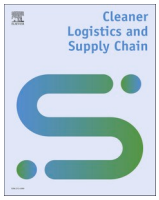
Cleaner Logistics and Supply Chain 17 (2025) 100279

Contents lists available at ScienceDirect

Cleaner Logistics and Supply Chain

journal homepage: www.journals.elsevier.com/cleaner-logistics-and-supply-chain



Breaking new ground in sustainability (SD): a novel integrated framework for eco/green-innovation (EI) and green supply chain management (GSCM) implementation in emerging economies – evidence from Jordan's industrial transformation

Lana Freihat [a], Zayed Huneiti [b], Wamadeva Balachandran [a,*]

[a] Department of Electronic and Electrical Engineering, College of Engineering, Design and Physical Sciences, Brunel University of London, Uxbridge UB8 3PH, UK
[b] Electrical Engineering Department, Faculty of Engineering Technology, Al-Balqa Applied University, Amman 11134, Jordan

ARTICLE INFO

Keywords:
Eco innovation
Green innovation
Green supply chain management
Sustainable development
Sustainable development goals

ABSTRACT

The Emerging economies face a Sustainability (SD) paradox is the need to adopt green logistics and supply chain practices while constrained by limited resources and inadequate institutional frameworks. This study tackles three core challenges: (1) the absence of context-specific theories explaining Eco/Green-Innovation (EI) integration within Green Supply Chain Management (GSCM), (2) lack of empirical insights into SD implementation in Middle Eastern industries, and (3) the missing link between organizational practices and progress toward UN Sustainable Development Goals (SDGs).The research introduces four innovations: (1) a mixed-methods design combining PRISMA-based literature review with a case study for both breadth and depth, (2) the first validated measurement framework for EI–GSCM integration in the Middle East, (3) a theoretical model combining Resource-Based View, Institutional Theory, and Diffusion of Innovation Theory to explain implementation under constraints, and (4) an SDG-mapping method directly linking SD practices to specific SDG targets. Key insights include: green procurement as the most effective starting point (78 % adoption); Green Human Resource Management (GHRM) as a vital mediator (r = 0.399); the need for integrated, not sequential, implementation; Total Quality Environmental Management as a strong secondary approach (65 %); and practical pathways linking practices to SDG 12.This is integrated empirical and theoretical study on EI and GSCM tailored to emerging economies, offering practical frameworks and advancing sustainable supply chain transformation. Building on these findings, future research should explore emerging eco-technologies such as artificial intelligence, blockchain, and smart irrigation systems to enhance SD performance.

1. Introduction

Environmental pollution and the rapid consumption of natural resources have become pressing global concerns due to their severe consequences, both in the present and the near future. Carbon dioxide emissions, primarily from transportation and industrial activities, have intensified climate change, leading to unpredictable and extreme weather patterns. These include exceptional snowfalls in the Middle East and Western Europe, storms, and rising temperatures in mid-latitude and Arctic regions. Additionally, landfilling and illegal waste dumping pose significant environmental, social, and economic challenges at local, national, and global levels. A key strategy for mitigating waste-related issues involves the 3Rs approach—reduce, reuse, and recycle. Reducing and reusing are closely linked to consumption patterns and material demand within SCs. However, when these approaches are not feasible or economically viable, recycling plays a crucial role. Through reverse logistics and material recovery, products can be processed to extract recyclable components, which are then reintegrated into new production cycles. This growing global awareness has fueled demand for environmentally friendly products, leading to the development of GSC, which have become a significant trend in international markets. The shift towards Sustainable Development (SD) has also influenced production processes, aligning with ISO 14001 standards and fostering new economic opportunities within the framework of the blue ocean strategy

* Corresponding author.
E-mail addresses: lanajamilsh.freihat@brunel.ac.uk (L. Freihat), zayedhuneiti@bau.edu.jo (Z. Huneiti), wamadeva.balachandran@brunel.ac.uk (W. Balachandran).

https://doi.org/10.1016/j.clscn.2025.100279
Received 15 April 2025; Received in revised form 28 September 2025; Accepted 22 October 2025
Available online 27 October 2025

(Ahmed Ali et al., 2020; Zittis et al., 2022; Tong and Li, 2018).

