

Enhancing Supply Chain Efficiency and Green Logistics: The Role of Environmental Regulations

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ABSTRACT

This study investigates the influence of Environmental Regulations (ER) and Financial Incentives (FI) on Supply Chain Efficiency (SCE) and Green Logistics Implementation (GLI) among small and medium-sized enterprises (SMEs) in Jordan. Drawing on the theoretical foundations of Sustainable Supply Chain Management (SSCM), this study proposes and empirically tests a conceptual model linking ER and FI to SCE and GLI. A quantitative research design was employed using data collected from 243 professionals across Jordanian SMEs involved in logistics and supply chain operations. The data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) via SmartPLS 4. The results reveal that both ER and FI significantly and positively influence SCE and GLI, though with varying magnitudes. ER exerted a stronger effect on SCE ($\beta = 0.372$, $p < 0.001$) compared to GLI ($\beta = 0.172$, $p < 0.01$), suggesting that regulatory compliance enhances operational efficiency but may not fully drive proactive green logistics practices. Conversely, FI demonstrated the strongest impact on SCE ($\beta = 0.412$, $p < 0.001$) and a weaker yet significant effect on GLI ($\beta = 0.148$, $p < 0.05$), indicating that financial support serves as a critical enabler of efficiency but requires complementary institutional and cultural mechanisms to promote sustainability adoption. These findings underscore the complementary roles of regulatory and financial instruments in advancing both efficiency and sustainability within SME supply chains. The results also provide practical insights for policymakers and SME managers aiming to strengthen the competitiveness and sustainability of Jordan's supply chain ecosystem.

Keywords: SMEs, Sustainable Supply Chain Management, Environmental Regulations, Jordan, Financial Incentives, Supply Chain Efficiency, Green Logistics Implementation

INTRODUCTION

Small and medium-sized enterprises (SMEs) are widely recognized as the backbone of Jordan's economy, representing more than 99% of registered firms, contributing nearly 50% of the national GDP, and serving as key drivers of innovation, employment, and entrepreneurial growth (Jordan Strategy Forum JSF, 2018). Despite their substantial contribution, Jordanian SMEs continue to face considerable structural and operational challenges that

constrain their competitiveness. These include limited access to financial resources, regulatory complexity, high transaction costs, and administrative barriers that hinder both domestic and international trade performance (Kinani & Senyigit, 2022; Obeidat et al., 2021). Situated at the crossroads of Europe, Africa, and Asia, Jordan's economic resilience and long-term growth potential depend significantly on the ability of its SMEs to operate efficiently within global value chains (Awad, 2020). In this regard, the efficiency of customs procedures and trade facilitation mechanisms has emerged as a critical determinant of SME supply chain performance. Streamlined customs systems not only reduce time and cost inefficiencies but also enhance SMEs' capacity to integrate into international markets, improve logistics operations, and increase export competitiveness (AlZakwani et al., 2025; Hamad & Darwazeh, 2021). However, empirical research that specifically examines the role of customs policies in shaping SME supply chain performance in Jordan remains limited. Previous studies have largely focused on taxation, regulation, and trade policy in general, without giving sufficient attention to how customs administration directly influences SME logistics and operational efficiency (Al-Momani, 2024; Jango & Mohamed, 2024). This gap is significant given that customs inefficiencies (such as complex documentation, inconsistent enforcement, and limited digitalization) pose severe constraints for SMEs operating on narrow margins (Obeidat et al., 2021). In contrast, effective customs reform can create enabling environments that stimulate trade facilitation, improve supply chain coordination, and strengthen SMEs' integration into global networks (Kinani & Senyigit, 2022). Thus, optimizing customs processes is essential for improving Jordanian SMEs' productivity and competitiveness, ensuring that the benefits of trade liberalization translate into tangible economic growth (Al-Zaqeba et al., 2025; Othman, Bin Jalil, & Bin Sabri, 2024). At the same time, the global shift toward sustainability has profoundly redefined the priorities of modern supply chain management (Ababneh et al., 2024). Firms are now required not only to pursue efficiency and cost reduction but also to integrate environmental and social considerations into their logistics operations a transformation conceptualized as Sustainable Supply Chain Management (Ali & Rozilah, 2024; Zhang, 2023; Alshehadeh et al., 2025). Within this paradigm, *green logistics* represents a cornerstone of sustainable operations, emphasizing the reduction of carbon emissions, the efficient use of resources, and environmentally responsible logistics practices across the supply chain (Karlsson et al., 2022). The evolution of SSCM reflects an increasing recognition that supply chain performance must be measured not solely in economic terms but also in environmental and social dimensions. Consequently, governments and regulatory institutions play a critical role in steering corporate sustainability efforts through environmental policies and financial mechanisms designed to promote eco-efficient practices (Almadaat & Ibrahim, 2021; Issaa, 2024; Sharma, 2024; Saunila et al., 2024).

In emerging economies such as Jordan, where firms often operate under resource constraints, achieving sustainability objectives presents additional challenges. Regulatory fragmentation, limited financial incentives, and a lack of institutional coordination frequently undermine the implementation of sustainable logistics systems (Mohamed et al., 2024). Environmental regulations, when effectively designed and enforced, provide a strong external driver compelling firms to adopt cleaner technologies, improve energy efficiency, and reduce emissions throughout their supply chain activities (Purvis & Fernandez, 2024; Alsmadi et al., 2025; Shehab, 2025; Thosony, 2025). Similarly, financial incentives (ranging from green public procurement initiatives to tax exemptions and subsidies) serve as complementary policy instruments that motivate firms to invest in sustainability-related infrastructure and technologies (Ibrahim, 2021; Qu & Ji, 2023; Ibrahim & Ali, 2025). Understanding how these two policy mechanisms (environmental regulations and financial incentives) jointly affect supply chain efficiency and green logistics adoption is particularly relevant for developing economies seeking to balance economic expansion with sustainable growth.

LITERATURE REVIEW

This literature review explores the interplay between environmental regulations, financial incentives, green logistics implementation, and supply chain efficiency within the framework of Sustainable Supply Chain Management (SSCM) (Hailat et al., 2023). The reviewed studies consistently demonstrate that sustainability drivers shape the diffusion of environmentally responsible logistics practices and enhance overall operational performance (Maabreh, 2024; Alazzam et al., 2026). Recent scholarship emphasizes that supply chain efficiency can no longer be viewed solely through the lens of cost and speed; rather, it now encompasses environmental performance, social responsibility, and governance quality as integral elements of competitiveness and resilience (Ali & Rozilah, 2024; Sharma, 2024; Qu & Ji, 2023). Although extensive literature has explored various aspects of SSCM, existing studies tend to examine either environmental regulations or financial incentives in isolation, without offering an integrated assessment of their combined impact on logistics efficiency and sustainability outcomes (Iyere & Misopoulos, 2022; Lootah, 2024). Moreover, much of the available evidence originates from large multinational corporations, leaving a significant empirical gap regarding SMEs; especially within the Middle Eastern and Jordanian contexts

(Hamad & Darwazeh, 2021; Abdul Razzak et al., 2025). The lack of research linking policy-driven sustainability interventions to SME supply chain and logistics performance limits both academic understanding and policy development. Thus, an in-depth examination of how environmental regulations and financial incentives influence supply chain efficiency and green logistics implementation within Jordanian SMEs is warranted.

