into education and healthcare investments, underscoring trade's role in social development. While organizations like the World Bank (2023) may not explicitly categorize trade as a social sustainability metric, their reports acknowledge trade's indirect social benefits, including poverty reduction and gender equality. This evolving understanding of trade's multidimensional impacts reinforces its suitability as a social sustainability indicator within the model's framework.

By integrating TBL and Logistics Theory, the conceptual model offers a comprehensive tool for analyzing and improving the sustainability of logistics operations. It goes beyond traditional, compartmentalized approaches by showing how logistics practices can simultaneously advance economic, environmental, and social objectives. The model's use of international trade as a proxy for social sustainability is an important innovation, supported by extensive theoretical and empirical evidence. This approach is especially valuable in contexts where direct social metrics are unavailable or difficult to measure, providing a practical solution for assessing the social impacts of logistics activities. The model's flexibility allows adaptation to different regional and sectoral contexts, making it a versatile tool for researchers and practitioners. For businesses, the model offers clear guidance on aligning logistics strategies with broader sustainability goals, ensuring that efficiency improvements support rather than compromise environmental and social well-being. Future research could build on this foundation by exploring sector-specific applications of the model or developing more detailed metrics for social sustainability in logistics. The model's theoretical rigor and practical applicability make it a valuable contribution to sustainable logistics, offering a pathway for the industry to reconcile operational efficiency with environmental responsibility and social progress. Its comprehensive perspective ensures that economic growth in the logistics sector does not come at the expense of ecological degradation or social inequality, but instead contributes to a more sustainable and equitable global economy.

