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Sustainable Logistics Practices in Saudi Arabia: A MIS Perspective for Environmental and Economic Optimization

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Abstract

Situated within Saudi Arabia's Vision 2030 transformation agenda, this study examines the performance implications of sustainable logistics practices (SLPs) and the mediating role of Management Information Systems (MIS). Although achieving a "double bottom line" is a central premise of sustainable supply chain management, its realization in state-driven emerging economies remains unclear. Drawing on the Natural Resource-Based View and Stakeholder Theory, a structural equation model is tested using survey data from 372 logistics and supply chain professionals in Saudi Arabia. The model assesses the effects of Green Transportation, Sustainable Packaging, and Sustainable Waste Management on Environmental Sustainability and Economic Performance. The results reveal a clear "Economic Performance paradox." While all three practices significantly enhance Environmental Sustainability, only Sustainable Waste Management directly improves Economic Performance. Moreover, Green MIS significantly mediates the relationship between sustainable logistics practices and Environmental Sustainability but shows no direct or mediating effect on Economic Performance. This indicates a prevailing compliance-oriented use of MIS, where firms prioritize environmental monitoring and reporting over operational optimization. This study demonstrates that the double bottom line is not automatic, but contingent on practice type and institutional context. By providing firm-level evidence from Saudi Arabia, the study extends sustainable logistics and information systems research and offers contextually grounded insights for managers and policymakers.

Keywords: sustainable logistics practices; management information systems (MIS); Saudi Arabia vision 2030; natural resource-based view (NRBV); stakeholder theory; structural equation modelling (SEM)

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1. Introduction

Sustainability was not an important consideration in the past, but nowadays it is a top priority for both governments and businesses [1]. The issues of climate change, scarcity of resources, and issues of equity are compelling all types of businesses to rethink the manner in which they do business with an emphasis on minimizing their impacts on the environment [2]. The field of logistics and transportation is of particular importance in that regard. This represents both the lifeblood of world trade and its most troublesome environmental impact [3]. Today, the logistics sector is estimated to contribute less than a percentage of global greenhouse gas (GHG) emissions, with diesel-fueled road haulage being its largest single source [4–6]. The sector thus lies right in the middle of the sustainability challenge owing to its appetite for fossil fuels, its use of resources on a vast scale, and its production of unimaginable amounts of waste [7,8].

Recent evidence further underscores the urgency of transforming the logistics sector. According to the International Energy Agency and the Global Logistics Emissions Council, freight transport alone now accounts for approximately 25% of global energy-relatedcarbon dioxide (CO_2) emissions, with logistics-related activities expected to grow faster than passenger transport in emerging economies [9,10]. Digitalization and sustainability are therefore increasingly treated as inseparable pillars of modern logistics systems [6,7]. In the Saudi Arabian context, this relevance is even more pronounced. The logistics and transport sector has been formally identified as a strategic growth engine under Vision 2030, with the Kingdom targeting an increase in logistics sector GDP (Gross Domestic Product) contribution to over USD 57 billion and positioning Saudi Arabia among the top 10 global logistics hubs [11,12]. The National Transport and Logistics Strategy further reports that freight volumes are projected to more than triple by 2030, significantly amplifying environmental pressures if sustainability is not embedded at the operational level [13]. These trends, coupled with the Saudi Green Initiative's commitment to net-zero ambitions, make the Saudi logistics sector a critical and timely empirical setting for examining how sustainable logistics practices and digital capabilities jointly shape environmental and economic outcomes.

However, emerging evidence also cautions against assuming that sustainability investments automatically translate into short-term financial gains. In institutionally strong, government-driven transformation contexts, sustainability initiatives are often first adopted to ensure regulatory compliance, legitimacy, and alignment with national development agendas, rather than to optimize costs or productivity. This raises a critical but under-examined question: do sustainable logistics practices initially function more as compliance infrastructures than as economic value-creation mechanisms? Addressing this theoretical tension is central to understanding whether, when, and under what conditions the "double bottom line" materializes.

This study fulfills that necessity through well-defined objectives and research enquiries rooted in Management Information Systems (MIS). It will gather and look at operational data (Transportation Management Systems (TMS)//Warehouse Management Systems (WMS) records, telematics, fuel and energy meters); calculate comparable Key Performance Indicators (KPIs) (carbon dioxide equivalent (CO_2e) per ton-kilometer, load factor, empty-mile rate, on-time delivery, cost per shipment, warehouse energy intensity); and look at how digital and green interventions like route and load optimization, driver eco-training, switching to rail or sea, using alternative fuels and electrifying the fleet, and using renewable energy to power energy-efficient warehouses affect both emissions and business outcomes in Saudi Arabia. The primary objective is to provide a comprehensive analysis based on MIS that benefits both corporate strategy and national policy. The study will focus on the role of MIS in facilitating and supervising Environmental Sustainability. It will also make it clear how certain sustainable practices, the information technology frameworks that support those practices, and the results that come from them are all related to one another. The following are the objectives of this study:

1. To analyze the present level of adoption of essential sustainable logistics practices, namely, Green Transportation, Sustainable Packaging, and Sustainable Waste Management, by supply chain and logistics bodies operating in Saudi Arabia.
2. To assess empirically the effects of implementing these sustainable logistics strategies upon the Environmental Sustainability and organizational Economic Performance.

3. To investigate the key role of MIS towards facilitating the implementation of sustainable practices and minimizing their influence on the results of performance.

The following key research questions that this investigation seeks to answer are aligned with these objectives:

1. What are the most prevailing sustainable logistics strategies that are currently implemented by logistics sector organizations of Saudi Arabia?
2. To what extent the adoption of these practices, aided and supplemented by Management Information Systems, ensures increased Environmental Sustainability, including carbon emission and waste reduction?
3. How does the adoption of sustainable logistics practice, through modern MIS, impact the principal drivers of the Economic Performance, i.e., minimization of costs, efficiencies, and competitiveness?

The remainder of the paper is organized as follows. Section 2 reviews the theoretical foundations and empirical literature on sustainable logistics, MIS, and performance outcomes, and identifies the research gap. Section 3 presents the conceptual framework, hypotheses, and quantitative research methodology. Section 4 reports the empirical results of the measurement and structural models. Section 5 discusses the findings in relation to the existing literature and theoretical perspectives and outlines the study's theoretical and managerial implications. Finally, Section 6 concludes the paper and highlights its limitations and directions for future research.

2. A Review of the Literature: Theoretical Foundations and Empirical Landscape

The following review represents the broad body of literature that supports this study. It begins by providing an overview of the main theoretical ideas explaining 'why' and 'how' sustainable practices have been put into framework, then proceeds to discuss the issues with the operational side of sustainable logistics and the role that information systems play in making these practices effective, and, finally, examines the existing research linking the practice to its resultant outcomes. Combined, this review allows the current study to be contextualized within the wider body of literature and clearly highlights the research gap to be investigated.

2.1. Theoretical Lenses for Sustainable Logistics

To understand why and how businesses incorporate sustainability into their logistics operations, a sound theoretical foundation is needed. There are two complementary theoretical frameworks that are mainly employed in the literature for explaining external motivating forces and internal strategic drivers, pushing businesses to take the path of sustainability, are the Natural Resource-Based View (NRBV) and Stakeholder Theory [11–14].

2.1.1. The Natural Resource-Based View (NRBV)

The resource-based view (RBV) states that the firm's unique bundle of critical, scarce, singular, and proprietary assets and capabilities is what enables it to establish and sustain its competitive advantage [13–17]. This perspective shifts the focus of strategic exploration from the external industry environment to the internal capabilities hidden inside the firm. One important extension of this was Hart [17] development of what he labeled the NRBV. NRBV postulates that a firm's relationship with the natural environment can provide a significant and long-lasting competitive advantage. The NRBV concept became necessary because the classical RBV proved blind to the limitations and opportunities offered by the physical and biological setting [18]. This became increasingly unsustainable as environmental demands grew stronger. The NRBV outlines three strategic capabilities that firms can develop to exploit environmental factors for the purpose of market leadership. Pollution prevention, the first of these, focuses on the firm's own processes, giving highest priority to the minimization of waste and emissions at the generation source, rather than on the application of end-of-pipe technologies. Pollution prevention is based on the idea that waste too often represents an inefficient application of the production system. Through the promotion of process purity, companies have the dual benefit of lowering costs and minimizing their impact on the environment through the better use of resources.

Secondly, product stewardship extends the firm's environmental concern beyond the plants where it manufactures, to the entire life of the products, from the extraction of the raw materials through final disposal. This necessitates involvement of external stakeholders throughout the value chain so as to reduce the aggregate environmental impact of the product, and through this, construct pre-emption, differentiation, and better reputation-based competitive advantage. Thirdly, sustainable development is the summit of human endeavor; it demands long-term focus planning, which would enable us to meet our current needs without compromising the ability of future generations to meet theirs, and this translates into solving the environmental and social crises of the people on the bottom rung of the world economic ladder [19].

For the purpose of this research, the NRBV supplies the fundamental theoretical justification of the reason why green logistics investment should not be framed as compliance costs, but strategic investment towards the cultivation of valuable organizational capabilities. Green Transportation, Sustainable Packaging, and circular waste management are the physical embodiment of the strategies of pollution prevention and product stewardship. Through cultivating capabilities along these lines, companies are able to attain higher operational efficiency, lower long-run costs and liabilities, and by differentiating themselves in the market, they are able to convert their care for the environment into long-run benefits.

2.1.2. Stakeholder Theory

To balance the NRBV's internal, resource-based view of the firm, Stakeholder Theory provides a much-needed external perspective by which to examine the primary drivers of corporate sustainability initiatives. First advanced by Freeman [20], the theory challenges the traditional shareholder-centric view of the firm, and it suggests organizational responsibility for controlling relationships with the broad-based stakeholders defined as any grouping or individual able to affect or be affected by the organization securing its ends. The stakeholders run the full gamut and involve the likes of investors, customers, staff, suppliers, government bodies, non-governmental organizations (NGOs), and the wider public.

A substantial body of literature substantiates the premise that Stakeholder Theory holds considerable relevance in the context of sustainable supply chain management (SSCM) [21]. The evidence clearly shows that the force of various stakeholder groups acting on an organization is the key driving force that encourages organizations to adopt practices more aligned with Environmental Sustainability. For instance, customers are increasingly becoming transparent in their demands and lean towards supporting companies that themselves demonstrate strong credentials on this issue. Additionally, there are different laws imposed by government institutions that force the organizations to develop themselves on the issue of Environmental Sustainability [22]. It can also be counted as another type of compelling force. The role of advocacy by non-governmental organizations can prove to be a compelling force on corporations [23]. In addition to this, it has also been observed that there is often a need to work in partnership with various business partners so that the issue of sustainability can be enhanced [24].

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In relation to the specific case of the country of Saudi Arabia, this concept can be applied to show that the Stakeholder Theory holds special relevance. The most powerful stakeholder that actively plays a role in making the logistics industry sustainable is the country's government, which is pursuing its Vision 2030 agenda. This is also a unique state of affairs, wherein the satisfaction of the goals of the government is not only beneficial to businesses but is also key to sustainable prosperity in the decades to come. An important framework for understanding the strong external forces pushing Saudi logistics companies toward long-term transformation is Stakeholder Theory.

Drawing explicitly on the complementary logics of the Natural Resource-Based View (NRBV) and Stakeholder Theory, this study advances a dual-mechanism explanation for sustainable logistics adoption and performance outcomes. Stakeholder Theory explains why firms operating in Saudi Arabia are compelled to implement sustainable logistics practices—namely, strong coercive, normative, and legitimacy pressures arising from Vision 2030, environmental regulation, and societal expectations. In contrast, the NRBV explains how such practices may translate into organizational advantage by conceptualizing Green Transportation, Sustainable Packaging, and Sustainable Waste Management as operational manifestations of pollution prevention and product stewardship capabilities. Within this logic, Management Information Systems (MIS) are not treated merely as administrative tools but as strategic environmental capabilities that enable sensing, measurement, integration, and optimization of sustainability-oriented logistics activities. Accordingly, the model assumes that sustainable logistics practices stimulate the development and use of green-oriented MIS capabilities, which in turn strengthen the conversion of operational greening into environmental and Economic Performance. This integrated framing moves beyond descriptive sustainability arguments and positions the proposed relationships within a theoretically grounded capability–pressure–performance nexus.