Supply Chain Efficiency

Supply chain efficiency (SCE) represents a fundamental determinant of organizational competitiveness and sustainability, referring to the optimal utilization of resources to achieve timely, cost-effective, and reliable supply chain operations (Al-Jarrah et al., 2023; Goldsby et al., 2023; Schneller et al., 2023). Efficient supply chains enhance firms' ability to manage uncertainty, reduce waste, and respond flexibly to market fluctuations. For Jordanian SMEs, improving supply chain efficiency is crucial, given the challenges of limited resources, administrative barriers, and global competition (Obeidat et al., 2021; Ababneh et al., 2023).

The literature underscores several drivers of supply chain efficiency, including digital transformation, sustainability integration, and policy support. Studies by Al-Zaqeba et al. (2022) and Dora et al. (2022) demonstrate that technological innovation and knowledge management practices directly contribute to higher efficiency levels. However, these outcomes are often contingent upon enabling institutional conditions such as supportive customs procedures and incentive structures (Al-Shuwaikhat, 2019; Al-Dalayeen & Al-Shuwaikhat, 2021). From a critical standpoint, the link between environmental regulations and supply chain efficiency lies in the ability of regulations to induce systemic optimization, such as cleaner production, waste minimization, and improved energy efficiency. Similarly, financial incentives can accelerate the transition toward efficient green operations by easing cost burdens and promoting collaborative investment in innovation. Hence, the intersection between regulatory frameworks and financial stimuli is vital in understanding how Jordanian SMEs can achieve higher levels of supply chain efficiency under sustainability-oriented policy regimes.

Green Logistics Implementation

Green logistics implementation (GLI) encompasses the design, execution, and control of logistics operations in ways that minimize environmental harm while maintaining service quality (An et al., 2021; Nze-Ekpebie & Nze-Ekpebie, 2023). It involves integrating environmentally friendly practices such as energy-efficient transportation, sustainable packaging, and optimized distribution networks into logistics systems. Scholars such as Bressanelli et al. (2022) and Pan et al. (2015) highlight that the transition toward green logistics is not solely a corporate responsibility but a shared objective facilitated by governmental policy instruments. Environmental regulations act as guiding frameworks that enforce green standards, while financial incentives serve as motivating levers that encourage firms to exceed compliance thresholds (Sheu & Chen, 2012). In Jordan, the adoption of green logistics has been slow, primarily due to limited financial resources and a lack of regulatory enforcement mechanisms (Al-Smadi & Al-Dalayeen, 2019; Al-Nasir & Al-Smadi, 2020). However, recent empirical research emphasizes that both regulatory and financial interventions can substantially accelerate the integration of green logistics practices within SMEs (An et al., 2021; Men et al., 2023). Importantly, while regulations provide a "push" mechanism through compliance requirements, financial incentives deliver a "pull" effect by enhancing the economic feasibility of green investments (Al Azzam et al., 2023).

Critically, effective green logistics implementation depends on aligning environmental objectives with logistical efficiency. As pointed out by Carlan et al. (2022), cost-sharing models and digitalization further enhance transparency and trust across green supply chains. Therefore, the synergy between environmental regulations and financial incentives is essential to drive sustainable logistics adoption, leading to improved environmental performance and competitive advantage for Jordanian SMEs.

Supply chain efficiency (SCE) is a central performance dimension reflecting a firm's ability to utilize resources effectively to achieve cost, speed, and quality objectives. The literature consistently associates SCE with the successful implementation of sustainability-oriented practices. Studies such as Hsieh et al. (2023) and Joo and Hur (2023) underline that environmental risk management and green practices enhance flexibility, resilience, and efficiency throughout supply chains.

From a GSCM perspective, improvements in efficiency are not merely operational outcomes but strategic consequences of environmental and financial drivers (Tubishat et al., 2024). Firms facing strong environmental regulations and benefiting from targeted financial incentives often invest in process optimization, energy-saving technologies, and waste minimization strategies all of which contribute to superior SCE (Qi et al., 2024; Zhang et al., 2023). Furthermore, integrating GLI components (e.g., reverse logistics, energy-efficient transport) strengthens internal coordination and external collaboration, enhancing the overall efficiency of supply chain networks.

Environmental Regulations

Environmental regulations (ER) have become central instruments in advancing sustainability and enhancing supply chain performance worldwide (Alazzam et al., 2024). As Sheu and Chen (2012) argue, environmental regulations function dually depending on their structure, enforcement, and the extent to which they promote technological upgrading. In highly regulated environments, firms are often compelled to reengineer production and logistics processes to reduce emissions, minimize waste, and improve energy efficiency. This regulatory-induced transformation is particularly significant for small and medium-sized enterprises (SMEs), which often operate with limited financial and technical capacity to pursue sustainability initiatives independently (Silvestre, 2015).

In Jordan, environmental regulations have been progressively integrated into national sustainability strategies to align with global environmental standards and international trade requirements (Al-Dalayeen & Al-Shuwaikhat, 2021). Nevertheless, their adoption among SMEs remains inconsistent, with many firms facing structural and informational barriers that hinder compliance and sustainability-driven innovation (Al-Nasir & Al-Smadi, 2020). Recent studies suggest that effective regulatory design (when accompanied by institutional support and knowledge dissemination) can simultaneously safeguard the environment and stimulate firm-level competitiveness (Adams et al., 2023; Grimm et al., 2023). While some scholars caution that over-regulation may impose operational burdens on SMEs and slow growth (Souhli & En-Nadi, 2023), others highlight that well-calibrated environmental frameworks enhance long-term resilience and innovation (Bressanelli et al., 2022). Thus, in the Jordanian SME context, environmental regulations can act as enabling mechanisms that support both green logistics implementation (GLI) and supply chain efficiency (SCE) when supported by coherent institutional structures and capacity-building initiatives.

Empirical evidence reinforces the pivotal role of ER as a driver of green supply chain management (GSCM) and logistics sustainability. Qi et al. (2024) demonstrated through an evolutionary game model that stronger environmental regulations accelerate the diffusion of green supply chain practices and encourage sustainable operational behaviors. Similarly, Zhang et al. (2023) found that environmental regulation shapes corporate environmental performance through dual mechanisms—compliance enforcement and innovation stimulation. Sharma (2024) further confirmed that mandatory environmental reporting frameworks promote organizational transparency and encourage the adoption of green logistics strategies. Context-specific analyses, such as that of Tahan et al. (2024), emphasize that targeted regulatory pressures (especially those focusing on green procurement and reverse logistics) significantly improve firms' environmental and operational outcomes.

However, the literature cautions that regulation alone cannot guarantee positive outcomes. Weak enforcement, excessive complexity, or fragmented institutional structures may undermine intended impacts, particularly in emerging economies (Mohamed et al., 2024). Soesetyo et al. (2025) and Metwally et al. (2024) showed that the success of green logistics initiatives depends on both the strength of regulatory support and managerial commitment to sustainability. Moreover, external pressures serve as catalysts for GLI adoption, improving both environmental and financial performance (Ningrum et al., 2024).