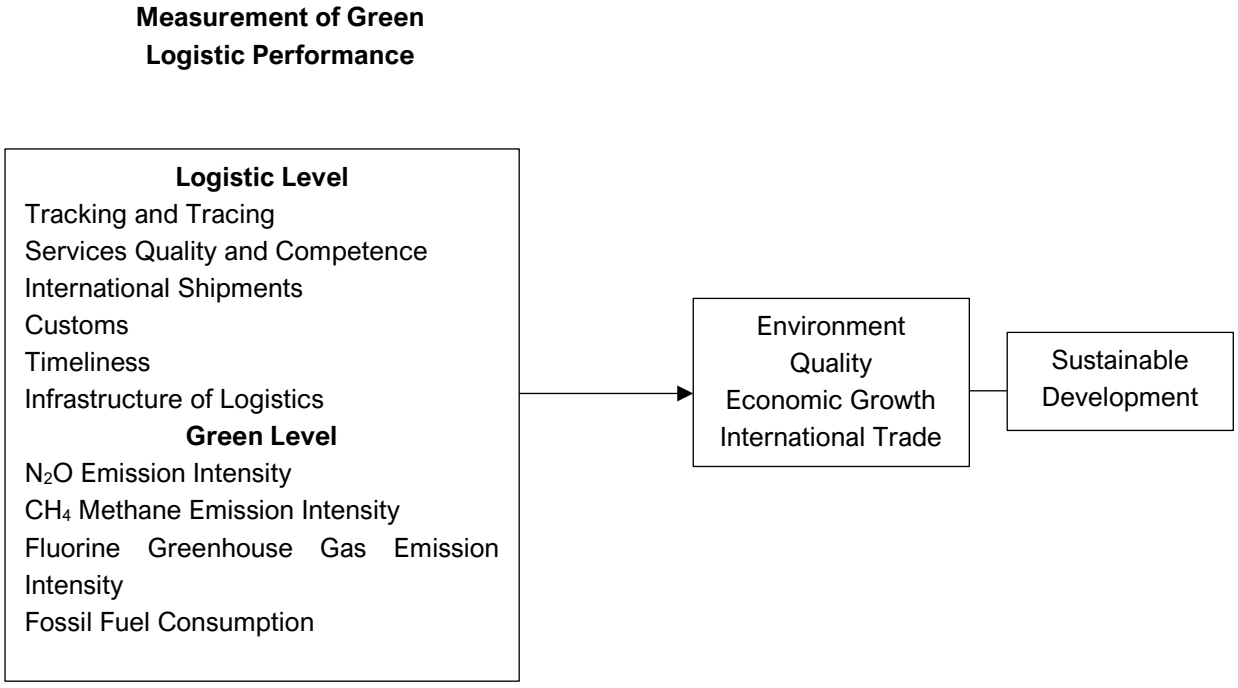

Figure 4 Proposed Conceptual Model

5. CONCLUSION

Green logistics is a relatively new field within logistics management, focused on reducing the negative environmental impacts of the logistics industry. The objective of this study was to develop a theoretical framework that explains how measuring green logistics performance affects economic growth, international trade, and environmental quality over time. Previous research on green logistics performance has mainly focused on its effects on environmental outcomes, such as reducing carbon emissions or improving resource efficiency. Similarly, studies on economic growth and global trade often overlook the specific effects of implementing green logistics practices. To thoroughly examine the impact of green logistics on economic growth, international trade, and environmental quality, existing research lacks studies that integrate both the logistics and green dimensions. This study addresses this gap and provides a comprehensive understanding of the relationship between green logistics performance and sustainability outcomes by combining these two aspects. Comparing traditional and modern green logistics performance indicators shows that a comprehensive and standardized evaluation method is urgently needed—one that considers all aspects of logistics operations and their environmental impacts. The conceptualization of the research variables indicates that factors such as government regulations, corporate social responsibility, and stakeholder engagement can influence the relationship between green logistics performance and sustainable development. Assessing green logistics performance can provide insights into the environmental impacts of logistics operations, which can then inform mitigation strategies. The study also identifies carbon emissions, energy consumption, and waste production as key indicators of green logistics success. It recommends that policymakers and logistics managers adopt green logistics practices and emphasizes the need for further research in this area.

5.1. Research Implication

The assessment of the sustainability implications associated with measuring green logistics performance introduces a significant conceptual model with far-reaching consequences for corporate governance. For organizations, this model offers a systematic approach to evaluating the effectiveness of green logistics practices in achieving sustainability objectives. Managers can use the model's key performance indicators (KPIs) to monitor environmental metrics, optimize resource use, and identify areas needing improvement. Implementing sustainable logistics strategies can enhance supply chain efficiency, reduce operational costs, and strengthen the company's reputation with environmentally conscious consumers and investors. By incorporating green logistics performance metrics, managers can drive positive change within their organizations, foster a culture of environmental responsibility, and support the long-term sustainability of growth.

Additionally, applying the conceptual model can transform the retail and logistics landscape. By integrating sustainability considerations into trade and logistics operations, companies and governments can balance economic growth with environmental protection and social well-being. Trade policies that emphasize measuring green logistics performance can promote sustainable supply chains and lower the carbon footprint of international trade. Sustainable logistics practices, such as adopting green modes of transport, can improve the efficiency and resilience of logistics networks. Enhanced measurement of logistics performance can spur innovation, with technology- and data-driven solutions creating a more sustainable and adaptable logistics sector.

In addition, adoption of the conceptual model strengthens the environmental, social, and governance aspects of companies and industries. Environmental benefits include reduced emissions, lower energy consumption, and minimized waste in logistics operations. Socially, this approach improves worker well-being, promotes fair labor practices, and encourages community engagement, raising social standards along the supply chain. In terms of corporate governance, the model promotes transparency, accountability, and ethical business practices, building stakeholder trust. Companies and industries that adhere to ESG principles attract socially responsible investors, gain access to green financing, and enhance their reputations, promoting sustainable growth and long-term success.