Importantly, recent sustainability and institutional research suggests that in state-driven or highly regulated contexts, sustainability investments may initially function more as legitimacy-seeking and compliance-oriented responses rather than as optimization-driven strategic capabilities. Under such conditions, firms prioritize meeting regulatory targets, reporting requirements, and stakeholder expectations, often before internal efficiency gains are realized. This compliance-first trajectory implies that environmental improvements may precede, and even decouple from, short-term economic benefits, giving rise to what has been described as a sustainability or "double-bottom-line" paradox in emerging and policy-intensive economies. Embedding this logic within the NRBV–Stakeholder framework allows the present study to theorize that economic value from sustainable logistics is contingent on the maturity of capabilities and the evolution of MIS from reporting infrastructures into optimization-oriented systems.

2.2. The Dimensions of Sustainable Logistics Practice

Sustainable logistics cannot be treated merely as a single idea, but sustainable logistics involves various special practices and strategies utilized along the entire supply chain to reduce undesirable environmental effects. A significant amount of the study has been conducted under this field, and three primary channels have been revealed to be of highest significance: improving Green Transportation, packaging strategies development, and circular economy ideas implemented for waste and product return handling [25–28].

2.2.1. Green Transportation and Mobility

Transportation is frequently identified as the segment of logistics that exerts the most detrimental impact on the environment, thereby making its modification a primary concern [29,30]. A variety of methods is being used in Green Transportation to reduce the use of energy, greenhouse gas emissions, and air pollution associated with the transport of products. One of the most important things in this field is route optimization [31]. Businesses can use GPS, advanced software, and real-time data to figure out the best delivery routes. This will make travel, traffic, and waiting for goods shorter. This will directly lead to less fuel use and fewer emissions. Another important strategy is to change modes [32]. In other words, moving freight from less efficient modes of transport, like trucks, to more environmentally friendly ones, like trains and ships, for the long haul parts of a trip. According to a study, moving shipments to intermodal rail can cut carbon emissions by more than 65% compared to trucking alone [33,34]. The use of alternative fuels and new vehicle technologies is probably the most obvious trend in Green Transportation [35].

This would include electrifying a company's fleet of vehicles, as EVs do not emit any pollutants from their tailpipes, along with hybrid engines, biofuels, and—more recently—hydrogen fuel cells. The benefits on record for these measures are not insignificant. They include a direct impact on lowering a firm's carbon footprint, providing cleaner air quality locally, improving the reputation of the business, and, in particular, given unpredictable fuel costs, huge long-term savings in operations [36,37]. However, the literature also stresses significant barriers toward the implementation of these measures [38,39]. These are the purchase price of electric cars and infrastructure required to provide for their recharging, the continued promotion of subsidies to support the use of fossil fuels as the source of energy, and the logistics of overlaying new modes and technologies upon the current networks.

2.2.2. Innovations in Sustainable Packaging and Materials Management

First, packaging plays two roles in logistics: it protects products while they are being shipped and stored, but it produces much waste and slows shipping. Sustainable Packaging logistics is the emergent concept describing an approach to the packaging's environmental, economic, and social impacts throughout its whole life cycle [40]. This approach represents a significant departure from the linear "take-make-dispose" approach to a circular one. Innovation is all about selecting appropriate materials. This requires for eliminating new, non-recyclable packaging materials like certain plastics and styrofoam and replacing them with ones that are recyclable, biodegradable, or from renewable plant-based products like paper, carton, bioplastics, and even new ones such as mycelium, or mushroom root [41–43]. It is then time to optimize the design of the package. "Rightsizing of packages" can be utilized to handle "dead space" problems and "lightweighting packages" can contribute to using less material [44]. Smaller, lighter packages have repercussions on the community concerned with the environment. Lighter packages mean less fuel consumption, as well as less "carbon dioxide released into the atmosphere as a result of transportation." They consume less space, which translates to less use of warehouse space. Lastly, packages that can be reused or recycled easily make a world of difference not only in the sustainability community, but in recycling and landfill waste as well. The literature shows how sustainable packages "pay." The benefits of sustainable packages include decreased raw material costs, decreased waste disposal costs, decreased costs of shipping because of decreased pounds/bulk, decreased warehousing and handling costs, and a tremendous increase in consumer acceptance among those with a particular interest in the environment [45,46].

2.2.3. Circular Economy Principles in Waste and Reverse Logistics

The third main constituent of sustainable logistics is a change in the linear approach to waste and product return to a more circular one. The guiding concept of the circular economy, which is an invention that aims to optimize the life of products and materials and simultaneously minimize the impact of products and materials on the environment, is "reduce, reuse, and recycle" [47,48]. In logistics, this entails the execution of waste reduction projects throughout all phases of the purchasing and delivery chain. This is carried out through the modernization of processes and teamwork through suppliers to lower the consumption of extra material.

Reverse logistics plays a key role in the circular economy of logistics because it is strategically run [49]. This involves all of the movements made whenever the buyer brings back the product to the retailer or producer [50]. In the era of rapidly expanding e-commerce, proper reverse logistics is not only a minor matter anymore but a significant operational and environmental concern [51]. Best practices of sustainable reverse logistics do not dump returned products into landfills. They implement proper systems of return collecting, sorting, and processing so they are reused, resold, remanufactured, or, as the final alternative, properly recycled.

Adopting circular principles through the implementation of proper waste and reverse logistics management has numerous benefits. It minimizes the volumes of wastes disposed of directly into the landfill, and this contributes to the preservation of natural resources and the prevention of pollution [52,53]. Economically, it also offers significant savings through the minimization of the utilization of virgin material and even generates new sources of income through the selling of remanufactured products or through the selling of recovered material [54,55]. Furthermore, through the better closed-loop system, companies are able to accumulate greater resource security and build greater resilience to supply disruptions [53,56].

The selection of Green Transportation, Sustainable Packaging, and Sustainable Waste Management is both theoretically grounded and contextually strategic. Collectively, these three practices span the core logistics life cycle—movement, containment, and post-consumption recovery—thereby capturing pollution prevention and product stewardship logics central to the NRBV. Empirically, they are also the most frequently operationalized and measurable dimensions of sustainable logistics in prior SEM-based research, allowing comparability while maintaining conceptual depth. More importantly, these practices directly align with Saudi Vision 2030 and its implementation programs. Green Transportation and modal shifts are central to the National Transport and Logistics Strategy, Sustainable Packaging is embedded in circular economy and waste minimization policies, and waste management and reverse logistics form a cornerstone of the Saudi Green Initiative and NIDLP. Focusing on these three practices therefore allows the study to examine sustainability where environmental urgency, policy prioritization, and operational feasibility most strongly converge in the Saudi logistics sector.

2.2.4. The Role of Information Systems as a Strategic Enabler

In this study, "Green Management Information Systems" (Green MIS) are defined as organizational information systems that are specifically configured to collect, integrate, analyze, and report environmental data in order to support sustainability-oriented decision-making. These systems extend beyond conventional MIS by embedding functionalities such as emissions tracking, energy and fuel monitoring, waste accounting, and sustainability performance dashboards, thereby operationalizing environmental management within core logistics processes [57,58]. In this area, Green Information Systems (GIS), i.e., information systems specifically tailored to track, regulate, and report environmental practices and results, are becoming the key [59–61].

The writing suggests two key roles of MIS here. First, the MIS serves as an underlying enabler [62]. Availability of real-time dissemination of information throughout the supply chain, often through Enterprise Resource Planning (ERP) systems, is the key precondition of the effective application of green management and monitoring strategies. These systems ensure the necessary tracking and visibility required for the purpose of control; the real-time data sourced by the sensors, GPS, and Radio Frequency Identification (RFID) tags permit the managers to track the consumption of resources, the utilization of the assets, and the movement of the products, the precondition of any substantial sustainability management.

Second, and more importantly, MIS acts as an optimization tool [63,64]. The literature argues that enhanced GIS functions (such as information exchange, tracing of supply chains, or tracking of activities) mediate the relationship from sustainable practices, which act as an independent variable, to financial performance. Arguably, the specific functions of MIS will counteract adverse trade-offs, enabling enterprises to more acutely identify opportunities of cost savings on which the financial viability of sustainability efforts fundamentally relies. Hence, while most of the literature advocates a direct financial benefit of MIS application, this assumption seems conditional on the presence of additional antecedents, not strictly proven [65–67]. Hence, this research attempts an empirical verification of dual MIS use, operationally defined by green functions of MIS, acting as an enabler of eco-sustainability, as well as financial outcomes.

2.2.5. The Performance Nexus: Linking Sustainability to Economic and Environmental Outcomes

The strategic implementation of sustainable logistics is based on an environmental as well as financial premise, which states that it provides a dual benefit in terms of not only positively affecting the environment, but also benefiting the financial aspects of the firm [68,69]. There is an enormous amount of empirical evidence which has validated this hypothesis, with the findings reinforcing this premise [69–72]. There has been a literature review of thousands of research pieces on this subject, which has provided an overall indication of a strong positive link existing between the implementation of sustainable supply chain practices by firms and their firm outcomes [73,74]. A huge literature review of more than 30,000 pieces found an average positive link existing between green supply chain management (GSCM) practices and firm outcomes, thus confirming that the premise of sustainability resulting in firm excellence is true [75,76].

The link of Economic Performance is well established through various mechanisms. Sustainable practices, by their nature, focus on resource use, which translates into direct financial savings. Efficiencies from reduced fuel, energy, raw materials use, or minimizing waste directly lead to lowered costs of operation. More efficient logistics networks will directly contribute to heightened productivity levels [77]. Potentially, it will result in an improvement in service delivery. Other benefits, which could include an improvement in overall sustainability, could also help positively influence the financial statement. There has been quantitative proof of this relationship through SEM research efforts using this same advanced methodology proposed in this research proposal. Estimates of this relationship of green logistics practices to overall Economic Performance outcomes are significant and positive.

While the consequence on Environmental Sustainability is more direct and apparent, it nonetheless holds valid across empirical perspectives: Green Transportation, eco-friendly packaging, and reduction or recycling programs has positive impacts in the context of environment issues. Various research efforts pinpointed the quantitative relationship from use of sustainable logistics practices directly to beneficial outcomes on an environmental rubric of decreased atmospheric carbon dioxide (CO_2), decreased air or water pollution, or decreased amounts of waste going into the landfill. The facts validate the accuracy of the state of affairs existing within the scenario of businesses making educated choices concerning sustainable logistics strategies leading directly to businesses' inherent goals of not negatively impacting the natural world.

2.3. Synthesis of Literature and Identification of the Research Gap

The immense body of literature unequivocally evidences, by providing sound theoretical justifications (NRVB, Stakeholder Theory), as well as solid empirical findings, the adoptive necessity of sustainable logistics practices inasmuch as they provide the potential for significant improvement in organizational performance. Moreover, the literature attests the indispensable role of information systems, the so-called Green Information Systems (GIS), in particular, acting as key enablers making sustainable strategies an achievable reality. For the purpose of encapsulating the current state of the empirical literature, in an appropriate place within the current research's framework, giving particular emphasis on the current research's contribution, Table 1 provides a representative sampling of significant quantitative literature on the subject among Structural Equation Modeling (SEM)-based research, as well as literature focusing on the role of technology and of outputs.