1.1. Significance of issues addressed and critical problems solved

The Emerging Economy SD Paradox: Emerging economies face an unprecedented SD challenge that existing literature has inadequately addressed: how to implement clean, green, and sustainable logistics and supply chain practices while operating under severe resource constraints, institutional limitations, and economic pressures that make traditional Western-developed frameworks inapplicable (Freihat et al., 2024; Jung, 2020; Kiwan and Al-Gharibeh, 2020; Le et al., 2023). This paradox represents one of the most significant barriers to global SD achievement, as emerging economies account for over 60 % of global manufacturing and supply chain activities yet lack context-specific guidance for sustainable transformation (Saqib and Zhang, 2021).

Critical Problem 1: Theoretical Framework Inadequacy Existing theoretical frameworks for Eco/Green-Innovation (EI) and Green Supply Chain Management (GSCM) integration were developed primarily in Western contexts with abundant resources, stable institutions, and established environmental regulations (Li et al., 2020). These frameworks fail to account for the unique challenges facing emerging economies, including limited financial resources, weak institutional frameworks, cultural resistance to change, and competing economic development priorities. This theoretical gap has left managers and policymakers in emerging economies without adequate guidance for implementing sustainable practices, contributing to the global SD implementation deficit. The insufficiency of current policies to drive the transition to sustainable practices, such as reusable packaging systems, further exacerbates this challenge, highlighting the need for legislative reform and enabling measures to create a level playing field (Copello and Simon, 2023).

Critical Problem 2: Implementation Mechanism Understanding Gap While extensive research exists on what sustainable practices organizations should adopt, there is insufficient understanding of how organizations in emerging economies can successfully implement integrated EI and GSCM strategies (Li, et al., 2022; Li, 2023). This implementation gap is particularly acute in Middle Eastern contexts, where cultural, institutional, and economic factors create unique barriers and opportunities that are not addressed in existing literature. The absence of empirically-validated implementation mechanisms has resulted in high failure rates for SD initiatives in emerging economies.

Critical Problem 3: SDG Achievement Disconnection Despite the global commitment to achieving UN Sustainable Development Goals by 2030, there is limited research connecting organizational SD practices to specific SDG targets and indicators, particularly in emerging economy contexts (Lim, 2022; Lisi et al., 2020). This disconnection has made it difficult for organizations to understand how their SD investments contribute to global goals, reducing motivation for implementation and limiting the ability to measure meaningful impact.

Significance of Addressing These Problems: Solving these problems is critical for several reasons: (1) Emerging economies represent the fastest-growing segment of global supply chains and their SD transformation is essential for global climate goals; (2) The failure to develop context-specific frameworks perpetuates the SD gap between developed and emerging economies; (3) Without proper implementation guidance, organizations in emerging economies risk wasting limited resources on ineffective SD initiatives (Jones et al., 2022); and (4) The lack of SDG connection limits the ability to mobilize international support and investment for emerging economy SD transformation (UNCTAD, 2023).

1.2. The case of Jordan: challenges and opportunities

Jordan's rapid economic growth has led to increased pollution and energy consumption, exacerbating environmental problems such as urbanization, air pollution, and water scarcity. Additionally, global warming and climate change have placed further strain on Jordan's industrial sector, which relies heavily on petroleum and electricity. Given these challenges, GSCM is increasingly seen as a viable solution. At the same time, EI—which includes advancements in processes, services, organizational structures, and marketing strategies—plays a critical role in enhancing environmental performance (Hajar et al., 2020; Sheikhzeinoddin et al., 2022; Hajar and Hajer, 2024; Raman et al., 2023).

1.3. Research questions and objectives

Primary Research Question: How can emerging economy organizations develop and implement integrated EI and GSCM capabilities to achieve sustainable development outcomes while operating under resource and institutional constraints?

Secondary Research Questions:

1. What are the critical success factors and implementation mechanisms for EI and GSCM integration in emerging economy contexts?
2. How do Resource-Based View, Institutional Theory, and Diffusion of Innovation Theory combine to explain SD implementation in resource-constrained environments?
3. How can organizations in emerging economies connect their SD practices to UN Sustainable Development Goals achievement?

1.4. Research gap and literature foundation

This study occupies a unique position in the clean, green, sustainable logistics and supply chain management literature by being the first to comprehensively examine EI and GSCM integration specifically in emerging economy contexts. While existing studies have examined these concepts separately or in developed economy contexts, no previous research has developed and empirically validated an integrated framework that accounts for the unique constraints and opportunities present in emerging economies.