Finally, integration of the conceptual model reinforces circular economy principles. By measuring green logistics performance, companies can identify opportunities for circular practices such as resource recovery, remanufacturing, and closed-loop supply chains. Logistics networks can be optimized to facilitate reverse logistics, reduce waste, and maximize product value throughout their lifecycle. Applying circular economy principles improves resource efficiency, reduces environmental impact, and promotes economic resilience. By following these principles, companies contribute to a regenerative and sustainable economic model in which resources are conserved, waste is minimized, and sustainability becomes a key driver of economic growth.

5.2. Limitation as motivation for Future Direction

The conceptual model used to analyze the impact of measuring green logistics performance on the long-term sustainability of international trade, economic growth, and environmental quality has several limitations. These limitations are discussed along with potential research opportunities. One limitation is the lack of empirical data supporting the proposed conceptual model. The model was not empirically tested; instead, it is based on a review of previous research on green logistics and sustainable development. Therefore, an empirical study is needed to evaluate the applicability of the proposed framework.

Another limitation is the challenge of evaluating green logistics performance. As a multifaceted concept, green logistics performance includes several metrics, such as carbon emissions, energy consumption, waste reduction, and sustainable procurement. The model also suggests that green logistics performance positively impacts environmental quality, economic growth, international trade, and sustainable development. However, other factors, such as political stability, technological progress, and market demand, could also influence these outcomes. It is therefore critical that future research considers these factors.

The proposed framework emphasizes the macro-level impacts of green logistics performance on the sustainability of economic growth, international trade, and environmental quality. However, it does not address micro-level impacts, such as those on specific firms or delivery networks. Future studies could examine the micro-level impacts of green logistics and how they influence macro-level outcomes.

Additionally, the proposed model does not account for regional differences in the stringency of environmental laws and policies. In countries with varying environmental legislation, the effectiveness of green logistics may have different impacts on economic growth, international trade, and environmental quality. Future research could investigate the influence of green logistics performance in different legal contexts.

Empirical research is necessary to substantiate the proposed future directions of the framework. Scholars could conduct surveys or case studies to collect data on green logistics performance and its effects on sustainable development, economic growth, global trade, and environmental quality. They could then assess the utility of the suggested framework and identify the key factors that affect green logistics performance.

Future efforts could include establishing standardized measures to assess the effectiveness of green logistics. This would enable more accurate monitoring of environmental impacts, economic growth, and global trade, and would facilitate comparisons of green logistics effectiveness across diverse contexts.

Further research could explore how green logistics can leverage technological advancements. Innovative technologies such as the Internet of Things, blockchain, and big data analytics demonstrate how advanced technologies can enhance the success and efficiency of green logistics operations. Given the importance of green logistics to global trade, economic growth, and environmental quality, it is essential to investigate how these technologies can be used to improve green logistics performance. Green logistics is central to all these factors.

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CONFLICT OF INTEREST STATEMENT:

Authors declare no conflicts of interest

REFERENCES

Agrawal, R., Majumdar, A., Majumdar, K., Raut, R. D., & Narkhede, B. E. 2022. Attaining sustainable development goals (SDGs) through supply chain practices and business strategies: A systematic review with bibliometric and network analyses. Business Strategy and the Environment, 31(7), 3669-3687. Available at: https://doi.org/10.1002/bse.3057

An, H., Razzaq, A., Nawaz, A., Noman, S. M., & Khan, S. A. R. 2021. Nexus between green logistic operations and triple bottom line: evidence from infrastructure-led Chinese outward foreign direct investment in Belt and Road host countries. Environmental Science and Pollution Research, 28(37). Available at: 51022-51045. https://doi.org/10.1016/j.jclepro.2018.12.322

Baah, C., Jin, Z., & Tang, L. 2020. Organizational and regulatory stakeholder pressures friends or foes to green logistics practices and financial performance: investigating corporate reputation as a missing link. Journal of cleaner production, 247, 119125. Available at: https://doi.org/10.1016/j.jclepro.2019.119125