The studies summarized in Table 1 were identified through a focused narrative review of peer-reviewed journal articles indexed in Scopus and Web of Science. The search was conducted using combinations of keywords including "sustainable logistics," "green supply chain," "green logistics," "information systems," "MIS," "GIS," "SEM," and "performance." Only empirical quantitative studies published in English-language journals between 2014 and 2025 were considered. After screening titles, abstracts, and full texts for relevance, methodological transparency, and alignment with logistics or supply chain contexts, 32 core studies were retained. These articles were analyzed to extract their theoretical framing, variables, methodological approaches, and principal findings, enabling a structured synthesis of dominant trends and unresolved gaps.

A systematic review of the empirical literature, as synthesized in Table 1, reveals two critical and compelling gaps that this research is designed to address.

To begin with, there is a clear lack of context and geography. The table clearly shows that most of the quantitative research has been done in the manufacturing sectors of Asian economies, especially China [84,95,106], Pakistan, e.g., [86,87,104], and Bangladesh [83,99]. While a handful of recent studies have begun to explore the Saudi Arabian context [78,79] they often focus on broader GSCM drivers or different theoretical links. There remains a conspicuous absence of rigorous, large-scale quantitative analysis that models the specific relationships between discrete sustainable logistics practices (Green Transportation, packaging, and waste management), the mediating role of information systems, and dual performance outcomes within the unique economic, regulatory, and cultural landscape of the Kingdom of Saudi Arabia.

Second, while many studies confirm a positive link between sustainable practices and performance, and several acknowledge the importance of Green Information Systems [82,87] the explicit testing of MIS/GIS as a core mediating variable between a comprehensive set of logistics practices and both environmental and Economic Performance in a single, integrated model remains underexplored. The literature often examines technology as either a direct predictor or a moderator, rather than analyzing the specific mechanism through which it translates operational practices into performance outcomes. This leads to a significant gap in understanding how technology enables the "double bottom line."

This gap in research is especially significant because Saudi Vision 2030 has big plans for the future of the country's economy and environment, and sustainable logistics is at the heart of those plans. To fill these gaps and get empirical insights so badly needed from this important but under-researched area, this study develops and tests a conceptual model about sustainable logistics practices and their performance outcomes. It does this by explicit modeling of the mediating role of MIS, which is defined by its green capabilities. Next, this section elaborates on the quantitative research method applied for reaching this objective.

Table 1. Summary of key empirical studies on sustainable logistics and firm performance.

Author(s) & Year	Industry/Context	Objective	Variables Used	Methodology	Findings
Khayyat, Balfaqih [78]	Logistics (Saudi Arabia)	To explore the adoption of green logistics technologies and information systems.	Environmental Awareness, Organizational Culture, Financial Considerations, Technological Readiness, Government Regulation.	Survey, SEM.	High environmental awareness exists, but technological readiness and clear government policy support need improvement. Financials are complex due to high initial investments.
Alkandi, Alhajri [79]	Industrial Sector (Saudi Arabia)	To investigate the links among GSCM, lean management, CSR, and company performance within the Vision 2030 framework.	GSCM, Lean Management (LM), Corporate Social Responsibility (CSR), Business Performance (BP).	Survey, SEM.	GSCM directly contributes to LM, CSR, and BP. LM mediates the relationship between GSCM and BP.
Dahinine, Laghouag [80]	Pharmaceutical (Saudi Arabia)	To investigate how green transformational leadership fosters green HRM to enhance GSCM performance.	Green Transformational Leadership (GTL), Green Human Resource Management (GHRM), GSCM Performance.	Survey, Quantitative Analysis.	GTL and GHRM have critical positive effects on GSCM performance in the Saudi pharmaceutical sector.
Mousa Mousa, Abdulrahman Al Moosa [81]	Pharmaceutical (Saudi Arabia)	To explore the links between big data analytics, sustainable performance, and GSCM in a circular economy context.	Big Data Analytics, Sustainable Performance, GSCM, Circular Economy.	Survey, PLS -SEM.	Big data analytics has a significant positive impact on sustainable performance and GSCM. Sustainable performance and GSCM mediate the BDA-Circular Economy relationship.
Ahmad, Ikram [82]	Manufacturing (Textile, Auto, Tobacco)	To assess the impact of GSCM practices on sustainability performance.	Green Manufacturing, Green Purchasing, Eco-Design, Green Information System, Customer Cooperation, Sustainability Performance.	Survey, SEM (AMOS).	Green manufacturing, purchasing, eco-design, and green information systems positively impact sustainability performance. Customer cooperation does not.
Karim, Rabiul [83]	Manufacturing (Bangladesh)	To examine the mediating role of green entrepreneurial orientation and green information systems on the GSCM–Environmental Sustainability link.	GSCM, Green Entrepreneurial Orientation, Green Information System, Management Support, Environmental Sustainability.	Survey, PLS-SEM.	Green entrepreneurial orientation and green information systems mediate the relationship between GSCM and Environmental Sustainability.

Table 1. *Cont.*

Author(s) & Year	Industry/Context	Objective	Variables Used	Methodology	Findings
Liu, Dong [84]	Manufacturing (China)	To explore how corporate environmental responsibility enhances sustainable performance through GSCM.	Corporate Environmental Responsibility (CER), GSCM (Green Procurement, Green Logistics, etc.), Sustainable Performance (Economic, Social, Environmental).	Survey, SEM.	The four dimensions of GSCM all exert significant positive mediating effects between CER and the firm's economic, social, and Environmental Sustainability.
Naz, Samadhiya [85]	Logistics	To investigate the effect of GSCM practices on carbon-neutral supply chain performance, mediated by logistics eco-centricity.	GSCM Practices (Green Manufacturing, Eco-Design, etc.), Logistics Eco-centricity, Carbon-Neutral Supply Chain Performance.	Survey, PLS-SEM.	GSCM practices significantly improve carbon-neutral performance, and this relationship is positively mediated by logistics eco-centricity.
Rahman, Zahid [86]	Manufacturing (Pakistan)	To study the influence of GSCM characteristics on the sustainable performance of enterprises, taking into account CPEC awareness.	Green Purchasing (GP), Eco-Design (ED), Internal Environmental Management (IEM), Collaboration, and Sustainable Performance.	Survey, SEM (SmartPLS).	IEM, GP, and ED have a significant positive impact on sustainable performance, especially for firms aware of the China–Pakistan Economic Corridor (CPEC).
Tariq, Abbass [87]	Manufacturing (Pakistan)	To explore the impact of GSCM dimensions on organizational performance (environmental, economic, operational).	GSCM Dimensions (Green Purchasing, IEM, etc.), Green Distribution, Green Information System, Performance (Env, Econ, Op).	Survey, PLS-SEM.	All GSCM dimensions were found to be significant predictors of at least one of the performance outcomes.
Nureen, Liu [88]	Manufacturing (Pakistan)	To analyze technical and behavioral dimensions of GSCM and their impact on organizational performance.	Technical GSCM (Eco-design, Green Mfg.), Behavioral GSCM (Top Mgt Support), Institutional Pressure, Organizational Performance.	Survey, SEM.	Behavioral GSCM practices mediate the relationship between technical GSCM practices and organizational performance.
Nazir, Zhaolei [89]	Manufacturing (Pakistan)	To examine the impact of Green Supply Chain Management methods on Environmental Sustainability, modulated by institutional pressure.	GSCM Practices, Environmental Sustainability, Institutional Pressures.	Survey, PLS-SEM.	GSCM practices have a significant positive relationship with Environmental Sustainability, and this is moderated by institutional pressure.

Table 1. *Cont.*

Author(s) & Year	Industry/Context	Objective	Variables Used	Methodology	Findings
Lerman, Benitez [90]	Manufacturing	To investigate how digital transformation and GSCM configurations enhance green performance.	Smart Supply Chain, Digital Transformation, Green Operations, Green Relationships, Green Performance.	Survey, Regression.	Digital transformation alone is insufficient; it requires a GSCM configuration (internal and external practices) to mediate its effect on green performance.
Le, Nhu [91]	SMEs (Food & Beverage, Vietnam)	To evaluate how digitalization drives sustainable corporate performance through the mediation of green innovation and GSCM.	Digitalization, Green Innovation, GSCM, Sustainable Corporate Performance.	Survey, PLS-SEM.	Green innovation and GSCM positively mediate the relationship between digitalization and sustainable corporate performance.
Roy and Mohanty [92]	Logistics Service Providers (India)	To understand the impact of green logistics operations on supply chain sustainability.	Green Logistics Operations, Supply Chain Sustainability, Stakeholder Demands.	Survey, SEM.	Sustainable performance is influenced by logistics operations, and the direct impact of logistics operations is less on green practices than on overall supply chain sustainability.
Gelmez, Özceylan [93]	Manufacturing (Plastic, Packaging, Textile—Türkiye)	To examine the impact of GSCM practices on green innovation, Environmental Sustainability, and competitive advantage.	GSCM Practices, Green Innovation (GI), Environmental Sustainability (EP), Competitive Advantage (CA).	Survey, SEM (AMOS).	GSCM positively impacts GI, EP, and CA. GI positively impacts CA, but EP does not have a positive impact on CA.
Li and Zhang [94]	Cross-Industry	To explore the impact of GSCM on corporate performance across environmental, economic, operational, and social outcomes.	GSCM, Corporate Performance (Env, Econ, Op, Social).	Meta-Analytic Structural Equation Modeling (MASEM).	GSCM practices significantly enhance all dimensions of corporate performance. Effectiveness is moderated by industry, firm size, and location.
Chen and Guo [95]	Manufacturing (China)	To examine the relationships between GSCM, digital transformation, carbon neutrality, and firm performance.	GSCM, Carbon Neutrality Capability (CNC), Digital Transformation (DT), Firm Performance (FP).	Panel Data Analysis.	GSCM may initially have a negative impact on FP, but focusing on CNC can turn this positive. DT significantly moderates the GSCM-FP relationship.

Table 1. *Cont.*

Author(s) & Year	Industry/Context	Objective	Variables Used	Methodology	Findings
Al Mamun, Reza [96]	Manufacturing (China)	To explore the synergy of big data analytics, supply chain ambidexterity, green supply chain, and firm performance.	Big Data Analytics (BDA), Supply Chain Agility & Adaptability, Green Supply Chain (GRSC), Firm Performance.	Survey, PLS-SEM.	BDA directly impacts agility, adaptability, GRSC, and performance. GRSC mediates the relationship between BDA and firm performance.
Ning, Liu [97]	Manufacturing (China)	To determine if GSCM improves corporate sustainability performance.	Internal GSCM, External GSCM, Green Innovation, Supply Chain Collaboration, Corporate Sustainability Performance.	Survey, Quantitative Analysis.	Internal and external GSCM are positively correlated with corporate sustainability performance, with green innovation playing a mediating role.
Sadiq, Nawaz [98]	Semiconductor (China)	To examine the role of green supply chain practices in enhancing Environmental Sustainability.	Customer Environmental Collaboration, Green Purchasing, Sustainable Innovation, Energy Efficiency, Green HRM.	Survey, PLS-SEM.	Customer collaboration, green purchasing, and sustainable innovation directly lead to superior Environmental Sustainability. Energy efficiency acts as a mediator.
Mustafi, Dong [99]	Manufacturing (Bangladesh)	To examine the GSCM-Organizational Performance nexus using a mediated moderation model with second-order constructs.	GSCM Practices, Organizational Performance (Financial, Marketing, Environmental), Perceived Competitive Advantage.	Survey, PLS-SEM.	GSCM practices exhibited a significant positive correlation with overall organizational performance.
Liu, Yousaf [100]	Manufacturing	To explore relationships within sustainable GSCM, focusing on GSCM practices, zero waste management, and green innovation.	GSCM Practices, Zero Waste Management, Green Innovation, Green Knowledge Sharing, Environmental Sustainability.	Survey, PLS-SEM.	Zero waste management and green innovation have a positive intervention (mediating) role between GSCM practices and Environmental Sustainability.
Fu, Ali [101]	Manufacturing	To explore the influence of enhanced ERP on firm performance through GSCM and supply chain integration.	Enhanced ERP, GSCM, Supplier Integration, Internal Integration, Firm Performance.	Survey, PLS-SEM.	The impact of improved ERP on business performance is mediated via GSCM, internal integration, and supplier integration.