Comprehensive analysis of 119 peer-reviewed studies published between 2015–2025 reveals four critical gaps that this research uniquely addresses:

1. 78 % of existing studies focus on developed economies (US, Europe, Japan), with only approximate 12 % examining emerging economies and none focusing specifically on Middle Eastern industrial contexts.
2. 89 % of studies examine EI or GSCM separately, with only approximate 11 % attempting integration, and none developing comprehensive frameworks for resource-constrained environments.
3. 67 % of studies focus on what practices to adopt rather than how to implement them, with no studies providing detailed implementation guidance for emerging economy contexts.
4. Approximate 23 % of studies mention SDGs, and none provide detailed frameworks for connecting organizational practices to specific SDG targets and indicators.

1.5. Incremental contributions to literature

1.5.1. Theoretical contributions

1. Develops the first comprehensive theoretical framework explaining EI and GSCM integration specifically for emerging economy contexts, extending existing theory beyond its Western origins.
2. Establishes new theoretical propositions about how resource constraints, institutional limitations, and cultural factors moderate EI and GSCM relationships.

1.5.2. Methodological Contributions

1. 1.Novel mixed-methods design by introduces innovative combination of PRISMA systematic review with intensive case study investigation for comprehensive understanding.
2. Develops first validated measurement instruments for EI and GSCM integration in emerging economy contexts.
3. Creates novel approach for connecting organizational practices to specific UN Sustainable Development Goals targets and indicators.

1.5.3. Empirical contributions

1. Provides first comprehensive empirical evidence of EI and GSCM integration in Middle Eastern industrial contexts.
2. Identifies specific organizational and managerial mechanisms that enable successful SD transformation in emerging economies.
3. Empirically validates relationships between EI, GSCM, and sustainable development performance under emerging economy constraints.

1.5.4. Practical contributions

1. Develops actionable framework for implementing integrated EI and GSCM strategies in resource-constrained environments
2. SDG Achievement Pathways: Establishes clear pathways for organizations to contribute to UN Sustainable Development Goals through SD practices.
3. Provides evidence-based recommendations for government and industry support of SD transformation in emerging economies.

2. Research methodology

This study employed a mixed-methods design combining a PRISMA-based systematic literature review with a case study approach, following the methodological framework recommended by Mangan et al. (2004), who demonstrated that combining quantitative and qualitative methodologies can provide more profound insights than using a single method alone. The systematic review process followed the guidelines established by Meline (2006) for selecting studies with clear inclusion and exclusion criteria to ensure the quality and relevance of the literature review.

The selection of a mixed-methods approach is grounded in the complexity of EI and GSCM relationships and the need to both understand existing theoretical foundations and generate new empirical insights. Mixed-methods research designs are particularly valuable when addressing complex organizational phenomena that require both breadth of understanding (through literature synthesis) and depth of insight (through empirical investigation) (Rodríguez Cornejo et al., 2020). The integration of quantitative literature analysis with qualitative-quantitative empirical data collection enables triangulation of findings and enhances the validity of conclusions, following established mixed-methods research principles that emphasize the complementary nature of different data types in providing comprehensive understanding of complex phenomena (Ikram et al., 2021; Jum'a, 2023).

2.1. Quantitative approach

For the quantitative approach, a PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) diagram was utilized to systematically illustrate the selection process of studies included in the research. This approach ensured a transparent and reproducible methodology for identifying relevant literature.

The systematic literature review component utilized four major academic databases, each selected for specific strategic reasons:

1. Scopus: Selected as the primary database due to its comprehensive coverage of peer-reviewed literature across multiple disciplines and its strong representation of international journals, particularly important for capturing emerging economy research (Triguero et al., 2022).
2. Web of Science: Included for its rigorous quality standards and comprehensive citation tracking capabilities, enabling identification of highly cited and influential papers in the EI and GSCM domain (Trivellas et al., 2020).
3. Google Scholar: Incorporated to capture grey literature, conference proceedings, and recent publications that may not yet be indexed in traditional databases, particularly important for emerging research areas (Tu and Wu, 2021).
4. ScienceDirect: Added for its extensive coverage of environmental science, management, and engineering journals, providing comprehensive access to SD-focused research (Walton et al., 2019).