Baah, C., Opoku-Agyeman, D., Acquah, I. S. K., Agyabeng-Mensah, Y., Afum, E., Faibil, D., & Abdoulaye, F. A. M. 2021. Examining the correlations between stakeholder pressures, green production practices, firm reputation, environmental and financial performance: Evidence from manufacturing SMEs. Sustainable Production and Consumption, 27, 100-114. Available at: https://doi.org/10.1016/j.spc.2020.10.015

Balsalobre-Lorente, D., Abbas, J., He, C., Pilař, L., & Shah, S. A. R. 2023. Tourism, urbanization and natural resources rents matter for environmental sustainability: The leading role of AI and ICT on sustainable development goals in the digital era. Resources Policy, 82, 103445. Available at: https://doi.org/10.1016/j.resourpol.2023.103445

Barbier, E. B., & Burgess, J. C. 2019. Sustainable development goal indicators: Analyzing trade-offs and complementarities. World development, 122, 295-305. Available at: https://doi.org/10.1016/j.worlddev.2019.05.026

Bhavsar, A., Diallo, C., & Ülkü, M. A. 2021. Towards sustainable development: Optimal pricing and sales strategies for retailing fair trade products. Journal of Cleaner Production, 286, 124990. Available at: https://doi.org/10.1016/j.jclepro.2020.124990

Boklan, D. 2022. Channeling of Liability: Shall Arctic States Be Liable for Environmental Harm in the Arctic Caused by Navigation or Polluter Pays Principle Should Prevail? In Arctic Fever: Political, Economic & Environmental Aspects (pp. 451-469). Singapore: Springer Nature Singapore. Available at: https://link.springer.com/chapter/10.1007/978-981-16-9616-9_17

Butt, A. S., Ali, I., & Govindan, K. 2023. The role of reverse logistics in a circular economy for achieving sustainable development goals: a multiple case study of retail firms. Production Planning & Control, 1-13. Available at: https://doi.org/10.1080/09537287.2023.2197851

Chatti, W., & Majeed, M. T. 2022. Investigating the links between ICTs, passenger transportation, and environmental sustainability. Environmental Science and Pollution Research, 29(18), 26564-26574. Available at: https://link.springer.com/article/10.1007/s11356-021-17834-3

Christopher, M. 2016. Logistics & supply chain management (5th ed.). Pearson Education.

D'Amore, G., Di Vaio, A., Balsalobre-Lorente, D., & Boccia, F. 2022. Artificial intelligence in the water–energy–food model: a holistic approach towards sustainable development goals. Sustainability, 14(2), 867. Available at: https://doi.org/10.3390/su14020867

Denyer, D., & Tranfield, D. (2009). Producing a systematic review. In D. A. Buchanan & A. Bryman (Eds.), The Sage handbook of organizational research methods (pp. 671-689). Sage Publications Ltd.

Evangelista, P. 2014. Environmental sustainability practices in the transport and logistics service industry: An exploratory case study investigation. *Research in Transportation Business & Management*, *12*, 63-72. Available at: https://doi.org/10.1016/j.rtbm.2014.10.002

Evangelista, P., Huge-Brodin, M., Isaksson, K., & Sweeney, E. 2011. The impact of 3PL's green initiatives on the purchasing of transport and logistics services: an exploratory study, 1-16. Available at: https://arrow.tudublin.ie/nitlcon/55

Fan, M., Wu, Z., Qalati, S. A., He, D., & Hussain, R. Y. 2022. Impact of green logistics performance on China's export trade to regional comprehensive economic partnership countries. Frontiers in Environmental Science, 10, 879590. Available at: https://www.frontiersin.org/articles/10.3389/fenvs.2022.879590/full

Gioia, D. A., Corley, K. G., & Hamilton, A. L. 2013. Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organizational research methods*, *16*(1), 15-31. Available at: https://doi.org/10.1177/1094428112452151