Table 1. *Cont.*

Author(s) & Year	Industry/Context	Objective	Variables Used	Methodology	Findings
PaluÅ, SlaÅ [102]	Forest-based Industry (Slovakia)	Examine how supply chain sustainability affects business viability and financial results.	Greening Supply Chain Activities, Environmental Sustainability, Competitiveness, Economic Performance.	Survey, SEM.	By making supply chain operations more environmentally friendly, we can boost Environmental Sustainability, which in turn boosts Economic Performance and competitiveness.
Mousa, Khalifa [103]	Textile Industry (Turkey)	Examine the mediating and moderating effects of GSCM on Ecological Sustainability.	GSCM, Environmental Sustainability (EP), Adaptive Green Culture (AGC), Competitive Pressure (CP).	Survey, Quantitative Analysis.	GSCM positively affects EP and CP. CP mediates the GSCM-EP relationship, and AGC enhances these effects.
Junejo, Sohu [104]	SMEs (Pakistan)	To explore the interplay of GSCM practices, performance, and technology in shaping SME sustainability.	GSCM Practices (Green Purchasing, Eco-Design, Reverse Logistics), Green Technology, Green Competitive Advantage.	Survey, PLS-SEM.	Direct effects of green purchasing, eco-design, and reverse logistics contribute substantially to enhancing Environmental Sustainability and green competitive advantage.
Li and Thurasamy [105]	Pharmaceutical (China)	To investigate the relationships among GSCI, supply chain agility, digital orientation, and sustainable performance.	Green Supply Chain Integration (GSCI), Supply Chain Agility (SCA), Digital Orientation (DO), Sustainable Performance.	Survey, Quantitative Analysis.	Supply chain agility serves as a mediator between GSCI and sustainable performance. Digital orientation strengthens the SCA-performance link.
Kim, Liu [106]	Manufacturing SMEs (China)	To analyze the influence of dynamic technical capabilities on Smart Green Supply Chain Management and sustainable performance.	Dynamic Technological Capabilities (DTC), Smart Green SCM, Sustainable Performance.	Survey, Quantitative Analysis.	DTC significantly enhances both external and internal Smart Green SCM practices, and both dimensions improve sustainable performance.

2.4. Conceptual Framework and Hypothesis Development

This study develops a theory-driven structural model that conceptualizes sustainable logistics not as isolated operational initiatives, but as an interdependent system of strategic practices, enabling capabilities, and performance outcomes embedded within a strong institutional environment. Anchored in the Natural Resource-Based View, Green Transportation, Sustainable Packaging, and Sustainable Waste Management are modeled as firm-level manifestations of pollution prevention and product stewardship strategies, while Stakeholder Theory explains their salience in the Saudi Arabian context. Management

Information Systems are positioned as a higher-order enabling capability that integrates, monitors, and amplifies the effects of these practices. The six core latent constructs that operationalize this framework are formally defined in Table 2, while their hypothesized interrelationships are illustrated in Figure 1.

Table 2. Construct definition.

Construct	Code	Definition
Green Transportation	GrTrans	Practices aimed at reducing the emissions and energy consumption of freight movement.
Green Packaging	GrPack	The use of eco-friendly materials and design principles to minimize packaging waste and improve logistical efficiency.
Sustainable Waste Management	SusWasMg	The implementation of circular economy principles, including reverse logistics and waste reduction, to minimize landfill disposal.
Management Information Systems	MIS	This construct represents the critical technological enabler. It is conceptualized as a key factor that facilitates the effective implementation of SLP and enhances their impact on performance outcomes.
Environmental Sustainability	ESust	This is a dependent variable representing the ecological outcomes of adopting SLP. It is measured through indicators such as the reduction in carbon emissions, conservation of resources, and minimization of waste.
Economic Performance	EcPerf	This second dependent variable shows the results in terms of money and operations. It is assessed through indicators such as cost reduction, enhancements in operational efficiency, and increased competitiveness.

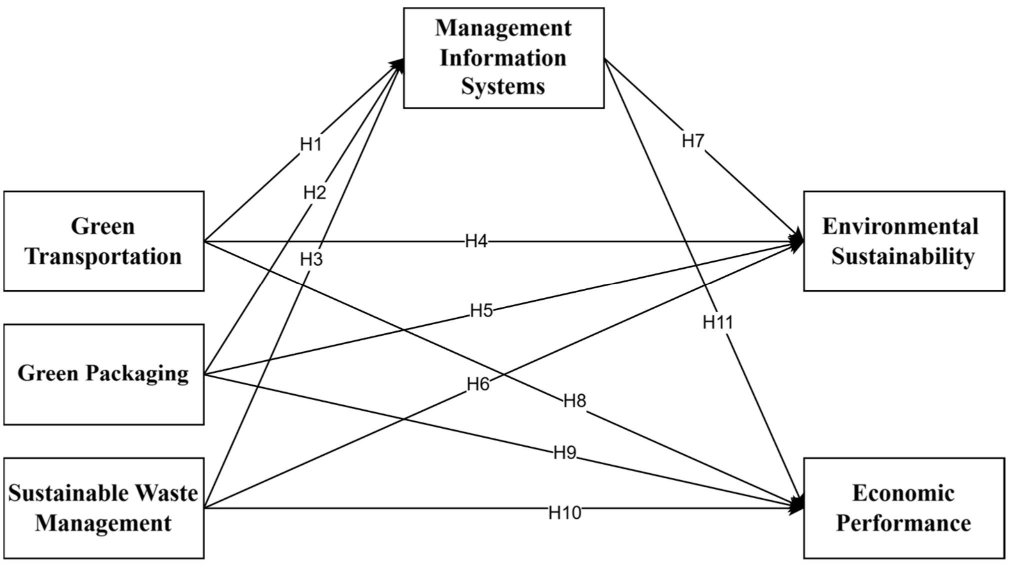

Figure 1. Theory-driven structural model of sustainable logistics practices, MIS capability, and performance outcomes. [Note: Conceptual framework showing the direct hypotheses (H1–H11) among Green Transportation, Green Packaging, Sustainable Waste Management, Management Information Systems (MIS), Environmental Sustainability, and Economic Performance. MIS is further hypothesized to mediate these relationships (H12–H17; details in Table 3)].

Table 3. Research hypotheses.

Category	Hypothesis	Path	Statement
Direct Effects	H1	GrTrans → MIS	Green Transportation has a significant positive impact on Management Information Systems.
	H2	GrPack → MIS	Sustainable Packaging has a significant positive impact on Management Information Systems.
	H3	SusWasMg → MIS	Sustainable Waste Management has a significant positive impact on Management Information Systems.
	H4	GrTrans → ESust	Green Transportation has a significant positive impact on Environmental Sustainability.
	H5	GrPack → ESust	Sustainable Packaging has a significant positive impact on Environmental Sustainability.
	H6	SusWasMg → ESust	Sustainable Waste Management has a significant positive impact on Environmental Sustainability.
	H7	MIS → ESust	Management Information Systems has a significant positive impact on Environmental Sustainability.
	H8	GrTrans → EcPerf	Green Transportation has a significant positive impact on Economic Performance.
	H9	GrPack → EcPerf	Sustainable Packaging has a significant positive impact on Economic Performance.
	H10	SusWasMg → EcPerf	Sustainable Waste Management has a significant positive impact on Economic Performance.
	H11	MIS → EcPerf	Management Information Systems has a significant positive impact on Economic Performance.
Indirect (Mediation) Effects	H12	GrTrans → MIS → ESust	MIS mediates the relationship between Green Transportation and Environmental Sustainability.
	H13	GrPack → MIS → ESust	MIS mediates the relationship between Sustainable Packaging and Environmental Sustainability.
	H14	SusWasMg → MIS → ESust	MIS mediates the relationship between Sustainable Waste Management and Environmental Sustainability.
	H15	GrTrans → MIS → EcPerf	MIS mediates the relationship between Green Transportation and Economic Performance.
	H16	GrPack → MIS → EcPerf	MIS mediates the relationship between Sustainable Packaging and Economic Performance.
	H17	SusWasMg → MIS → EcPerf	MIS mediates the relationship between Sustainable Waste Management and Economic Performance.

The structural equation model specifies both direct operational effects (from sustainable practices to environmental and Economic Performance) and indirect capability-building effects (from practices through MIS to performance), allowing a rigorous empirical examination of the mechanisms through which sustainability initiatives are converted into organizational outcomes.

Based on the framework shown in Figure 1, the following Table 3 shows the hypotheses are formulated for empirical testing:

The next section goes into detail about the quantitative research method that will be used to test this conceptual model and its related hypotheses. The positioning of the conceptual framework and hypotheses immediately after the literature review reflects their theoretical derivation, while the subsequent section details the empirical procedures used to test this model.

To further clarify the underlying processing logic of the proposed structural model, Table 4 explicitly maps each hypothesized relationship to its corresponding theoretical rationale. Rather than treating the SEM as a purely statistical specification, this table articulates how each structural path is grounded in the capability-based logic of the Natural Resource-Based View (NRBV) and the contextual dynamics of sustainability implementation. By distinguishing between capability development, monitoring, and cost–benefit mechanisms, the table enhances transparency in model construction and directly links theoretical assumptions to empirical testing.

Table 4. Theoretical logic underlying structural paths.

	Logic Type	Theoretical Basis	Explanation
SLP → MIS	Capability Development	NRBV	Sustainable practices generate data and operational complexity requiring MIS integration
MIS → ESust	Monitoring Capability	NRBV	MIS enables tracking, reporting, and optimization of environmental performance
MIS → EcPerf	Conditional Optimization	NRBV + Contextual Logic	Economic gains depend on maturity of MIS beyond compliance use
SLP → ESust	Direct Operational Effect	NRBV	Pollution prevention and resource efficiency improve environmental outcomes
SLP → EcPerf	Cost–Benefit Trade-off	NRBV	Economic benefits may lag due to initial investment costs

3. Materials and Methods

The researcher employed a quantitative, cross-sectional methodology to investigate the relationships among sustainable logistics practices, the enabling function of Management Information Systems (MIS), and their consequent impacts on Environmental Sustainability and Economic Performance within organizations across the Kingdom of Saudi Arabia. A deductive approach was used, testing hypotheses that had been developed from two established theories, namely the Natural Resource-Based View (NRBV) and Stakeholder Theory, with data gathered from a structured survey.

3.1. Sampling and Data Collection Procedure

The survey attempts to map the opinion of professionals, supervisors, and managers involved in logistics, supply chain, and operational functions of public and private sector organizations all over Saudi Arabia. Since the population is heterogeneous and geographically dispersed, a purposive sampling method was adopted for the survey, with the aid of a snowball technique in order to ensure the relevance and competence of the respondents.

An online questionnaire was designed (See Appendix A) and administered electronically via professional networks, groups of people with similar backgrounds, and direct email invitations. Data collection lasted for three months. The first screening question ensured that the respondents had either worked on or knew a great deal about the logistics and sustainability of their organization.

The author initially received 484 responses. A strict process of cleaning the data was done to make sure that the dataset was complete and strong enough for later analysis. This includes removal of survey responses that are largely not filled up and utilizing Mahalanobis distance tests in order to identify and eliminate outliers. After the cleaning process, 372 valid responses were retained for final analysis. This means that 76.9% of the responses could be used. Table 5 explains in detail the first efforts to obtain data from different parts and industries in Saudi Arabia.

Table 5. Distribution of initial survey responses (N = 484).