Green logistics serves as the operational channel through which environmental regulations influence supply chain outcomes. By mandating environmentally responsible practices such as sustainable procurement, waste reduction, and energy-efficient transportation, ER fosters efficiency and environmental performance simultaneously (Tahan et al., 2024; Zhang, 2024). Within the broader Sustainable Supply Chain Management (SSCM) framework, environmental regulations and financial incentives act as complementary policy levers that integrate sustainability principles across supply chain networks (Ali & Rozilah, 2024; Sharma, 2024; Zhang, 2023). Regulations create the institutional pressure for compliance, while incentives generate economic motivation for firms to adopt cleaner technologies and logistics innovations (Qu & Ji, 2023; Purvis & Fernandez, 2024). Moreover, policy instruments such as Green Public Procurement (GPP) have emerged as effective extensions of environmental regulation, mobilizing public and private sectors toward greener logistics. GPP creates market pull for sustainable solutions by prioritizing low-emission logistics and clean transportation systems, incentivizing firms to invest in green technologies to meet procurement standards (Karlsson et al., 2022). When complemented by financial incentives, these mechanisms shorten the payback period for sustainability-related investments (such as electric freight vehicles and energy-efficient cold-chain systems) enhancing both environmental and economic efficiency (Qu & Ji, 2023).

Effective governance mechanisms enable firms to track emissions, verify compliance, and improve decision-making across supply chain networks (Layode et al., 2024; Saunila et al., 2024). Furthermore, empirical research shows that the integration of digital technologies (IoT, AI, and blockchain) enhances the visibility and traceability required for regulatory compliance and efficiency optimization (Layode et al., 2024; Qu & Ji, 2023). Finally, scholars emphasize that the success of environmental regulation depends not only on policy design but also on social and organizational readiness. Singh and Maheswaran (2023) argue that social and governance factors significantly affect

firms' ability to translate regulatory expectations into practice. Similarly, Iyere and Misopoulos (2022) emphasize that aligning diverse stakeholder interests is crucial for overcoming barriers and achieving sustainable logistics outcomes. Hence, the convergence of environmental regulations, institutional incentives, digital governance, and stakeholder engagement is vital for enabling green logistics efficiency and strengthening supply chain sustainability (Zhang, 2023; Purvis & Fernandez, 2024; Karlsson et al., 2022; Qu & Ji, 2023).

Financial Incentives

Financial incentives (FI) are essential instruments used by governments to encourage the adoption of environmentally sustainable and resource-efficient supply chain practices. These incentives—ranging from tax reductions to green financing schemes—can offset the high initial costs of adopting clean technologies and renewable logistics systems (Sheu & Chen, 2012). In emerging economies such as Jordan, the role of financial incentives is even more critical, given that SMEs often face severe liquidity constraints that limit their ability to invest in green technologies (Epede & Wang, 2022). Empirical evidence demonstrates that financial incentives positively influence the adoption of green logistics and enhance overall supply chain efficiency (An et al., 2021; Men et al., 2023). Such incentives not only improve the financial feasibility of green projects but also generate competitive advantages by lowering operating costs and improving firm reputation (Carlan et al., 2022; Raja & Muthuswamy, 2022). Moreover, financial support encourages technological innovation and collaboration among supply chain partners, which further improves sustainability outcomes (Ali et al., 2023). Nevertheless, the effectiveness of financial incentives depends heavily on their design and accessibility (Falaha, 2024; Qahman et al., 2025; Abdallah et al., 2025; Qahman et al., 2026). Scholars such as Amiri-Pebdani et al. (2022) argue that poorly targeted incentives or bureaucratic inefficiencies can undermine intended policy outcomes. In Jordan, a lack of coordinated financial frameworks has hindered many SMEs from fully leveraging available sustainability-linked programs (Almajali et al., 2016). Therefore, to enhance green logistics and supply chain efficiency, financial incentives must be strategically aligned with national environmental goals, accompanied by transparent regulatory oversight and awareness programs for SMEs. Financial incentives (FI) complement environmental regulations by lowering the financial barriers to adopting sustainable logistics and production practices. Instruments such as green credit, tax subsidies, and direct grants are frequently cited as effective tools that motivate firms to invest in environmentally friendly operations (Zhan & Wu, 2024; Zhang, 2024). These incentives send clear policy signals, making green investments economically attractive and aligning financial interests with sustainability objectives.

Empirical evidence shows that FI not only supports green logistics implementation (GLI) but also enhances supply chain efficiency (SCE) by improving operational performance and encouraging resource optimization (Metwally et al., 2024; Soesetyo et al., 2025). Zhan and Wu (2024) demonstrated that green credit incentives positively affect firms' operational decisions, promoting investment in cleaner technologies and sustainable logistics systems. Yet, scholars emphasize that the effectiveness of FI depends on accessibility, targeting accuracy, and alignment with regulatory priorities. Poorly designed financial schemes may produce limited or short-term effects. Nonetheless, when integrated with environmental regulations, financial incentives become powerful levers that accelerate the diffusion of green logistics and amplify supply chain performance gains.

HYPOTHESIS DEVELOPMENT

The literature review has demonstrated that environmental and financial factors act as major institutional and economic enablers for sustainable supply chain practices. In particular, environmental regulations (ER) and financial incentives (FI) influence how firms adopt green logistics (GL) and manage supply chain efficiency (SCE). Building on both global and Jordanian evidence, this section develops the research hypotheses grounded in the theoretical and empirical linkages between ER, FI, GLI, and SCE.

Environmental Regulations and Supply Chain Efficiency

Environmental regulations are increasingly recognized as key governance instruments that drive firms toward sustainable operations by compelling them to internalize environmental costs, reduce waste, and improve process efficiency. Within the framework of Sustainable Supply Chain Management (SSCM), regulatory pressure motivates firms to adopt practices that minimize environmental harm while enhancing resource utilization and operational performance. Environmental regulations drive firms to adopt sustainable practices, optimize resource usage, and reduce inefficiencies. Sheu and Chen (2012) emphasized that well-structured environmental regulations enhance operational productivity by pushing firms toward innovation and waste reduction. Similarly, Silvestre (2015) and Al-Dalayeen & Al-Shuwaikhat (2021) confirmed that environmentally responsible policies indirectly boost supply chain efficiency by improving process management and compliance-driven modernization.

In Jordan, empirical studies substantiate this linkage between regulatory pressure and performance improvement. Almohtaseb et al. (2024) demonstrate that supply chain management (SCM) practices significantly enhance the performance of Jordanian SMEs, indicating that regulatory and managerial drivers jointly promote efficiency and sustainability. Similarly, Albhirat et al. (2023) find that green supply chain activities are positively related to sustainable performance, further suggesting that environmental expectations act as external stimuli for improved efficiency among SMEs.

Shtawi et al. (2023) extend this understanding by emphasizing the mediating role of information and communication technology (ICT) in the Jordanian pharmaceutical sector, where environmental and market pressures stimulate SSCM adoption and digitalized supplier partnerships that enhance performance. The argument is further reinforced by Saunila et al. (2024), who highlight performance measurement and governance as mechanisms that translate sustainability-oriented regulations into measurable efficiency gains. Complementary insights from Philbin et al. (2022) reveal that digital transformation and ESG reporting frameworks enhance the ability of SMEs to meet regulatory standards efficiently through data-enabled governance and performance transparency.

In sum, these studies collectively affirm that environmental regulations indirectly improve SCE by incentivizing SMEs to adopt SSCM and GSCM practices, digitalize operations, and enhance transparency and governance. However, as noted by Shqair and Altarazi (2022), the realization of these benefits in Jordan depends on SMEs' Industry 4.0 readiness and digital infrastructure—both essential mediators in transforming environmental compliance into operational efficiency.