Hajian, M., & Kashani, S. J. 2021. Evolution of the concept of sustainability. From Brundtland Study to sustainable development goals. In Sustainable resource management (pp. 1-24). Elsevier. Available at: https://doi.org/10.1016/B978-0-12-824342-8.00018-3

Hassan, S. T., Wang, P., Khan, I., & Zhu, B. 2023. The impact of economic complexity, technology advancements, and nuclear energy consumption on the ecological footprint of the USA: Towards circular economy initiatives. Gondwana Research, 113, 237-246. Available at: https://doi.org/10.1016/j.gr.2022.11.001

Hasson, F., & Keeney, S. 2011. Enhancing rigour in the Delphi technique research. *Technological forecasting and social change*, *78*(9), 1695-1704. Available at: https://doi.org/10.1016/j.techfore.2011.04.005

Jeevan, J., Mohd Salleh, N. H., Mohd Zaideen, I. M., Othman, M. R., Menhat, M. N. S., & Divine Caesar, L. 2020a. Application of geoeconomics in seaport operations: a theoretical proposal for post Covid-19 recovery strategy. Australian Journal of Maritime & Ocean Affairs, 12(4), 217-242. Available at: https://doi.org/10.1080/18366503.2020.1834060

Jeevan, J., Ramamoorthy, K., Salleh, N. H. M., Hu, Y., & Park, G. K. 2020b. Implication of e-navigation on maritime transportation efficiency. WMU Journal of Maritime Affairs, 19, 73-94. Available at: https://link.springer.com/article/10.1007/s13437-020-00194-z

Jie, H., Khan, I., Alharthi, M., Zafar, M. W., & Saeed, A. 2023. Sustainable energy policy, socio-economic development, and ecological footprint: The economic significance of natural resources, population growth, and industrial development. Utilities Policy, 81, 101490. Available at: https://doi.org/10.1016/j.jup.2023.101490

Kalyar, M. N., Shoukat, A., & Shafique, I. 2020. Enhancing firms' environmental performance and financial performance through green supply chain management practices and institutional pressures. Sustainability Accounting, Management and Policy Journal, 11(2), 451-476. Available at: https://doi.org/10.1108/SAMPJ-02-2019-0047

Kareska, K. 2023. Operational Management Strategies for Sustainable Productivity Growth. Available at SSRN 4532740. Available at: http://dx.doi.org/10.2139/ssrn.4532740

Kayikci, Y., Subramanian, N., Dora, M., & Bhatia, M. S. 2022. Food supply chain in the era of Industry 4.0: Blockchain technology implementation opportunities and impediments from the perspective of people,

process, performance, and technology. Production planning & control, 33(2-3), 301-321. Available at: https://doi.org/10.1080/09537287.2020.1810757

Khan, S. A. R., Zhang, Y., Kumar, A., Zavadskas, E., & Streimikiene, D. 2020. Measuring the impact of renewable energy, public health expenditure, logistics, and environmental performance on sustainable economic growth. Sustainable development, 28(4), 833-843. Available at: https://doi.org/10.1002/sd.2034

Kopnina, H. 2020. Education for the future? Critical evaluation of education for sustainable development goals. The Journal of Environmental Education, 51(4), 280-291. Available at: https://doi.org/10.1080/00958964.2019.1710444

Koval, V., Mikhno, I., Udovychenko, I., Gordiichuk, Y., & Kalina, I. 2021. Sustainable natural resource management to ensure strategic environmental development. Available at: https://www.ceeol.com/search/article-detail?id=977526

Kumar, R., Verma, A., Shome, A., Sinha, R., Sinha, S., Jha, P. K., ... & Vara Prasad, P. V. 2021. Impacts of plastic pollution on ecosystem services, sustainable development goals, and need to focus on circular economy and policy interventions. Sustainability, 13(17), 9963. Available at: https://doi.org/10.3390/su13179963