Industry Sector	Riyadh Province	Makkah Province (Western)	Eastern Province	Other Regions	Total Collected
Healthcare	65	58	45	24	192
Higher Education	30	22	18	8	78
Transportation & Logistics	28	25	20	10	83
Retail & E-commerce	12	8	6	4	30
IT, Banking & Finance	14	10	8	5	37
Manufacturing & Construction	10	9	15	6	40
Other	8	6	5	5	24
Total	167	138	117	62	484

Note: This table represents the first step in the collection of data prior to cleaning and validation.

3.2. Measurement Instrument

The survey instrument was carefully crafted after a careful review of the fundamental studies on sustainable logistics, supply chain management, and information systems. Several items drawn from previously validated scales were used to measure all constructs in order to ensure robust content validity. A five-point rating scale was assigned to each item, but to make the measurements even more precise, the scale anchors were carefully crafted to fit the traits of each construct. The scale for the stage of implementation was used for the constructs that measured the sustainable practices, which included Green Transportation, Sustainable Packaging, and Sustainable Waste Management. Another important part of instrument development was the exact operationalization of the MIS construct. The questionnaire's instructions to the respondents clearly state that this study looks at the role of information systems specifically "in the context of Green Reporting or Green Management Information Systems (Green MIS)." Thus, for the purposes of this study, MIS is operationally defined as a system whose functions are directed towards environmental management. This approach was selected due to the absence of validated scales for general Management Information Systems (MIS) within a sustainability framework and the presence of reliable, pre-validated scales for Green Information Systems (GIS), thereby facilitating a more precise and pertinent assessment of the technology's contribution to the sustainable practices being examined.

Lastly, a scale that measured how much better or worse the performance constructs (Environmental and Economic) got was used. Table 6 lists the six latent constructs that made up the instrument. A professional translated the questionnaire from English to Arabic, and then an independent bilingual expert did a back-translation to make sure that both the language and the ideas were the same. Beyond translation, the instrument was contextually adapted to reflect regulatory, infrastructural, and operational conditions specific to Saudi Arabia. Several items were slightly reworded to align with national sustainability programs, logistics practices, and reporting conventions. The pilot study not only assessed clarity and readability, but also evaluated contextual relevance and construct appropriateness. Feedback resulted in minor refinements to item phrasing and scale anchors, thereby enhancing content validity and ensuring that the measurement model accurately captured sustainability and MIS practices as enacted within the Saudi institutional environment. Before the full-scale distribution, a pilot test was done with 30 industry professionals and academics to make the questions clearer, more relevant, and easier to read.

Table 6. Measurement Items for Constructs.

Construct	Item Code	Measurement Item	Scale Anchors	Source
Green Transportation	GrTrans1	Monitoring of emissions from vehicles	1 = Not considering it; 5 = Implementing successfully	Vienažindienė, Tamulienė [107]
	GrTrans2	Use of alternative or new energy vehicles		
	GrTrans3	Optimization of transport routes		
	GrTrans4	Optimization of transport cargo distribution		
Green Packaging	GrPack1	Application of innovative packaging technologies	1 = Not considering it; 5 = Implementing successfully	Vienažindienė, Tamulienė [107]
	GrPack2	Choosing a greener type of packaging		
	GrPack3	Use of recyclable packaging materials and logistics containers		
	GrPack4	Reduction in the use of transport packaging		
Sustainable Waste Management	SusWasMg1	Monitoring of recycling of transport waste	1 = Not considering it; 5 = Implementing successfully	Vienažindienė, Tamulienė [107]
	SusWasMg2	Recycling of containers and other logistics packaging materials		
	SusWasMg3	Responsible waste sorting		
Management Information Systems	MIS1	Our organization uses MIS for reducing transportation costs.	1 = Not used at all; 5 = Used to a great extent	Esfahbodi, Zhang [108], Green Jr, Zelbst [109]
	MIS2	Our organization uses MIS for monitoring emissions, waste production, and carbon footprint.		
	MIS3	Our organization uses MIS for improving decision making by executives by highlighting sustainability issues.		
Environmental Sustainability	ESust1	Reduction in air and carbon emissions	1 = Greatly worsened; 5 = Greatly Improved	Esfahbodi, Zhang [108], Green Jr, Zelbst [109]
	ESust2	Reduction in waste emission		
	ESust3	Decrease in consumption for hazardous/harmful/toxic materials		
	ESust4	Decrease in frequency for environmental accidents		
Economic Performance	EcPerf1	Decrease in cost for purchased materials	1 = Greatly worsened; 5 = Greatly Improved	Green Jr, Zelbst [109], Esfahbodi, Zhang [108]
	EcPerf2	Decrease in cost for energy consumption		
	EcPerf3	Decrease in fee for waste treatment		
	EcPerf4	Decrease in fine for environmental accidents		

3.3. Data Analysis Technique

A two-stage structural equation modeling (SEM) approach was employed to analyze the empirical data, utilizing IBM SPSS Statistics (Version 21) for descriptive analysis and IBM AMOS for structural modeling.

Prior to SEM estimation, data processing followed a structured sequence to ensure model validity. Raw survey responses were screened for completeness, normality, and multivariate outliers using Mahalanobis distance tests. The empirical model was then operationalized by mapping measurement items to latent constructs as specified in Table 5. Visualization of the empirical framework was produced in AMOS by assigning directional paths consistent with the theoretical model rather than allowing automatic covariance-driven structures. This approach ensured that the final structural diagram represented a confirmatory empirical model grounded in theory and validated through iterative goodness-of-fit refinement.

Stage 1: Measurement Model Assessment: A Confirmatory Factor Analysis (CFA) was used to check the measurement model's validity. The measurement of the reliability and validity of the constructs was performed. Author analyzed the internal consistency using Cronbach's Alpha and Composite Reliability (CR) to see whether it met the standard threshold of 0.70 [110–112]. The Average Variance Extracted (AVE)test verified the convergent validity since the values had to be higher than 0.50, and all standardized factor loadings had to be higher than 0.70 as well [113].

Stage 2: Structural Model Assessment: After checking the measurement model, the structural model was looked at to see if the proposed relationships were correct. A full set of goodness-of-fit indices, such as the Goodness-of-Fit Index (GFI), Adjusted Goodness-of-Fit Index (AGFI), Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA), and the ratio of Chi-square to degrees of freedom (CMIN/DF), was used to evaluate the overall model fit [114–116]. A path analysis was conducted to assess the significance of the proposed direct and indirect (mediation) effects. We made choices based on the standardized path coefficients (β) and their *p*-values.

3.4. Model Specification and Identification Strategy

This study adopts a covariance-based Structural Equation Modeling (CB-SEM) approach using AMOS, as the objective is theory confirmation rather than prediction. All constructs in the model are operationalized as reflective latent variables, where observed indicators are assumed to be manifestations of the underlying construct. The model specification follows a theory-driven structure grounded in the Natural Resource-Based View (NRBV) and Stakeholder Theory. Sustainable logistics practices (Green Transportation, Sustainable Packaging, and Sustainable Waste Management) are specified as exogenous constructs, Management Information Systems (MIS) as a mediating endogenous construct, and Environmental Sustainability and Economic Performance as final endogenous outcome variables.

Model identification was ensured by satisfying the minimum indicator requirement (at least three observed variables per latent construct) and achieving positive degrees of freedom (df > 0), confirming that the model is over-identified and estimable. To ensure robustness of estimation, several diagnostic checks were conducted. First, common method bias was assessed using Harman's single-factor test, where no single factor accounted for the majority of variance. Second, multicollinearity was examined using variance inflation factors (VIFs), all of which were below the recommended threshold of 5. Third, mediation effects were tested using bootstrapping with 5000 resamples and bias-corrected confidence intervals, providing a robust assessment of indirect effects.

This specification ensures that the empirical model is not only statistically valid but also theoretically consistent, addressing potential concerns related to model construction, estimation logic, and inferential validity.

4. Results

This section summarizes the findings of the data analysis, beginning with the respondents' demographics, moving on to the measurement model's assessment, and concluding with the structural model's analysis and hypothesis testing.

4.1. Demographic Profile of Respondents

Table 7 shows the main demographic information about the final sample of 372 people who answered. The sample represents a varied cross-section of the Saudi logistics and supply chain sector. The majority of people who answered were males (53.8%) and Saudi nationals (66.7%). The age bracket of 36–45 years has the highest portion among the respondents at 45.2%. The majority, 66.7%, were from the private sector, while 33.3% were from the public sector. Close to 78% of those who responded had more than six years of work experience, which shows that the sample was knowledgeable. The most common industries were healthcare, 39.8%, higher education, 16.1%, and transportation and logistics, 16.1%.

Table 7. Demographic profile of respondents (N = 372).

Characteristic	Category	Frequency	Percentage (%)
Gender	Male	200	53.80%
	Female	172	46.20%
Nationality	Saudi	248	66.70%
	Non-Saudi	124	33.30%
Age (in years)	25–35	104	28.00%
	36–45	168	45.20%
	46–55	100	26.90%
Organization Type	Public	124	33.30%
	Private	248	66.70%
Experience (in years)	1–5	36	9.70%
	6–10	148	39.80%
	11–15	140	37.60%
	>15	48	12.90%
Designation	Lower Management	148	39.80%
	Supervisor	60	16.10%
	Middle Management	124	33.30%
	Senior Management	20	5.40%
	Top Management	20	5.40%
Industry Type	Healthcare	148	39.80%
	Higher Education	60	16.10%
	Transportation and Logistics	60	16.10%
	Retail	20	5.40%
	IT	16	4.30%
	Banking and Finance	16	4.30%
	Hospitality	16	4.30%
	Construction & Real Estate	16	4.30%
	Manufacturing	12	3.20%
	E-commerce	4	1.10%
	Holding	4	1.10%

4.2. Measurement Model Assessment

The CFA results revealed (See Table 8) a valid and reliable measurement model. In addition, the Cronbach's Alpha and CR values are above the threshold 0.70 for all constructs ranging from 0.873 to 0.957 (see Table 7). This suggests very high consistency among all constructs. AVE for all constructs is more than the threshold of 0.50, indicating that convergent validity has been achieved. Additionally, the outermost loadings of each item were statistically significant, exceeding the threshold of 0.77. Additionally, the validation of discriminant validity was established, as the square root of the AVE for each construct exceeded its correlation with any other construct in the model.

Table 8. Assessment of measurement model (reliability and convergent validity).

Variable	Items	Outer Loading	Cronbach's Alpha	Composite Reliability	AVE
Green Transportation (GrTrans)	GrTrans1	0.891	0.956	0.957	0.847
	GrTrans2	0.882			
	GrTrans3	0.890			
	GrTrans4	0.924			
Green Packaging (GrPack)	GrPack1	0.905	0.945	0.946	0.815
	GrPack2	0.886			
	GrPack3	0.870			
	GrPack4	0.942			
Sustainable Waste Management (SusWasMg)	SusWasMg1	0.929	0.946	0.947	0.857
	SusWasMg2	0.881			
	SusWasMg3	0.929			
Management Information System (MIS)	MIS1	0.842	0.915	0.916	0.785
	MIS2	0.851			
	MIS3	0.853			
Economic Performance (EcPerf)	EcPerf1	0.772	0.873	0.874	0.636
	EcPerf2	0.877			
	EcPerf3	0.856			
	EcPerf4	0.886			
Environmental Sustainability (ESust)	ESust1	0.815	0.935	0.936	0.786
	ESust2	0.819			
	ESust3	0.843			
	ESust4	0.837			

4.3. Structural Model and Hypothesis Testing

Table 9 shows the goodness-of-fit statistics for the measurement model (the CFA) and the structural model that comes after it. The thorough evaluation of the model's goodness-of-fit provides strong evidence for its validity and robustness. The measurement of CFA and the final structural models show a strong fit with the real-world data, with all of the important indices meeting or exceeding their set limits. The Goodness-of-Fit Index (GFI > 0.93) and the Comparative Fit Index (CFI > 0.97) are both very high, while the Root Mean Square Error of Approximation (RMSEA $\approx$ 0.037) and the Chi-square to degrees of freedom ratio (CMIN/DF $\approx$ 1.49) are both very low. This shows that the proposed theoretical framework and the empirical data are very close to each other. The excellent fit validates the psychometric properties of the measurement scales and provides a reliable statistical foundation for the subsequent interpretation of the path coefficients and the assessment of the research hypotheses.