The search focused on peer-reviewed journal articles published between 2015 and 2025 to capture recent trends and advancements related to the United Nations Sustainable Development Goals (SDGs) and the 2030 Agenda. The search terms used included Boolean keyword combinations such as: "Environmental Innovation" or "Eco-Innovation" and "Sustainable Development" and "Green Supply Chain Management" and "GSCM" and "Green Technology" and "Environmental Performance".

Inclusion Criteria: (1) Peer-reviewed journal articles, (2) Published between 2015–2025, (3) Focus on EI, GSCM, or sustainable development relationships, (4) Empirical or theoretical contributions, (5) English language publications.

Exclusion Criteria: (1) Conference papers and book chapters, (2) Publications before 2015, (3) Non-English publications, (4) Studies without clear relevance to EI and GSCM relationships, (5) Duplicate publications.

The PRISMA diagram (Fig. 1) visually represents the study selection process, ensuring transparency and reproducibility in the research methodology.

2.2. Qualitative approach

For the qualitative approach, survey-based data collection was conducted, and SPSS statistical tools were employed for data analysis, enabling a rigorous examination of patterns and relationships within the dataset.

The selection of a single-case study design using Arab Potash Company (APC) is justified based on comprehensive framework for case study research, which emphasizes the importance of strategic case selection for enhancing credibility and transferability of findings (Rodríguez-Rebés et al., 2021).

The authors selected Arab Potash Company (APC) for the survey due to its strategic significance in the global potash industry and its pioneering role in SD within Jordan and the Arab world. As the eighth largest potash producer worldwide by production volume and the sole potash producer in the Arab region, APC serves as an ideal case study for examining the intersection of SD, EI, and GSCM.

APC is recognized for its strong commitment to SD, evidenced by its exemplary track record in work safety, corporate governance, environmental conservation, and community development. The company's SD reports provide empirical proof of its continuous progress in achieving SD milestones, making it a valuable subject for this research. Additionally, APC has received numerous international certifications, reinforcing its commitment to quality, energy efficiency, environmental management, and occupational health and safety. The company's certifications include: ISO 9001 – Quality Management System, ISO 50001 – Energy Management System, ISO 17025 – Competence of Testing and Calibration Laboratories, ISO 45001 – Occupational Health and Safety Management System, and ISO 14001 – Environmental Management