Kurniawan, T. A., Liang, X., O'Callaghan, E., Goh, H., Othman, M. H. D., Avtar, R., & Kusworo, T. D. 2022. Transformation of solid waste management in China: Moving towards sustainability through digitalization-based circular economy. Sustainability, 14(4), 2374. Available at: https://doi.org/10.3390/su14042374

Li, X., Sohail, S., Majeed, M. T., & Ahmad, W. 2021. Green logistics, economic growth, and environmental quality: evidence from one belt and road initiative economies. Environmental Science and Pollution Research, 28, 30664-30674. Available at: https://link.springer.com/article/10.1007/s11356-021-12839-4

Lim, S. F. W., Jin, X., & Srai, J. S. 2018. Consumer-driven e-commerce: A literature review, design framework, and research agenda on last-mile logistics models. *International Journal of Physical Distribution & Logistics Management*, *48*(3), 308-332. Available at: https://doi.org/10.1108/IJPDLM-02-2017-0081

Maheshwari, P., Kamble, S., Kumar, S., Belhadi, A., & Gupta, S. 2023. Digital twin-based warehouse management system: a theoretical toolbox for future research and applications. The International Journal of Logistics Management. Available at: https://doi.org/10.1108/IJLM-01-2023-0030

Mayring, P. 2004. Qualitative content analysis. *A companion to qualitative research*, *1*(2), 159-176. Available at: https://www.researchgate.net/publication/215666096_Qualitative_Content_Analysis

Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., & Zacharia, Z. G. 2001. Defining supply chain management. *Journal of Business logistics*, *22*(2), 1-25.

Montiel, I., Cuervo-Cazurra, A., Park, J., Antolín-López, R., & Husted, B. W. 2021. Implementing the United Nations' sustainable development goals in international business. Journal of International Business Studies, 52(5), 999-1030. Available at: https://link.springer.com/article/10.1057/s41267-021-00445-y

Nayal, K., Raut, R. D., Yadav, V. S., Priyadarshinee, P., & Narkhede, B. E. 2022. The impact of sustainable development strategy on sustainable supply chain firm performance in the digital transformation era. Business Strategy and the Environment, 31(3), 845-859. Available at: https://doi.org/10.1002/bse.2921

Nwaulune, J. C., Ajike, E. O., & Bamidele, A. G 2023. The Impact of Green Logistics Practices on Social Sustainability of Fast-Moving Consumer Goods Firms in Lagos State, Nigeria: An Empirical Investigation.

International Research Journal of Economics and Management Studies IRJEMS, 2(2). Available at: https://doi.org/10.56472/25835238/IRJEMS-V2I2P147

Ogunmakinde, O. E., Egbelakin, T., & Sher, W. 2022. Contributions of the circular economy to the UN sustainable development goals through sustainable construction. Resources, Conservation and Recycling, 178, 106023. Available at: https://doi.org/10.1016/j.resconrec.2021.106023

Okoli, C., & Pawlowski, S. D. 2004. The Delphi method as a research tool: an example, design considerations and applications. *Information & management*, *42*(1), 15-29. Available at: http://dx.doi.org/10.1016/j.im.2003.11.002

Panchasara, H., Samrat, N. H., & Islam, N. 2021. Greenhouse gas emissions trends and mitigation measures in Australian agriculture sector—A review. Agriculture, 11(2), 85. Available at: https://doi.org/10.3390/agriculture11020085

Pererva, P., Kobielieva, T., Kuchinskyi, V., Garmash, S., & Danko, T. 2021. Ensuring the Sustainable Development of an Industrial Enterprise on the Principle of Compliance-Safety. Studies of Applied Economics, 39(5). Available at: https://doi.org/10.25115/eea.v39i5.5111

Perotti, S., Prataviera, L. B., & Melacini, M. 2022. Assessing the environmental impact of logistics sites through CO2eq footprint computation. Business Strategy and the Environment, 31(4), 1679-1694. Available at: https://doi.org/10.1002/bse.2976