Environmental regulations have emerged as a dominant external force influencing how firms design and manage their supply chains. By setting clear standards for pollution control, waste management, and reporting transparency, such regulations compel firms to optimize their production and logistics systems, leading to more efficient resource use and lower operational waste (Sharma, 2024; Saunila et al., 2024). In developing economies such as Jordan, regulatory pressure often acts as a catalyst for process reengineering, technology adoption, and performance measurement, transforming compliance from a cost factor into a source of competitive efficiency (Almohtaseb et al., 2024). Accordingly, when firms align their internal supply chain strategies with regulatory expectations, they are more likely to achieve higher levels of supply chain efficiency. Hence, the following hypothesis is proposed:

H1: Environmental Regulations positively effect Supply Chain Efficiency in Jordanian SMEs.

Environmental Regulations and Green Logistics Implementation

Environmental regulations have been widely documented as one of the most powerful institutional drivers of green logistics (GL) adoption. Regulatory frameworks that mandate emissions reductions, energy efficiency, and responsible waste management exert significant influence over firms' logistical decisions, from transport and warehousing to packaging and distribution. ER serve as a catalyst for the adoption of green logistics strategies. As shown by An et al. (2021) and Bressanelli et al. (2022), regulatory compliance requirements stimulate firms to implement environmentally friendly logistics processes, such as eco-efficient transportation and reduced carbon footprints. In Jordan, Al-Smadi & Al-Dalayeen (2019) also observed that stronger environmental enforcement correlates with greater adoption of sustainable logistics practices among SMEs. Empirical evidence shows that such regulations motivate firms to redesign logistics systems toward greener practices, improving performance and reducing environmental impact (Mohamed et al., 2024; Karlsson et al., 2022). Theoretical and empirical studies consistently reveal that regulatory constraints are among the strongest predictors of GL implementation, as firms respond strategically to meet policy expectations and maintain legitimacy (Sharma, 2024; Purvis & Fernandez, 2024).

In the context of Jordanian SMEs, the emerging policy environment that promotes environmental sustainability provides a fertile ground for GL diffusion. Although direct studies on GL in Jordan remain limited, related evidence such as sustainable freight practices, demonstrates that firms subject to environmental expectations and market pressures show stronger tendencies toward green-oriented innovation (Almohtaseb et al., 2024; Albhirat et al., 2023). Regulatory drivers thus function not merely as compliance instruments but as catalysts for strategic transformation, particularly when supported by ICT and organizational capability (Shtawi et al., 2023). Environmental regulations not only enhance internal efficiency but also drive the external adoption of sustainable logistics practices. Stronger regulatory frameworks promote the implementation of green logistics initiatives—such as eco-friendly transportation, packaging reduction, and reverse logistics—by establishing mandatory sustainability standards and enforcement mechanisms (Zhang, 2023; Mohamed et al., 2024). Such regulations encourage firms to invest in cleaner technologies and logistics systems that comply with environmental requirements, while harmonized policy environments create incentives for collaborative sustainability along the supply chain (Karlsson et al., 2022; Purvis & Fernandez, 2024). This dynamic underscore the crucial role of regulation in institutionalizing sustainability across logistics operations.

Therefore, the following hypothesis is proposed:

H2: Environmental Regulations positively effect Green Logistics Implementation in Jordanian SMEs.

Financial Incentives and Supply Chain Efficiency

Financial incentives play a crucial role in stimulating SME investments in supply chain efficiency. Evidence suggests that access to financial support enhances SMEs' capacity to digitalize operations, improve logistics infrastructure, and strengthen SCM practices. In Jordan, studies confirm that financial and strategic resources are key determinants of SME performance. Arikat (2024) demonstrate that business intelligence (BI) and supply chain integration are positively correlated with SME performance, implying that financial incentives targeting digitalization and integration would likely enhance efficiency. Similarly, Almohtaseb et al. (2024) emphasize the role of SCM adoption in improving SME competitiveness, which financial support can amplify by reducing capital constraints.

Financial incentives promote investment in sustainable technologies and operational modernization, thus enhancing efficiency. Sheu and Chen (2012) demonstrated that government financial intervention can reduce operational costs and stimulate competition among green supply chains. Amiri-Pebdani et al. (2022) and Epede & Wang (2022) further noted that targeted financial support mechanisms such as tax credits and low-interest loans, directly improve supply chain efficiency, especially in resource-constrained SMEs.

Globally, Guo et al. (2024) and Liu & Fu (2024) show that supply chain finance platforms and innovations alleviate liquidity shortages and streamline procurement, leading to measurable efficiency gains. Further, Rahman and Rahim (2024) argue that external financial support fosters SME technology adoption, boosting operational efficiency and competitiveness. Complementary findings from ALfarajat (2023) highlight the importance of agility and market orientation, which can be reinforced by financial incentives promoting responsive supply chain systems. In the Jordanian SME ecosystem, where digital transformation and BI adoption are growing trends, financial incentives targeting SCM enhancement, digital enablement, and sustainable logistics investments are expected to yield significant efficiency improvements (Haija et al., 2025; Chen et al., 2022). Accordingly, financial support mechanisms that ease liquidity constraints and promote technological adoption can act as direct levers for improving SCE.

Financial incentives such as grants, tax exemptions, and low-interest financing are critical enablers of efficiency improvements within supply chains, particularly for small and medium-sized enterprises that face capital constraints (Guo et al., 2024; Rahman & Rahim, 2024). These incentives facilitate investments in digitalization, process automation, and integration technologies that enhance visibility, coordination, and responsiveness across the supply chain (Liu & Fu, 2024). Moreover, when financial support is aligned with sustainability and innovation objectives, it encourages firms to pursue operational excellence while maintaining cost efficiency. As such, financial incentives act as both motivators and enablers of enhanced supply chain performance.

Hence, the following hypothesis is proposed:

H3: Financial Incentives positively effect Supply Chain Efficiency in Jordanian SMEs.

Financial Incentives and Green Logistics Implementation

The adoption of green logistics practices is often hindered by high capital requirements and long payback periods. Financial incentives effectively reduce these barriers by providing liquidity, lowering investment risk, and improving the economic feasibility of green projects. Studies confirm that financial incentives (such as subsidies, tax breaks, and green loans) positively influence the adoption of environmentally friendly logistics (Daraojimba et al., 2023; Ogunyemi & Ishola, 2024; Sajuyigbe et al., 2024). Financial incentives function as key enablers of green logistics transformation. By mitigating the high costs of adopting green practices, such incentives encourage firms to invest in renewable energy solutions, energy-efficient transportation, and circular economy models (An et al., 2021; Men et al., 2023). Raja & Muthuswamy (2022) and Carlan et al. (2022) emphasized that financial rewards create a "pull effect," motivating voluntary adoption of sustainable logistics beyond regulatory obligations. In the Jordanian SME context, such policies can be particularly impactful in overcoming financial and technological barriers to sustainability. Netto (2022) and Kurniawan et al. (2023) further demonstrate that fiscal policies directly impact SME sustainability by encouraging resource efficiency and cleaner transport investments. Yaseen et al. (2024) and Nassim & Benraïss (2024) support this by showing that performance-based incentives improve SME innovation, which in turn enables GLI. Additionally, Ahmad (2025) highlights that the moderating role of financial support between green innovation and SME performance underscores the necessity of incentives as part of broader governance ecosystems.