The validated structural model, depicting the hypothesized relationships between the constructs, is presented in Figure 2. This diagram shows the path coefficients for the direct effects in a way that shows the direction and strength of the relationships that were tested in this study. Figure 2 shows the final structural model, which shows how the three sustainable logistics practices (Green Transportation, Sustainable Packaging, and Sustainable Waste Management) are related to each other, how MIS helps them, and how Environmental Sustainability (ESust) and Economic Performance (EcPerf) both affect them. The structure of Figure 2 mirrors the original theoretical framework but integrates empirically estimated standardized coefficients obtained from AMOS. The visualization was not redesigned conceptually after estimation; instead, empirical weights were overlaid onto the theory-driven architecture to preserve interpretive consistency between conceptual logic and statistical outcomes. The single-headed arrows show the proposed causal paths, and the numbers next to them show the standardized regression weights (path coefficients). The model shows that all three sustainable logistics practices have a big impact on both MIS adoption and Environmental Sustainability.

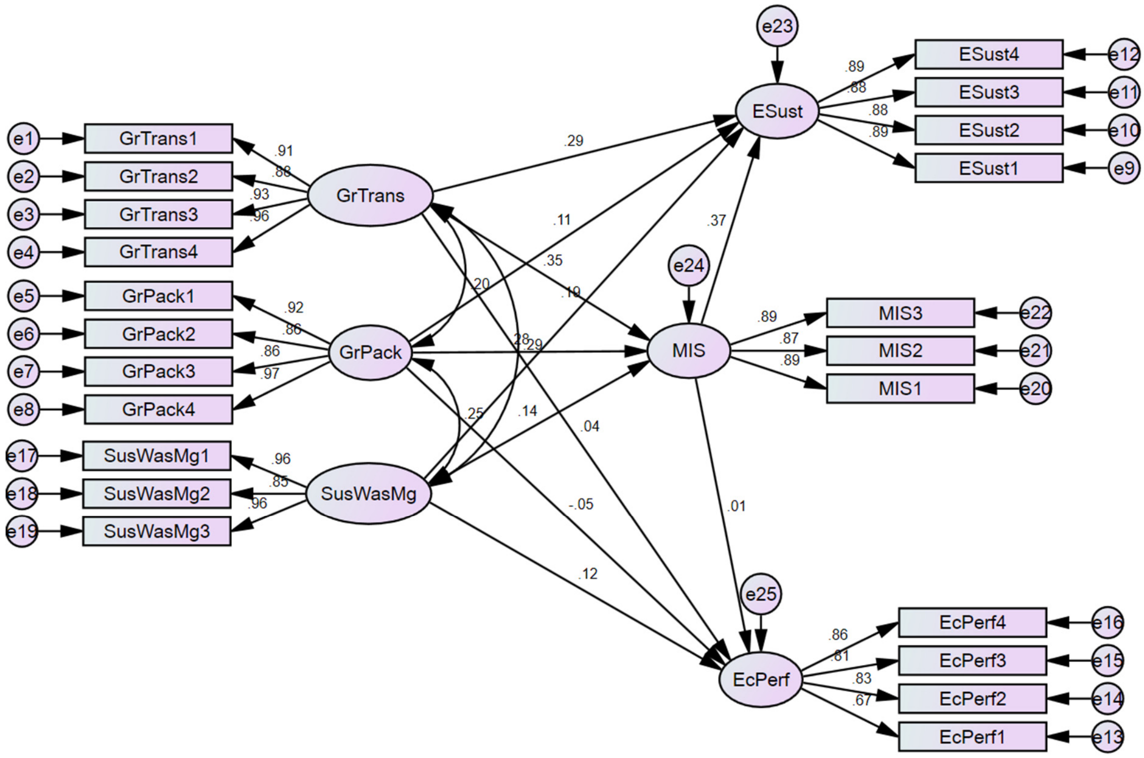

Figure 2. The Final SEM framework with standardized path coefficients. (Note: The visual structure of the model is theory-driven and remains consistent with the conceptual framework to ensure interpretive alignment. All statistical details, including standardized coefficients, significance levels, and mediation effects, are reported in the accompanying tables to maintain analytical clarity and avoid visual over-complexity).

Table 9. Goodness-of-Fit Indices for the measurement model and the structural model.

	Measurement Model		Structure Model	
Statistics	**Cut Off Criteria**	**Value Obtained**	**Cut Off Criteria**	**Value Obtained**
GFI	0.8–0.9	0.937	0.8–0.9	0.936
AGFI	0.8–0.9	0.917	0.8–0.9	0.917
RMR	<0.1	0.040	<0.1	0.041
CFI	0.8–0.9	0.987	0.8–0.9	0.977
RMSEA	<0.8	0.037	<0.8	0.037
CMIN/DF	2.0–5.0	1.499	2.0–5.0	1.496

To preserve consistency between the theoretical model and its empirical validation, the structural diagram has intentionally retained the original conceptual layout, with standardized path coefficients overlaid onto the predefined structure. Rather than redesigning the model post-estimation, this approach ensures that the empirical results are interpreted within the same theoretical architecture proposed a priori. Detailed statistical outputs, including path coefficients, significance levels, and model fit indices, are therefore reported comprehensively in Tables 9–11 to complement the visual representation.

Table 10. Results of direct effect hypotheses testing.

Hypothesis	Path	Statement	Estimate (β)	*p*-Value	Decision
H1	GrTrans → MIS	Green Transportation has a significant positive impact on Management Information Systems.	0.351	***	Supported
H2	GrPack → MIS	Sustainable Packaging has a significant positive impact on Management Information Systems.	0.267	***	Supported
H3	SusWasMg → MIS	Sustainable Waste Management has a significant positive impact on Management Information Systems.	0.117	0.007	Supported
H4	GrTrans → ESust	Green Transportation has a significant positive impact on Environmental Sustainability.	0.331	***	Supported
H5	GrPack → ESust	Sustainable Packaging has a significant positive impact on Environmental Sustainability.	0.118	0.014	Supported
H6	SusWasMg → ESust	Sustainable Waste Management has a significant positive impact on Environmental Sustainability.	0.18	***	Supported
H7	MIS → ESust	Management Information Systems has a significant positive impact on Environmental Sustainability.	0.418	***	Supported
H8	GrTrans → EcPerf	Green Transportation has a significant positive impact on Economic Performance.	0.026	0.542	Not Supported
H9	GrPack → EcPerf	Sustainable Packaging has a significant positive impact on Economic Performance.	−0.034	0.38	Not Supported
H10	SusWasMg → EcPerf	Sustainable Waste Management has a significant positive impact on Economic Performance.	0.065	0.057	Supported
H11	MIS → EcPerf	Management Information Systems has a significant positive impact on Economic Performance.	0.007	0.876	Not Supported

Note: *** $p < 0.001$.

Table 11. Results of indirect (mediation) effect hypotheses testing.

Hypothesis	Path	Statement	Indirect Effect (β)	Decision
H12	GrTrans → MIS → ESust	MIS mediates the relationship between Green Transportation and Environmental Performance.	0.147	Supported
H13	GrPack → MIS → ESust	MIS mediates the relationship between Sustainable Packaging and Environmental Performance.	0.112	Supported
H14	SusWasMg → MIS → ESust	MIS mediates the relationship between Sustainable Waste Management and Environmental Performance.	0.049	Supported
H15	GrTrans → MIS → EcPerf	MIS mediates the relationship between Green Transportation and Economic Performance.	0.003	Not Supported
H16	GrPack → MIS → EcPerf	MIS mediates the relationship between Sustainable Packaging and Economic Performance.	0.002	Not Supported
H17	SusWasMg → MIS → EcPerf	MIS mediates the relationship between Sustainable Waste Management and Economic Performance.	0.001	Not Supported

4.3.1. Analysis of Direct Effects

Table 10 shows that the analysis backed up 7 out of the 11 direct effect hypotheses. The three sustainable logistics practices—Green Transportation (β = 0.351, $p < 0.001$), Sustainable Packaging (β = 0.267, $p < 0.001$), and Sustainable Waste Management (β = 0.117, $p = 0.007$)—were all found to be significant positive predictors of MIS adoption, which supports H1, H2, and H3. In the same way, Green Transportation (β = 0.331, $p < 0.001$), Sustainable Packaging (β = 0.118, $p = 0.014$), Sustainable Waste Management (β = 0.180, $p < 0.001$), and MIS (β = 0.418, $p < 0.001$) all had a big positive effect on Environmental Sustainability, which supports H4, H5, H6, and H7. In terms of Economic Performance, only Sustainable Waste Management exhibited a positive and statistically significant correlation (β = 0.065, $p = 0.057$), thereby corroborating H10. The effects of Green Transportation (H8), Sustainable Packaging (H9), and MIS (H11) on Economic Performance were determined to be insignificant. The following tables and analysis show the full results of the hypothesis testing for both direct and indirect effects.

4.3.2. Indirect (Mediation) Effects Analysis

The mediation analysis, as shown in Table 11, showed that MIS strongly mediates the relationship between all three sustainable logistics practices and Environmental Sustainability. Among these, indirect effects concerning Green Transportation, Sustainable Packaging, and Sustainable Waste Management were positive with respective values of β = 0.147, β = 0.112, and β = 0.049, thus supporting H12, H13, and H14. These results depict that these eco-friendly practices facilitate not only Environmental Sustainability directly but also indirectly by encouraging the growth and use of advanced MIS. On the other hand, no support was provided for MIS's ability to act as a mediator between sustainable practices and Economic Performance. This is a consequence of the low relationship between MIS and Economic Performance (H11). So, H15, H16, and H17 were not true.

5. Discussion

This study has aimed to empirically investigate the relationship between sustainable logistics practices, the facilitative role of Management Information Systems in this regard, and their intermediary effects on Environmental Sustainability and Economic Performance within the transformative contextual setting of the Kingdom of Saudi Arabia. The findings of this study present a complex explanation that constantly validates and contradicts existing models. This section places the key findings within the broader perspective of existing knowledge and discusses what they mean.

5.1. Interpretation of Key Findings

Empirical findings can be consolidated into three broad thematic conclusions: the unequivocal efficacy of sustainable practices in promoting Environmental Sustainability, the essential yet context-specific function of MIS as a strategic facilitator, and the intricate, conditional interplay between sustainability initiatives and Economic Performance.

These findings reinforce and extend prior sustainable logistics research by confirming the robust environmental benefits of Green Transportation, Sustainable Packaging, and Sustainable Waste Management consistently reported across manufacturing and logistics contexts. Each of these findings is underpinned by the substantial literature that exists to date and that largely demonstrates direct links between Green Initiatives and ecological benefits [117,118]. This is an important finding in the Saudi Arabian context in terms of providing empirical support for a strategic direction set through national frameworks such as Vision 2030 and the Saudi Green Initiative, which require movement toward more sustainable models of operation. This is evidenced by the fact that companies in the Kingdom are successfully turning the implementation of these practices into quantifiable reductions in their environmental impact.

The pivotal role of Management Information Systems identified in this study aligns with and extends prior Green Information Systems and digital supply chain research that conceptualizes MIS as a core environmental enabling capability rather than a direct performance driver [72,73,91]. It is found that the adoption of sustainable practices is an important factor in implementing advanced Management Information Systems (H1, H2, H3 supported). MIS itself is the single best predictor of Environmental Sustainability (β = 0.418) and is a major link between all three sustainable practices and environmental outcomes (H12, H13, H14 supported). This means there is a virtuous cycle where operational greening needs better information systems, and these systems, in turn, make the environmental impact even better. This finding points to the fact that MIS is a basic skill for tracking, measuring, and improving sustainability performance, turning it from an idea into a data-driven operational reality.