Persdotter Isaksson, M., Hulthén, H., & Forslund, H. 2019. Environmentally sustainable logistics performance management process integration between Buyers and 3PLs. Sustainability, 11(11), 3061. Available at: https://doi.org/10.3390/su11113061

Rehman, A., Ma, H., Ozturk, I., & Ulucak, R. 2022. Sustainable development and pollution: The effects of CO 2 emission on population growth, food production, economic development, and energy consumption in Pakistan. Environmental Science and Pollution Research, 1-12. Available at: https://link.springer.com/article/10.1007/s11356-021-16998-2

Roy, V., & Schoenherr, T. 2020. Implications of sectoral logistical capabilities for export competitiveness: a public policy perspective for interventions in the logistics sector. IEEE Transactions on Engineering Management, 69(6), 2930-2943. Available at: https://doi.org/10.1109/TEM.2020.3024240

Sakalasooriya, N. 2021. Conceptual analysis of sustainability and sustainable development. Open Journal of Social Sciences, 9(03), 396. Available at: http://creativecommons.org/licenses/by/4.0/

Sandra Marcelline, T. R., Chengang, Y., Ralison Ny Avotra, A. A., Hussain, Z., Zonia, J. E., & Nawaz, A. 2022. Impact of green construction procurement on achieving sustainable economic growth influencing green logistic services management and innovation practices. Frontiers in Environmental Science, 9. Available at: https://www.frontiersin.org/articles/10.3389/fenvs.2021.815928/full

Seroka-Stolka, O. 2014. The development of green logistics for implementation sustainable development strategy in companies. *Procedia-Social and Behavioral Sciences*, *151*, 302-309. Available at: https://doi.org/10.1016/j.sbspro.2014.10.028

Sovacool, B. K., Griffiths, S., Kim, J., & Bazilian, M. 2021. Climate change and industrial F-gases: A critical and systematic review of developments, sociotechnical systems and policy options for reducing synthetic

greenhouse gas emissions. Renewable and Sustainable Energy Reviews, 141, 110759. Available at: https://doi.org/10.1016/j.rser.2021.110759

Seuring, S., & Gold, S. 2012. Conducting content-analysis based literature reviews in supply chain management. *Supply chain management: An international journal*, *17*(5), 544-555. Available at: http://dx.doi.org/10.1108/13598541211258609

Sheu, J. B., & Kundu, T. 2018. Forecasting time-varying logistics distribution flows in the One Belt-One Road strategic context. *Transportation Research Part E: Logistics and Transportation Review*, *117*, 5-22. Available at: https://doi.org/10.1016/j.tre.2017.03.003

Tan, B. Q., Wang, F., Liu, J., Kang, K., & Costa, F. 2020. A blockchain-based framework for green logistics in supply chains. Sustainability, 12(11), 4656. Available at: https://doi.org/10.3390/su12114656

Tetteh, F.K., Kwateng, K.O. and Mensah, J., 2024. Green logistics practices: A bibliometric and systematic methodological review and future research opportunities. *Journal of Cleaner Production*, *476*, p.143735. https://doi.org/10.1016/j.jclepro.2024.143735

Tetteh, F.K., Owusu Kwateng, K. and Mensah, J., 2025a. Enhancing carbon neutral supply chain performance: can green logistics and pressure from supply chain stakeholders make any differences?. *Sustainability Accounting, Management and Policy Journal*, *16*(2), pp.521-551. https://doi.org/10.1108/SAMPJ-08-2024-0884

Tetteh, F.K., Mensah, J. and Owusu Kwateng, K., 2025b. Understanding what, how and when green logistics practices influence carbon-neutral supply chain performance. *International Journal of Productivity and Performance Management*, *74*(6), pp.2211-2244.https://doi.org/10.1108/IJPPM-08-2024-0517

Tranfield, D., Denyer, D., & Smart, P. 2003. Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British journal of management*, *14*(3), 207-222.