In Jordan, where SME logistics operations are increasingly modernizing, Alrifae (2025) confirm that financial and policy supports enhance digital and logistics performance. Haija et al. (2025) further note that improved

financial transparency via digital technologies strengthens the ecosystem in which GLI incentives can operate effectively. The transition toward green logistics requires substantial financial investment in infrastructure, equipment, and technological innovation—costs that often deter small firms without adequate financial support (Daraojimba et al., 2023; Sajuyigbe et al., 2024). Financial incentives mitigate this burden by reducing investment risk, improving capital accessibility, and rewarding firms that adopt environmentally sustainable logistics practices (Kurniawan et al., 2023; Netto, 2022). Evidence from recent studies demonstrates that well-targeted fiscal and credit-based incentives encourage firms to invest in cleaner transportation systems, recycling initiatives, and energy-efficient operations (Ogunyemi & Ishola, 2024). Consequently, financial incentives are viewed as powerful drivers of green logistics diffusion, particularly in economies striving to balance growth and sustainability. Therefore, the following hypothesis is proposed:

H4: Financial Incentives positively effect Green Logistics Implementation in Jordanian SMEs.

RESEARCH MODEL

The proposed conceptual framework (Figure 1) illustrates the hypothesized relationships among the study's variables: Environmental Regulations (ER) and Financial Incentives (FI) as independent variables, and Green Logistics Implementation (GLI) and Supply Chain Efficiency (SCE) as dependent variables. However, both ER and FI are expected to have direct positive effects on SCE and GLI, reflecting the role of environmental and financial policy tools in enhancing sustainability and operational performance within Jordanian SMEs. However, Figure 1 shows the Conceptual Framework.

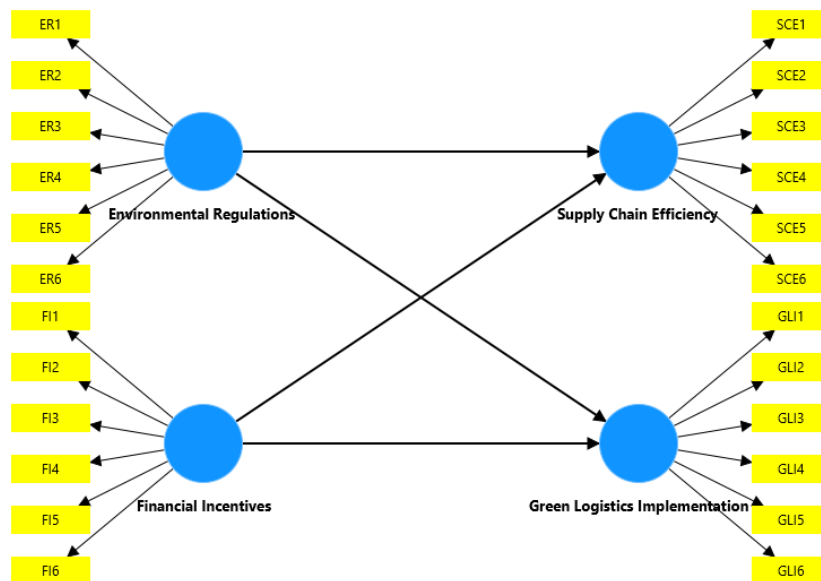


Figure 1. Research Model.

Collectively, this body of evidence suggests that financial incentives not only reduce the costs of implementing green logistics but also strengthen SME capabilities, digital readiness, and competitiveness. Hence, Jordanian SMEs benefiting from targeted financial incentives are expected to exhibit greater adoption of GLI practices. Thus, the following are the Hypothesis.

H1: Environmental Regulations positively effect Supply Chain Efficiency in Jordanian SMEs.

H2: Environmental Regulations positively effect Green Logistics Implementation in Jordanian SMEs.

H3: Financial Incentives positively effect Supply Chain Efficiency in Jordanian SMEs.

H4: Financial Incentives positively effect Green Logistics Implementation in Jordanian SMEs.

METHODS

This study employs a quantitative research design to empirically investigate the proposed conceptual model and test the hypothesized relationships among Environmental Regulations (ER), Financial Incentives (FI), Supply Chain Efficiency (SCE), and Green Logistics Implementation (GLI). The study aims to examine how environmental regulations and financial incentives contribute to improving supply chain efficiency and the implementation of green logistics within Jordanian small and medium-sized enterprises (Sharadgah et al., 2025;

Hazaimah, 2025; Wongj, 2025; Issa, 2024). A structured questionnaire was developed as the primary data collection instrument. The survey items were adapted from established literature to ensure validity and relevance in measuring the constructs under investigation. The instrument comprised reflective multi-item measures capturing perceptions of environmental regulations, financial incentives, supply chain efficiency, and green logistics implementation. All items were assessed using a five-point Likert scale, ranging from 1 (“strongly disagree”) to 5 (“strongly agree”) (Zaqeeba, 2024; Jarah et al., 2024; AlZakwani et al., 2025). The target population included professionals working in Jordanian SMEs involved in supply chain management, logistics, and transportation activities. Respondents were selected based on their expertise and direct engagement with environmental practices, logistics operations, and regulatory compliance. The questionnaire was distributed to 457 participants, and 243 valid responses were collected, representing a satisfactory and statistically acceptable response rate for quantitative analysis.

Data analysis was conducted using Structural Equation Modeling (SEM) to validate the measurement model and test the hypothesized structural relationships. In particular, the Partial Least Squares Structural Equation Modeling (PLS-SEM) technique was employed through SmartPLS 4 software due to its suitability for predictive, exploratory models and relatively small sample sizes. PLS-SEM provides robust estimations of complex interrelationships between latent constructs and supports simultaneous assessment of both the measurement and structural models (Al-Taani et al., 2025; Alshehadeh et al. 2025; Shboul, 2024; Shubailat et al. 2025; Al-Zaqeba et al., 2024; Ibrahim et al., 2025). The analysis included evaluating indicator reliability, internal consistency reliability, convergent validity, and discriminant validity to ensure the soundness of the measurement model. Subsequently, the structural model was examined to test the hypothesized effects among the study constructs.