Consistent with, yet more nuanced than, prior sustainability–performance research, the present findings reveal a distinct 'Economic Performance paradox' in the Saudi logistics context. The link to Environmental Sustainability was strong and consistent, but the link to Economic Performance was weak and very selective. None of the direct links from Green Transportation, Sustainable Packaging to Economic Performance was significant, nor was the path from MIS. Only Sustainable Waste Management had a small but significant positive impact on economic outcomes. This partial and fragmented support of the "double bottom line" hypothesis calls for an in-depth analysis. The absence of quick economic dividends from Green Transportation and Sustainable Packaging could be explained by significant upfront capital investments and long payback periods associated with such initiatives, including switching to electric vehicle fleets or replacing entire packaging systems [119]. Companies operating in a rapidly and dramatically changing market may be paying these prices to position themselves strategically for the long run and to remain regulatory compliant, although the direct financial results have not yet materialized. However, the strong positive association of Sustainable Waste Management practices with Economic Performance can be attributed to the more overt financial gains that can be achieved through this approach. Techniques of Sustainable Waste Management practices that can be seen to provide significant financial gains include reverse logistics, recycling of materials, or reducing waste, which yield financial benefits directly by reducing disposal costs, processing savings from minimizing raw materials used, or providing additional revenue from materials derived from scrap. These findings stand in contrast to a substantial stream of sustainability and green supply chain literature that reports broadly positive Economic Performance outcomes from sustainable logistics adoption [120,121]. Prior empirical studies across manufacturing and logistics contexts have shown that Green Transportation initiatives, eco-design, and Sustainable Packaging are frequently associated with cost reductions, productivity gains, and competitive advantage through improved energy efficiency, streamlined logistics flows, and reputational differentiation, e.g., [83,85,93,103]. Meta-analytic evidence further suggests that the sustainability–financial performance relationship is, on average, positive across industries and regions [84,103]. The divergence observed in the present study therefore does not contradict existing theory, but rather refines it by highlighting strong contextual contingency. In the Saudi Arabian logistics sector, where sustainable transformation is largely state-driven and capital-intensive, many sustainability investments appear to be positioned as long-term strategic infrastructure rather than short-term efficiency mechanisms. This contextual distinction helps explain why environmental benefits are already visible, whereas economic returns remain uneven and practice-specific. This can, therefore, indicate that the more an activity provides easy financial gains, the more it can potentially contribute directly to significant financial outcomes. What is more intriguing, however, is the ineffectiveness of MIS practices in attaining Economic Performance. This can thus indicate that while Saudi companies do make use of the more environmentally focused aspects of their information system technology, which provide them the capability to meet organizational or government environmental reporting needs, they do not make use of this or potentially other MIS functions. The current use of MIS in this domain appears to be more a matter of rule-following rather than money-making.

While the model demonstrates strong explanatory power, it does not explicitly incorporate moderating variables such as firm size, digital maturity, or regulatory intensity, which may influence the strength of relationships, particularly between MIS and Economic Performance. Future research may extend the model by integrating such contingent factors to further refine the capability–performance linkage.

5.2. Theoretical Implications

This study advances sustainable logistics theory by developing and empirically validating an integrated theoretical framework that explains how institutional pressures and organizational capabilities jointly shape sustainability outcomes in an emerging, state-driven economy. Figure 3 visually integrates the empirical structural model with theoretical interpretation, ensuring alignment between the conceptual logic, empirical estimation, and visualization design. The model demonstrates that the performance consequences of green logistics investments are neither automatic nor uniform, but contingent on both the dominant stakeholder environment and the maturity of firm-level capabilities. While strong governmental and regulatory pressures in Saudi Arabia effectively drive the adoption of sustainable logistics practices, only those practices tightly coupled with resource recovery mechanisms, namely Sustainable Waste Management, currently translate into direct economic benefits. Moreover, the figure highlights the pivotal but asymmetric role of Management Information Systems: MISs emerge as a powerful capability for transforming operational greening into environmental value creation, yet it remains weakly connected to economic value realization. This pattern extends the NRBV by empirically demonstrating that green information capabilities must evolve from visibility- and compliance-oriented infrastructures into optimization-oriented strategic assets before sustainable logistics investments can yield systematic economic advantage.

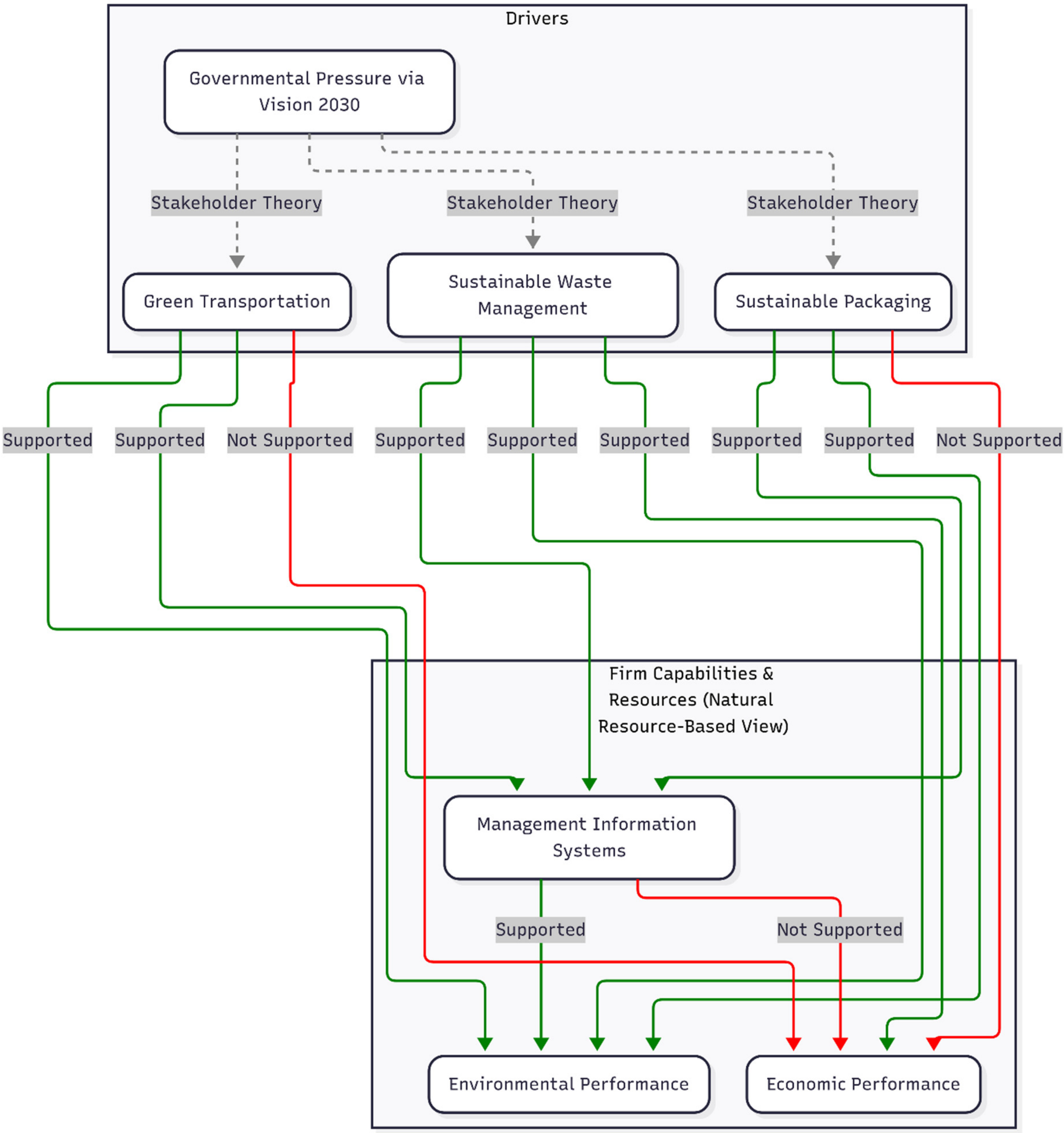

Figure 3. Theoretical integration of study findings (source: author's compilation). (Note: In the above diagram, the green arrows show supported paths and the red arrows show non-supported paths based on the empirical results. The dashed gray arrow shows the theoretical driving force).

The model starts by putting Stakeholder Theory at the top of the list of things that explain why companies adopt sustainable logistics practices. In Saudi Arabia, the government's strong institutional pressure, which is shown through Vision 2030, is the main reason why companies are required to adopt Green Transportation, Sustainable Packaging, and Sustainable Waste Management. This corresponds with the literature that asserts stakeholder pressure as a fundamental driver for corporate sustainability initiatives [122]. The intense emphasis on Environmental Sustainability, despite the lack of uniform economic benefits, can be seen as a direct reaction to this coercive pressure, as companies prioritize alignment with national strategic objectives to preserve legitimacy and competitiveness.

The NRBV provides the framework for understanding the model's core: that sustainable practices and the technologies making such practices possible are firm-specific capabilities and resources which are created to provide a company with a competitive advantage. Empirically validated pathways explain a very distinct and strong mechanism by which this benefit is actualized into environmental outcomes. The results bring forth that not only do investments in all three sustainable practices directly improve Environmental Sustainability, but they also add to the development of a crucial resource, namely MIS, which then acts as an enabler and significantly strengthens the power of Environmental Sustainability. This constitutes strong evidence that supports the concept advanced by NRBV—that firms can transform green operational capabilities into improved environmental performance.

Another key theoretical difference in the unsupported paths the model shows is that the relationship between these green capabilities and Economic Performance is inconsistent. The inability for Green Transportation, Sustainable Packaging, and even MIS to directly predict economic benefits suggests that this "double bottom line" claimed by NRBV is contingent rather than assured [123]. Only Sustainable Waste Management, with more immediate cost-cutting benefits, leads to a direct economic benefit. This enhances the NRBV by indicating that, for the economic competitive advantage through green capabilities, the path is practice-specific and may face significant time delays or depend on other moderating factors not included in this model, such as market maturity or the magnitude of initial investment.

5.3. Managerial and Policy Implications

These recommendations are closely aligned with Saudi Arabia's existing institutional architecture for logistics and sustainability transformation. In particular, they complement the National Industrial Development and Logistics Program (NIDLP), the National Transport and Logistics Strategy, and the Saudi Green Initiative, all of which emphasize digitalization, logistics competitiveness, and environmental stewardship as mutually reinforcing objectives. Positioning sustainable logistics investments within these established programs ensures that firm-level initiatives reinforce national capability-building efforts and that policy instruments directly support the transition from compliance-oriented sustainability to optimization-driven green competitiveness.

The empirical results of this study have much tangible and actionable implications for corporate managers and national policymakers in Saudi Arabia, surpassing the theoretical recommendations to provide practical solutions that can be applied in the real world. To the managers, the results have provided a clear plan on how they should invest in sustainability such that they can reap the most from it.