Trivellas, P., Malindretos, G., & Reklitis, P. 2020. Implications of green logistics management on sustainable business and supply chain performance: evidence from a survey in the greek agri-food sector. Sustainability, 12(24), 10515. Available at: https://doi.org/10.3390/su122410515

Wang, F., Wong, W. K., Wang, Z., Albasher, G., Alsultan, N., & Fatemah, A. 2023. Emerging pathways to sustainable economic development: An interdisciplinary exploration of resource efficiency, technological innovation, and ecosystem resilience in resource-rich regions. Resources Policy, 85, 103747. Available at: https://doi.org/10.1016/j.resourpol.2023.103747

Xu, X., Sharma, P., Shu, S., Lin, T. S., Ciais, P., Tubiello, F. N., ... & Jain, A. K. 2021. Global greenhouse gas emissions from animal-based foods are twice those of plant-based foods. Nature Food, 2(9), 724-732. Available at: https://www.nature.com/articles/s43016-021-00358-x

Xuan, D., Jiang, X., & Fang, Y. 2023. Can globalization and the green economy hedge natural resources? Functions of population growth and financial development in BRICS countries. Resources Policy, 82, 103414. Available at: https://doi.org/10.1016/j.resourpol.2023.103414

Yenugula, M., Sahoo, S., & Goswami, S. 2024. Cloud computing for sustainable development: An analysis of environmental, economic and social benefits. Journal of future sustainability, 4(1), 59-66. Available at: https://doi.org/10.5267/j.jfs.2024.1.005

Yingfei, Y., Mengze, Z., Zeyu, L., Ki-Hyung, B., Avotra, A. A. R. N., & Nawaz, A. 2022. Green logistics performance and infrastructure on service trade and environment-measuring firm's performance and service quality. Journal of King Saud University-Science, 34(1), 101683. Available at: https://doi.org/10.1016/j.jksus.2021.101683

Yu, Z., Khan, A. R., Thomas, G., Jameel, K., Tanveer, M., & Janjua, L. 2022. Nexuses between international trade, renewable energy, and transport services: Leading toward practical implications and trade policies. Frontiers in Environmental Science, 10, 980648. Available at: https://www.frontiersin.org/articles/10.3389/fenvs.2022.980648/full

Zafar, M. W., Shahbaz, M., Sinha, A., Sengupta, T., & Qin, Q. 2020. How renewable energy consumption contribute to environmental quality? The role of education in OECD countries. Journal of Cleaner Production, 268, 122149. Available at: https://doi.org/10.1016/j.jclepro.2020.122149

Zhang, W., Zhang, M., Zhang, W., Zhou, Q., & Zhang, X. 2020. What influences the effectiveness of green logistics policies? A grounded theory analysis. Science of the Total Environment, 714, 136731. Available at: https://doi.org/10.1016/j.scitotenv.2020.136731

Zhang, Y., Khan, I., & Zafar, M. W. 2022. Assessing environmental quality through natural resources, energy resources, and tax revenues. Environmental Science and Pollution Research, 29(59), 89029-89044. Available at: https://link.springer.com/article/10.1007/s11356-022-22005-z

Zhu, J., Luo, Z., Sun, T., Li, W., Zhou, W., Wang, X., ... & Yin, K. 2023. Cradle-to-grave emissions from food loss and waste represent half of total greenhouse gas emissions from food systems. Nature Food, 4(3), 247-256. Available at: https://www.nature.com/articles/s43016-023-00710-3

Zorzini, M., Hendry, L. C., Huq, F. A., & Stevenson, M. 2015. Socially responsible sourcing: reviewing the literature and its use of theory. *International Journal of Operations & Production Management*, *35*(1), 60-109. Available at: https://doi.org/10.1108/IJOPM-07-2013-0355