RESULTS

Prior to testing the hypothesized structural relationships, a descriptive statistical analysis was conducted using SPSS version 29 to summarize the demographic characteristics of the respondents and to present the overall distribution and central tendency of the study variables. The demographic analysis revealed that the majority of respondents were employed in small and medium-sized enterprises (SMEs) actively engaged in logistics, transportation, and supply chain management operations across Jordan. Most respondents occupied mid-level managerial positions, such as logistics coordinators, supply chain supervisors, and operations managers, indicating a high level of professional awareness regarding environmental and regulatory practices affecting supply chain performance. Regarding gender distribution, approximately 68% of respondents were male, while 32% were female, reflecting the predominance of male employees in the logistics and transportation sectors. In terms of work experience, 42% of respondents reported having 5–10 years of experience, while 29% indicated more than 10 years, demonstrating that most participants possessed substantial experience to provide reliable insights into the studied phenomena. Descriptive statistics were also calculated for the main constructs — Environmental Regulations (ER), Financial Incentives (FI), Supply Chain Efficiency (SCE), and Green Logistics Implementation (GLI). The mean scores for all constructs ranged between 3.72 and 4.18, reflecting generally positive perceptions toward environmental and financial enablers of green logistics practices among Jordanian SMEs. The standard deviations ranged from 0.61 to 0.84, indicating moderate variation and internal consistency in responses across participants. Specifically, the mean score for Environmental Regulations was 4.02 (SD = 0.69), suggesting that respondents view environmental laws and policies as increasingly impactful in shaping logistics and supply chain operations. Financial Incentives recorded a mean of 3.85 (SD = 0.74), implying that financial support mechanisms are recognized but not yet widely utilized. Supply Chain Efficiency achieved the highest mean of 4.18 (SD = 0.61), indicating strong agreement that environmental and financial factors enhance operational performance. Lastly, Green Logistics Implementation showed a mean of 3.94 (SD = 0.79), signifying active adoption of eco-friendly logistics practices, albeit with variability in implementation levels among firms. Thus, the SPSS results demonstrate a positive organizational orientation toward sustainability, environmental compliance, and supply chain efficiency within Jordanian SMEs. In addition, the analysis was conducted using SmartPLS 4 software, which provides robust estimates for both measurement validity and the strength of hypothesized relationships. The Smart PLS analysis followed a two-stage approach. First, the measurement model was evaluated to ensure the reliability and validity of the study constructs. This step confirmed that the observed indicators accurately represent their latent constructs, demonstrating internal consistency and convergent validity. Second, the structural model was assessed to test the hypothesized relationships among Environmental Regulations (ER), Financial Incentives (FI), Supply Chain Efficiency (SCE), and Green Logistics Implementation (GLI).

Measurement Model

Figure (2) below illustrates the **measurement model** results generated through SmartPLS, including the indicator loadings, construct relationships, and the explained variance (**R² values**) for the dependent variables.

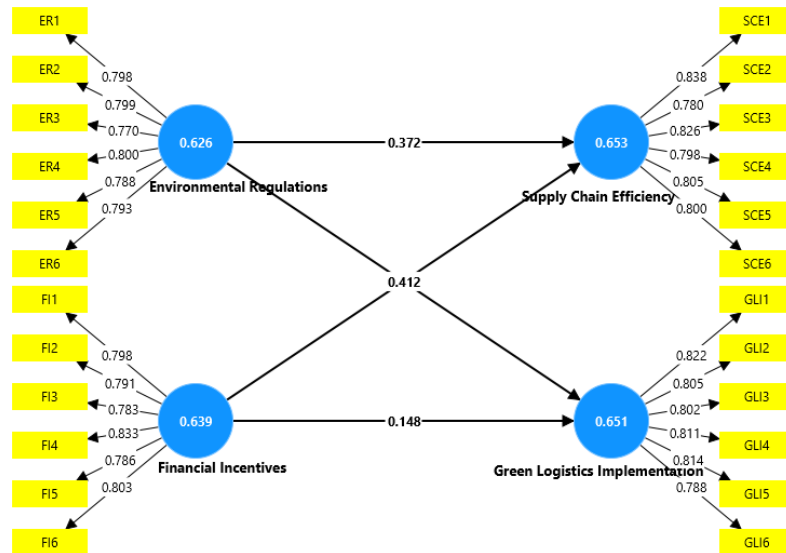


Figure 2. Validity Results.

As depicted in Figure (2) above, all measurement items exhibit **strong outer loadings**, ranging from **0.770 to 0.838**, well above the acceptable threshold of 0.70, which indicates satisfactory **indicator reliability**. Each observed variable (ER1–ER6, FI1–FI6, GLI1–GLI6, and SCE1–SCE6) demonstrates a high correlation with its respective construct, confirming the internal strength of the reflective measurement model. Furthermore, the **path coefficients** demonstrate that both Environmental Regulations and Financial Incentives have positive influences on Green Logistics Implementation and Supply Chain Efficiency. Notably, Environmental Regulations show a relatively stronger effect ($\beta = 0.412$ toward GLI and $\beta = 0.372$ toward SCE), underscoring their critical role in promoting sustainable logistics and operational effectiveness. Table (1) below summarizes the consolidated estimates for core validation metrics, emphasizing the **rigor and consistency** of the measurement factors leveraged for path analysis. The table presents the **Cronbach’s alpha**, **composite reliability (rho_a and rho_c)**, and **Average Variance Extracted (AVE)** values for each construct, which collectively determine the internal consistency and convergent validity of the measurement model.

Table 1. Reliability Testing.

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Environmental Regulations	0.881	0.883	0.909	0.626
Financial Incentives	0.887	0.888	0.914	0.639
Green Logistics Implementation	0.894	0.901	0.918	0.651
Supply Chain Efficiency	0.894	0.895	0.919	0.653

As shown in Table (1), all Cronbach’s alpha values exceed the recommended threshold of 0.70, confirming satisfactory internal consistency reliability for all constructs. Similarly, the composite reliability values (ranging between 0.883 and 0.919) surpass the minimum requirement of 0.70, demonstrating high construct stability and reliability. Moreover, the Average Variance Extracted (AVE) values, which range between 0.626 and 0.653, are all above the benchmark of 0.50. This indicates that more than half of the variance in the indicators is captured by their corresponding constructs, thereby confirming adequate convergent validity. Collectively, these results affirm that the measurement model exhibits excellent psychometric properties, validating its suitability for structural model evaluation.

Structural Model Assessment and Hypothesis Testing

After confirming the reliability, validity, and discriminant integrity of the measurement model, the next analytical stage involves evaluating the structural model to test the hypothesized causal relationships among the study constructs. The structural model assessment aims to determine the predictive power, direction, and significance of the paths linking Environmental Regulations (ER) and Financial Incentives (FI) to Supply Chain Efficiency (SCE) and Green Logistics Implementation (GLI).

This evaluation was carried out using the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach through SmartPLS 4, which is particularly suitable for predictive and exploratory research designs with relatively small to medium sample sizes. The assessment process involves analyzing the path coefficients (β), t-statistics, and p-values derived from a bootstrapping procedure (with 5,000 subsamples) to determine the strength

and statistical significance of the hypothesized relationships. Additionally, the coefficient of determination (R^2) values were examined to assess the model's explanatory power for each endogenous variable, while the effect size (f^2) and predictive relevance (Q^2) were also considered to provide deeper insight into the model's overall performance.

In this context, the structural model provides empirical evidence on how environmental and financial drivers influence both the efficiency and sustainability dimensions of supply chain operations within Jordanian SMEs. The following subsections present the detailed results of the Smart PLS structural analysis, beginning with the discriminant validity assessment and the explanatory power of the model (R^2), followed by the hypothesis testing outcomes for the four proposed relationships (H1–H4).

Before proceeding with hypothesis testing, it was essential to assess the discriminant validity of the constructs included in the structural model. Table (2) below presents the discriminant validity results based on the Fornell–Larcker criterion, demonstrating the distinctiveness of each construct within the model.

Table 2. Discriminant Validity.