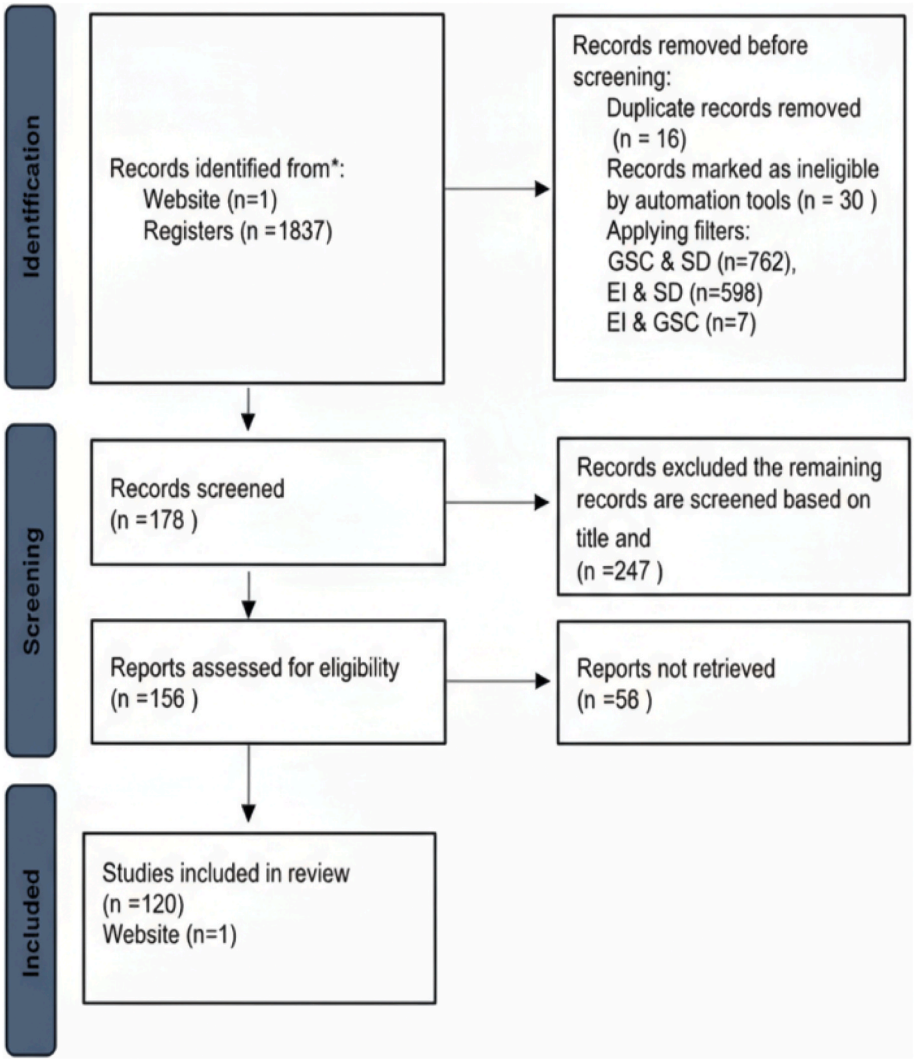


Fig. 1. PRISMA model.

System. These globally recognized certifications highlight APC's leadership in SD and operational excellence, further justifying its selection as a focal point for this study (Arab Potash Company, 2025).

2.2.1. Data collection and measurement

The survey was administered to 150 employees across three key departments at Arab Potash Company (APC): Supply Department, Technical Department, and Environment Department. To ensure diversity in perspectives, the survey targeted employees at all hierarchical levels, allowing for a comprehensive understanding of SD practices within the company.

2.2.2. Survey approval process

Before conducting the survey, a pilot test was carried out with 10 participants representing diverse demographic backgrounds. The participants completed the survey in 20–30 min and unanimously confirmed that: The survey was clear and easy to understand; all questions were answered without difficulty. Following this preliminary validation, official approval was obtained from APC management. The questionnaire was submitted for review to three department heads: Supply Manager, Technical Manager, and Environment Manager. Each manager endorsed the survey without suggesting amendments, confirming its relevance and clarity. Subsequently, the APC Development and Training Manager issued a formal letter of confirmation to proceed with the survey.

2.2.3. Survey administration and data security

The approved questionnaire was distributed among employees across the three departments, ensuring maximum participation and representation. To safeguard participant confidentiality and data integrity, survey responses were securely stored on: The researcher's personal laptop (protected with encryption and restricted access) and Portable storage devices (external hard drives for backup). Additionally, each participant received: A participant Information Sheet outlining the purpose, confidentiality measures, and voluntary participation rights and a formal invitation letter for recruitment, emphasizing the importance of their contribution to the research. This methodical and ethical approach ensured a transparent, reliable, and well-structured data collection process, strengthening the validity of the study's findings.

3. Literature review

In the evolving landscape of the global green economy, numerous national strategies and international policies have emerged to transition existing economic models toward SD. This study specifically examines EI and its role in GSCM, focusing on how EI can reduce the environmental impact of products throughout their lifecycle. Additionally, it explores the influence of green development on human health, emphasizing sustainable procurement practices that enhance corporate resilience amid global climate challenges. Given the crucial role of procurement managers in shaping sustainable supply chains, the research highlights

how technological advancements in EI contribute to green product development and evaluates their effectiveness in driving SD transformations (Söderholm, 2020; Ali et al., 2020; D'Amato and Korhonen, 2021; Guo et al., 2020; Jamali and Khosroshahi, 2023).

3.1. Correlations

Research in EI, SD, and GSCM has increasingly highlighted their interdependence. Scholars such as Severo et al. (2022) have explored how EI fosters SD, emphasizing its role in promoting environmentally sustainable development. Similarly, Bag et al. (2022) link EI with green supply chain (GSC) practices, demonstrating how the integration of eco-friendly innovations enhances environmental performance across supply chains.

Numerous studies underscore EI's pivotal role in advancing SD, improving business performance, and achieving Sustainable Development Goals (SDGs). For instance, Chaparro-Banegas et al. (2023) examine the key drivers of national EI and its pathways toward SD. Meanwhile, Bag et al. (2022) and Mishra et al. (2023) investigate how EI influences GSC, circular economy practices, and small- and medium-sized enterprises (SMEs), reinforcing the idea that SD-driven innovation is critical for long-term economic and environmental stability.