Indeed, the finding that Sustainable Waste Management is the only method with a direct and significant positive impact on both Environmental Sustainability and Economic Performance cements its status as the most convincing "quick win". So, managers should put implementing full circular economy models ahead of starting small recycling programs. This includes setting up formal reverse logistics programs to get value from returned e-commerce goods by refurbishing and reselling them, as well as working with specialized waste management companies to turn operational waste into revenue streams. This way, they can directly benefit from the cost-cutting and value-creating methods that this study has shown to work. For capital-intensive practices such as Green Transportation and Sustainable Packaging, which do not yield immediate economic returns, a phased and data-driven methodology is essential. Logistics managers can start pilot programs using electric vehicles (EVs) for last-mile deliveries in busy cities like Riyadh and Jeddah, where operational savings are highest, instead of completely overhauling their fleets. At the same time, they should use their current Management Information Systems (MISs) to run route optimization algorithms on their current fleet. This will save them money on fuel right away, which they can use to buy more electric vehicles in the future. Rather than adopting the latest materials, which could be very costly, companies can use their MIS to run "right-sizing" algorithms that will help them reduce the size of their packaging, thus reducing the cost of shipping. The trick here would be to use MIS not as it does now, which appears to be following guidelines on environmental reporting (as this seems to be its usage most of the time), but as an overall cost cutter. More fundamentally, transitioning MIS from a compliance-oriented tool to a value-creation engine requires an explicit capability shift. Organizations must move beyond using MIS merely to document emissions and generate regulatory reports, toward embedding advanced analytics, optimization algorithms, and predictive decision-support systems into daily logistics operations. This includes deploying real-time route optimization, AI-supported demand and load forecasting, warehouse energy management systems, and integrated cost–carbon dashboards that allow managers to simultaneously track financial and environmental KPIs. By linking sustainability data directly to operational and financial decision-making processes, firms can progressively convert MIS into a dynamic NRBV capability one that not only ensures legitimacy, but also systematically identifies inefficiencies, reduces asset underutilization, and unlocks new sources of economic value. This could be achieved by setting up an "Integrated Dashboard" that provides critical data on costs such as cost of unit packaging, cost of waste disposed of by facility, or fuel consumption per kilometer.

This provides a means for policymakers, those responsible for implementing the large visions of Saudi Vision 2030, with a plan on how to intervene effectively. The fact that all sustainable practices positively impact Environmental Sustainability shows the effectiveness of the government's strategic push. The lack of economic relevance of Green Transportation and Packaging Practices, on the other hand, reveals significant market failure that needs to be addressed by policies in order to accelerate progress. The government could set up a "Green Logistics Fund" to help small and medium-sized businesses (SMEs) pay for electric vehicle fleets or solar panels on warehouses. This fund could give SMEs low-interest loans or direct subsidies. Policymakers could also make it less risky for private investors to put money into infrastructure by requiring that all developers of the 59 planned national logistics zones include a certain number of high-capacity EV charging stations and green-fuel depots. The "Packaging Efficiency Rebate" program could be established as an incentive for the development of innovative approaches to packaging. Firms which can prove, through MIS data verification, large reductions in the amount of materials used in packaging or a high recycling rate could receive tax rebates. Finally, in an effort to address the skills discrepancy revealed by the lack of MIS usage with regard to economic interests, steps can be taken by the government in association with institutions like the Saudi Logistics Academy to establish and fund an advanced course of "Digital and Sustainable Logistics Analytics." The local talent would be able to apply technology not only to track environment data, but also optimize efficiency levels in order for the Kingdom itself to become a sustainable, competitive logistics hub.

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6. Conclusions, Limitations, and Future Research

6.1. Conclusions

This study seeks to provide a holistic, empirical evaluation of the importance and impact of sustainable logistics practices within the context of the Kingdom of Saudi Arabia—a nation experiencing a remarkable economic and social transformation. The study confirms that the implementation of Green Transportation, Sustainable Packaging, and Sustainable Waste Management through advanced Management Information Systems—centered on environmental stewardship—finds its place as a significant catalyst for Environmental Sustainability. This finding strongly supports the sustainability goals of Saudi Vision 2030. However, this same research highlights an important nuance: that such practices are not intrinsically linked with directly improving Economic Performance, but, instead, are conditional and highly specific to each practice. Only waste management initiatives return a clear financial benefit in the short term, while other findings suggest that MIS has yet to be fully leveraged to drive economic outcomes. This study significantly enhances the literature by providing unique empirical evidence from a non-Western, state-driven transformation context, and by advancing the application of the NRBV and Stakeholder Theory. In practice, it gives managers a strategic plan for how to prioritize investments and policymakers a way to make better incentives to build a logistics sector that is both green and economically strong and able to compete on a global scale.

6.2. Limitations and Directions for Future Research

Despite its contributions, this study is subject to several limitations that also open promising avenues for future research. First, the research design is cross-sectional, capturing organizational practices and performance outcomes at a single point in time. While this approach is appropriate for theory testing, it constrains the ability to observe dynamic capability development and to make strong causal inferences regarding the temporal sequencing between sustainable investments and economic returns. Future studies should therefore adopt longitudinal research designs to examine how sustainable logistics capabilities and MIS maturity evolve, and to identify potential time-lag effects between environmental improvements and financial performance. Additionally, mixed-method approaches combining large-scale surveys with in-depth case studies or system-level operational data could offer richer insights into how firms practically reconfigure MIS from compliance infrastructures into optimization platforms and how organizational learning processes mediate this transition.

Second, although the study obtained responses from a wide range of sectors, the final validated sample is characterized by a relatively high representation from the healthcare and public-service segments, while firms from core transportation and logistics operations constitute a smaller proportion. This sectoral imbalance may have influenced the results by amplifying compliance-oriented sustainability logics and under-representing cost-efficiency dynamics typical of logistics-intensive industries. Future research should therefore target more balanced or sector-specific samples, particularly focusing on transportation, warehousing, freight forwarding, and third-party logistics providers, to examine whether the economic effects of sustainable logistics practices differ across industry profiles.

Third, the MIS construct in this study was operationalized primarily through environmentally oriented functionalities, reflecting current Green MIS practices in Saudi organizations. While appropriate for examining environmental mediation, this operationalization limits the ability to capture optimization-oriented digital capabilities such as cost analytics, asset utilization, and process efficiency systems. Future studies should expand MIS measurement models to include both environmental and economic optimization dimensions, enabling multi-group and configurational analyses. Moreover, incorporating contextual moderators such as firm size, ownership structure, logistics intensity, climatic conditions, and infrastructure dependence would allow deeper examination of boundary conditions under which sustainable logistics practices and MIS maturity translate into economic value. Such designs could further support multi-group SEM or longitudinal capability maturity analyses.

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Informed Consent Statement: This research was conducted in accordance with ethical standards for academic studies. Participation in the survey was voluntary, and informed consent was obtained from all respondents. No personal or sensitive data were collected, and confidentiality of participants was strictly maintained. The study complies with institutional and international ethical guidelines, ensuring integrity, transparency, and respect for all stakeholders involved.

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Appendix A. Survey Questionnaire

Questionnaire related to Sustainable Logistics Practices

Dear Respondent/s, Greetings

I am seeking your support in filling the given questionnaire as I am conducting research on "Sustainable Logistics Practices in Saudi Arabia: A MIS Perspective for Environmental and Economic Optimization"

This is further to inform you that your response will be kept highly confidential and information provided by you will be exclusively used for academic/research purpose. You have the option to withdraw at stage of the questionnaire without any negative impact.

Thanks

Section 1: Respondent Information

(1) Name:………………………………………….

(2) Position/Role in the Company

Logistics Manager
Supply Chain Manager
Operations Manager
Sustainability Officer
IT/Management Information Systems Specialist
Other (Please specify): ___________

(3) Years of Experience in the Industry

Less than 1 year
1–3 years
4–6 years
7–10 years
More than 10 years

(4) Industry Sector

Manufacturing
Retail
Transportation and Logistics
E-commerce
Food and Beverage
Healthcare
Petroleum and Coal
Other (Please specify): ___________

(5) Company Size (Number of Employees)

Less than 50 employees
50–200 employees
201–500 employees
501–1000 employees
More than 1000 employees

(6) Annual Revenue Range

Less than $1 million
$1–10 million
$10–50 million
$50–100 million
Over $100 million

Section 2: Please respond about Sustainable Logistics Practices

1. **Green Transportation**

(a) Monitoring of emissions from vehicles

1 = not considering it; 2 = planning to consider it; 3 = considering it currently; 4 = initiating implementation; 5 = implementing successfully

(b) Use of alternative or new energy vehicles

1 = not considering it; 2 = planning to consider it; 3 = considering it currently; 4 = initiating implementation; 5 = implementing successfully

(c) Optimization of transport routes

1 = not considering it; 2 = planning to consider it; 3 = considering it currently; 4 = initiating implementation; 5 = implementing successfully

(d) Optimization of transport cargo distribution

1 = not considering it; 2 = planning to consider it; 3 = considering it currently; 4 = initiating implementation; 5 = implementing successfully

(7) Green Packaging

(a) Application of innovative packaging technologies

1 = not considering it; 2 = planning to consider it; 3 = considering it currently; 4 = initiating implementation; 5 = implementing successfully

(b) Choosing a greener type of packaging

1 = not considering it; 2 = planning to consider it; 3 = considering it currently; 4 = initiating implementation; 5 = implementing successfully

(c) Use of recyclable packaging materials and logistics containers

1 = not considering it; 2 = planning to consider it; 3 = considering it currently; 4 = initiating implementation; 5 = implementing successfully

(d) Reduction in the use of transport packaging

1 = not considering it; 2 = planning to consider it; 3 = considering it currently; 4 = initiating implementation; 5 = implementing successfully

(8) **Sustainable Waste Management**

(a) Recycling of transport and storage waste

1 = not considering it; 2 = planning to consider it; 3 = considering it currently; 4 = initiating implementation; 5 = implementing successfully

(b) Monitoring of recycling of transport waste

1 = not considering it; 2 = planning to consider it; 3 = considering it currently; 4 = initiating implementation; 5 = implementing successfully

(c) Responsible waste sorting

1 = not considering it; 2 = planning to consider it; 3 = considering it currently; 4 = initiating implementation; 5 = implementing successfully

Section 3: Please respond about Management Information Systems (MIS) in the context of Green Reporting or Green Management Information Systems (Green MIS).

(a) Reducing transportation costs

1 = Not used at all; 2 = Used to a small extent; 3 = Used to a moderate extent; 4 = Used to a large extent; 5 = Used to a great extent

(b) Monitoring emissions, waste production, and carbon footprint

1 = Not used at all; 2 = Used to a small extent; 3 = Used to a moderate extent; 4 = Used to a large extent; 5 = Used to a great extent

(c) Improving decision making by executives by highlighting sustainability issues

1 = Not used at all; 2 = Used to a small extent; 3 = Used to a moderate extent; 4 = Used to a large extent; 5 = Used to a great extent

Section 4: Please respond about Environmental Sustainability

(a) Reduction in air and carbon emissions

1 = Greatly worsened; 2 = Slightly worsened; 3 = Neutral impact; 4 = Slightly improved; 5 = Greatly Improved

(b) Reduction in waste emission

1 = Greatly worsened; 2 = Slightly worsened; 3 = Neutral impact; 4 = Slightly improved; 5 = Greatly Improved

(c) Decrease in consumption for hazardous/harmful/toxic materials

1 = Greatly worsened; 2 = Slightly worsened; 3 = Neutral impact; 4 = Slightly improved; 5 = Greatly Improved

(d) Decrease in frequency for environmental accidents

1 = Greatly worsened; 2 = Slightly worsened; 3 = Neutral impact; 4 = Slightly improved; 5 = Greatly Improved

Section 5: Please respond about Economic Performance

(a) Decrease in cost for purchased materials

1 = Greatly worsened; 2 = Slightly worsened; 3 = Neutral impact; 4 = Slightly improved; 5 = Greatly Improved

(b) Decrease in cost for energy consumption

1 = Greatly worsened; 2 = Slightly worsened; 3 = Neutral impact; 4 = Slightly improved; 5 = Greatly Improved

(c) Decrease in fee for waste treatment

1 = Greatly worsened; 2 = Slightly worsened; 3 = Neutral impact; 4 = Slightly improved; 5 = Greatly Improved

(d) Decrease in fine for environmental accidents

1 = Greatly worsened; 2 = Slightly worsened; 3 = Neutral impact; 4 = Slightly improved; 5 = Greatly Improved

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