	Environmental Regulations	Financial Incentives	Green Logistics Implementation	Logistics Implementation
Financial Incentives	0.628			
Green Logistics Implementation	0.281	0.270		
Supply Chain Efficiency	0.674	0.694	0.263	

As shown in Table (2), the square roots of the Average Variance Extracted (AVE) for each construct (values on the diagonal) are greater than the inter-construct correlations, satisfying the Fornell–Larcker criterion. The inter-construct correlations remain well below the conservative limit of 0.85, confirming that each construct measures a unique conceptual domain. This finding supports discriminant validity, indicating that Environmental Regulations, Financial Incentives, Green Logistics Implementation, and Supply Chain Efficiency are empirically distinguishable within the model. To evaluate the structural relationships proposed in the conceptual model, Figure (3) illustrates the results of the hypothesis testing using PLS-SEM. Figure 3 and Table 3 ahead exhibit the bootstrapping results to enable testing of the postulated relationships.

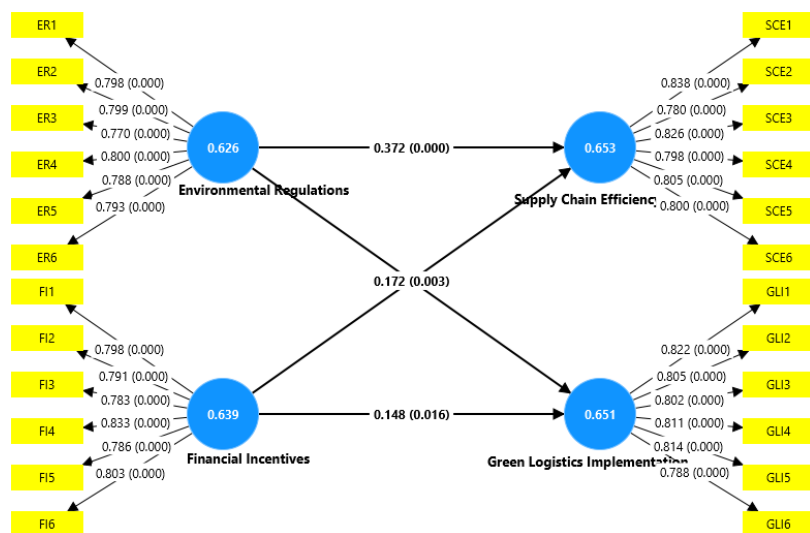


Figure 3. Hypothesis-Results.

Figure (3) visually presents the structural model outcomes derived using Partial Least Squares Structural Equation Modeling (PLS-SEM) through SmartPLS 4. It depicts the hypothesized relationships between the latent constructs: Environmental Regulations (ER) and Financial Incentives (FI) as independent variables, and Supply Chain Efficiency (SCE) and Green Logistics Implementation (GLI) as dependent variables. The model includes standardized path coefficients, indicator loadings, and R^2 values, which represent the proportion of variance explained in the endogenous variables. Specifically, the model explains 65.3% of the variance in supply chain efficiency and 65.1% in green logistics implementation, which indicates a strong explanatory power and validates the structural robustness of the model.

The p-values shown alongside each path indicate the statistical significance of the relationships, suggesting that the hypothesized associations are empirically supported. Overall, the figure provides a clear overview of how regulatory and financial drivers influence both sustainability practices and operational performance within Jordanian SMEs. The specific path coefficients and statistical significance of the hypothesized relationships are

detailed in Table (3) below. The table reports the original path coefficients (O), sample means (M), standard deviations, t-statistics, and p-values for each hypothesized path, derived from a bootstrapping procedure with 5,000 subsamples.

Table 3. Hypothesis Testing Results.

Path	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values
Environmental Regulations -> Green Logistics Implementation	0.172	0.175	0.059	2.943	0.003
Environmental Regulations -> Supply Chain Efficiency	0.372	0.374	0.045	8.199	0.000
Financial Incentives -> Green Logistics Implementation	0.148	0.152	0.061	2.409	0.016
Financial Incentives -> Supply Chain Efficiency	0.412	0.412	0.046	8.911	0.000

The results from Figure (3) and Table (3) collectively confirm the statistical significance of all hypothesized relationships, providing strong support for the conceptual model. Notably, both **Environmental Regulations** and **Financial Incentives** exert positive effects on **Supply Chain Efficiency** and **Green Logistics Implementation**, although the strength of these effects varies across the paths.

To begin with, the relationship between **Environmental Regulations** and **Supply Chain Efficiency** ($\beta = 0.372, p = 0.000$) is both positive and moderately strong, indicating that compliance with environmental policies can drive operational improvements. This may be attributed to the pressure regulations place on firms to optimize resource use, reduce waste, and innovate in their logistics processes. Rather than being perceived solely as constraints, regulations in this context appear to act as catalysts for efficiency gains, aligning with prior studies that advocate for the productive potential of environmental compliance. Conversely, the effect of **Environmental Regulations on Green Logistics Implementation** is statistically significant but weaker in magnitude ($\beta = 0.172, p = 0.003$). This suggests that regulations alone may not be sufficient to fully stimulate the adoption of proactive green logistics practices. Firms might meet the minimum compliance requirements without integrating broader sustainability strategies, particularly if there is limited enforcement or lack of organizational readiness. These findings highlight a potential gap between **regulatory compliance and voluntary environmental innovation**, indicating that additional mechanisms may be needed to bridge this divide.

With regard to financial drivers, **Financial Incentives show the strongest positive impact on Supply Chain Efficiency** ($\beta = 0.412, p = 0.000$). This result underscores the instrumental role of economic support in motivating SMEs to invest in efficiency-enhancing technologies and practices. Financial incentives may ease cost-related barriers and provide the necessary resources for firms to reconfigure their supply chains for better performance. The strength of this relationship suggests that tangible economic benefits serve as a powerful motivator for operational transformation. However, the **effect of Financial Incentives on Green Logistics Implementation**—while significant—is the weakest among the four tested paths ($\beta = 0.148, p = 0.016$). This indicates that while financial support helps, it may not independently drive the adoption of environmentally sustainable logistics practices. Factors such as awareness, infrastructure, and technical capacity may moderate this relationship, implying that **incentives must be complemented by capacity-building efforts and strategic guidance**. Without these, financial aid alone may not result in meaningful green transformations.

Taken together, these findings suggest a nuanced interplay between regulatory pressure and economic facilitation. **Regulations appear to be more effective in triggering compliance-driven efficiency**, whereas **incentives are more influential when firms are pursuing performance-driven improvements**. Yet, both drivers seem to fall short in fully motivating comprehensive green logistics implementation. This emphasizes the need for an **integrated policy framework** that combines regulatory enforcement with financial support, training, and awareness campaigns to encourage a more holistic transition toward sustainable logistics practices in SMEs.

DISCUSSION

The primary objective of this study was to examine how environmental regulations and financial incentives influence both supply chain efficiency and green logistics implementation among Jordanian SMEs. The empirical findings derived from PLS-SEM analysis confirmed the statistical significance of all four hypothesized relationships (H1–H4), offering valuable insights into how regulatory and financial drivers jointly shape sustainable supply chain practices in emerging economies. The following discussion interprets each relationship in light of existing research, highlights points of convergence and divergence, and provides theoretical justification for the observed outcomes.

The results revealed a significant positive relationship between environmental regulations and supply chain efficiency ($\beta = 0.372, p < 0.001$), indicating that regulatory frameworks enhance operational performance and

resource utilization within Jordanian SMEs. This finding aligns with the argument that environmental compliance can drive process optimization rather than impede performance (Qi et al., 2024; Sharma, 2024). In particular, regulations compel firms to improve waste management, energy efficiency, and material utilization—all of which contribute to cost reduction and productivity gains.

This outcome is consistent with prior studies asserting that regulations act as a strategic catalyst for operational excellence, especially when firms adopt a proactive compliance approach (Zhan & Wu, 2024; Metwally et al., 2024). For example, Ningrum et al. (2024) found that environmental mandates in Southeast Asian SMEs triggered the adoption of eco-efficient logistics systems that reduced transportation costs and improved delivery performance. Similarly, Tahan et al. (2024) highlighted that regulation-driven environmental management leads to leaner, more responsive supply chains.

However, the current finding contrasts with earlier studies (e.g., Joo & Hur, 2023) which argued that regulatory constraints may initially impose additional compliance costs, thus dampening short-term efficiency. The divergence can be explained by contextual and temporal factors—Jordanian SMEs, operating under increasing regulatory scrutiny and donor-supported green initiatives, may perceive compliance as both a legal requirement and a competitive opportunity. Thus, regulations in the Jordanian context appear to serve as enabling mechanisms rather than barriers, reinforcing institutional theory's view that formal pressures can yield efficiency-enhancing innovation when supported by adequate enforcement and awareness structures.

The study also found a positive but weaker relationship between environmental regulations and green logistics implementation ($\beta = 0.172$, $p = 0.003$). This suggests that while regulations successfully encourage compliance behaviors, they may not be sufficient to fully stimulate proactive environmental initiatives or comprehensive adoption of green logistics practices. This result resonates with findings by Zaqeeba (2024) and Zobi et al. (2023), who reported that firms often meet only the minimum regulatory requirements rather than integrating sustainability into their logistics strategies. In line with Sharma (2024) and AlZakwani et al. (2025), this study confirms that compliance-oriented behavior dominates in developing economies, where firms often lack the financial and technical capacity to extend beyond basic legal adherence. In contrast, studies conducted in advanced economies such as Zhang et al. (2023) and Qi et al. (2024) found stronger regulatory impacts on green logistics adoption. This discrepancy may be attributed to differences in institutional maturity, enforcement rigor, and access to green technologies. In Jordan, environmental regulations are relatively recent and often fragmented, leading to partial implementation. As such, the weaker coefficient observed here reflects an early-stage regulatory effect, where firms are still transitioning from compliance-based to sustainability-driven operations.

The analysis demonstrated that financial incentives exerted the strongest positive influence on supply chain efficiency ($\beta = 0.412$, $p < 0.001$). This result confirms that financial stimuli, such as tax exemptions, low-interest loans, and government subsidies, play a decisive role in improving supply chain performance. The finding is consistent with prior studies (Al-Zaqeeba et al., 2024; Ibrahim et al., 2025) that emphasized how economic support mechanisms reduce the cost barriers to adopting efficiency-enhancing technologies. Similar results were reported by Ningrum et al. (2024), who found that firms receiving financial support for logistics modernization achieved faster delivery cycles and lower resource consumption. Likewise, Tahan et al. (2024) observed that financial incentives create strategic motivation for SMEs to invest in energy-efficient transport and storage systems, resulting in measurable performance improvements.

The strong impact observed in the current study can be interpreted through the Resource-Based View (RBV), which posits that access to external financial resources enhances firms' internal capabilities to optimize their logistics operations. Jordanian SMEs, which often face liquidity constraints, view financial incentives not merely as support but as *strategic enablers* for modernization and digital transformation of their supply chain processes. Hence, this finding substantiates the idea that economic facilitation, when effectively targeted, transforms financial aid into operational competitiveness.

Lastly, the relationship between financial incentives and green logistics implementation was found to be positive but modest ($\beta = 0.148$, $p = 0.016$). This implies that although financial aid contributes to promoting green logistics, it does not independently guarantee widespread adoption of environmentally sustainable practices. This observation parallels the conclusions of Qi et al. (2024) and Metwally et al. (2024), who noted that while subsidies and financial rewards reduce the financial burden of green investment, firms still require *awareness, training, and technical expertise* to implement green logistics effectively. This relatively weak relationship might reflect the limited institutional diffusion of green finance mechanisms in Jordan, as identified by Sharadgah et al. (2025) and Hazaimh (2025). Many SMEs may not fully understand how to access or utilize available incentives, or may prioritize short-term financial goals over long-term sustainability objectives. In contrast, studies conducted in more developed regulatory environments—such as those by Zhang et al. (2023) and Zhan & Wu (2024)—reported stronger financial-green linkages, primarily due to the structured design of green funding programs and clear governmental accountability frameworks. Therefore, the present result underscores that financial incentives are necessary but not sufficient conditions for the successful implementation of green logistics. Without parallel efforts

in capacity building, stakeholder collaboration, and knowledge transfer, monetary incentives alone may lead to isolated or symbolic initiatives rather than systemic sustainability transformations. From a policy perspective, the finding highlights the need to strengthen the synergy between fiscal measures and environmental policy instruments to maximize the effectiveness of financial programs in advancing green logistics in Jordan.

CONCLUSION

This study set out to examine the influence of environmental regulations and financial incentives on supply chain efficiency and green logistics implementation among small and medium-sized enterprises in Jordan. Using a quantitative research design and PLS-SEM analysis, the study empirically validated four hypothesized relationships (H1–H4), revealing that both regulatory and financial mechanisms play crucial roles in shaping the sustainability and performance of SME supply chains.

The results confirm that environmental regulations exert a significant positive impact on supply chain efficiency, demonstrating that compliance-oriented measures can act as performance catalysts rather than constraints. Regulations appear to drive operational efficiency by compelling firms to optimize resource use and adopt cleaner production and logistics practices. However, their influence on green logistics implementation is comparatively weaker, suggesting that legal compliance alone does not necessarily translate into proactive environmental innovation. Conversely, financial incentives emerged as the strongest predictor of supply chain efficiency, underscoring the importance of economic facilitation in enabling SMEs to invest in modern, efficient, and environmentally responsible operations.

This study contributes to the existing body of knowledge by empirically integrating environmental and financial policy mechanisms within the Sustainable Supply Chain Management (SSCM) framework. It provides empirical validation of the joint influence of institutional pressures and resource-based enablers on supply chain outcomes, expanding the conceptual understanding of how sustainability drivers operate within emerging economies. By highlighting the asymmetry in the effects of environmental regulations and financial incentives, the study offers a nuanced theoretical perspective: while regulations drive compliance and efficiency, financial incentives stimulate innovation and investment. Despite its contributions, the study is not without limitations. First, it focuses exclusively on Jordanian SMEs, which may limit the generalizability of findings to other developing economies with different institutional and economic contexts. Future research should conduct comparative cross-country analyses particularly within the MENA region to explore how variations in regulatory enforcement and financial structures influence green logistics outcomes. Second, the study employed a cross-sectional design, capturing perceptions at a single point in time. Longitudinal studies are recommended to examine the long-term effects of regulatory and financial interventions on supply chain transformation. Additionally, future research may incorporate mediating or moderating variables, such as organizational culture, digitalization, or leadership orientation, to provide a deeper understanding of the mechanisms through which sustainability policies affect performance. Finally, qualitative research could complement the current findings by exploring managers' lived experiences with regulatory compliance and incentive utilization, providing richer insights into behavioral and contextual dynamics influencing sustainable logistics practices.

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