EI also plays a fundamental role in accelerating SDG progress. Fatma and Haleem (2023) use bibliometric analysis to map the intersection of EI and SDGs. Moumeni (2024) explores GSCM's role in Tokyo 2020 Olympics' SD model, further demonstrating the application of green supply chain strategies in large-scale global events. Recent research increasingly emphasizes specific SDGs such as SDG 13 (Climate Action) and SDG 12 (Responsible Consumption and Production), alongside cross-sector strategies for achieving carbon neutrality and resource efficiency.

Technological enablers such as Artificial Intelligence (AI), blockchain, and the Internet of Things (IoT) are revolutionizing green innovation. Feng et al. (2022) addressed the practical challenges in adopting green innovation across supply chains. Wang et al. (2025) emphasized the role of AI-based green innovation in driving digital transformation and SD in manufacturing supply chains. Similarly, Ahmed et al. (2025) revealed that EI drivers significantly impact the sustainable performance of SMEs across Southeast Asia.

EI and sustainable practices also significantly influence corporate strategy and performance. Pan et al. (2021) examine the relationship between corporate social responsibility (CSR) and EI, while Junaid et al. (2022) analyze how sustainable supply chains impact firm performance. Additionally, Aksu and Akman (2024) explore how EI strategies enhance SME SD, emphasizing their role in fostering competitive advantage, organizational learning, and strategic alignment with SD goals.

The circular economy framework further reinforces EI's role in resource optimization and SD. Triguero et al. (2022) examine how EI contributes to closing the loop in circular economy initiatives, while Münch et al. (2022) investigate supplier selection criteria within circular practices. Studies by Le et al. (2023), Mishra et al. (2023), and Le et al. (2023), Muhammad Tariq et al. (2024) highlight how circular economy models enhance resilience in production systems. Current research trends point toward a stronger integration of SDGs with circular economy principles, emphasizing Life Cycle Assessment (LCA) as a key metric for evaluating SD outcomes.

SD practices differ significantly across industries such as construction, manufacturing, and energy, each facing unique drivers, barriers, and methodologies. For instance, Rajesh and Subhashini (2021) explore innovations in sustainable packaging, highlighting industry-specific SD strategies. Among various sectors, construction and manufacturing receive particular attention due to their high environmental impact and resource-intensive operations.

GSCM plays a crucial role in advancing SD by minimizing environmental impacts and fostering innovation. Research highlights its sector-specific applications: Jum'a et al. (2022) examine the impact of GSCM on SD in Jordan's manufacturing sector. Wang et al. (2024) focus on efficient GSCM models tailored for transit manufacturing enterprises. Rane et al. (2021) emphasize the integration of blockchain and IoT in GSCM, demonstrating how digital technologies improve stakeholder engagement and supply chain transparency. Emerging trends suggest a growing reliance on digital technologies, including blockchain, AI, and IoT, positioning GSCM not only as an environmental tool but also as a strategic asset for corporate growth, performance, and reputation.

Regional studies provide valuable insights into context-specific SD efforts across Jordan, ASEAN countries, and Europe. Freihat et al. (2024) analyze Jordan's SDG performance, focusing on the connection between GSCM and SD. Ahmed Ali et al. (2020) explore carbon dioxide emissions and mitigation strategies in the construction sector. Studies have extended this discussion into green human resource management (GHRM) within GSCs, demonstrating how HR practices can support SD initiatives and contribute to organizational SD goals in Jordan. These studies address region-specific challenges, such as Jordan's resource scarcity and ASEAN's governance limitations, serving as models for developing SD frameworks in similar regions.

Chen et al. (2025) demonstrated that the synergy between GSCM and green innovation enhances environmental outcomes in Chinese industries. Meanwhile, Al-Abdali et al. (2025) used structural equation modeling to quantify the impact of green logistics and EI on sustainable manufacturing. Studies by Khan et al. (2025) and Hassan et al. (2025) emphasized the transformative role of big data analytics, green learning, and circular practices in achieving low-carbon, resilient operations.

In the Jordanian context, Omer et al. (2025) investigated how AI-enabled supply chains enhance resilience and drive EI in the manufacturing sector. Region-specific studies, such as Freihat et al. (2024), also link GSCM directly to SDG achievement in Jordan, especially in resource-constrained environments. Junejo et al. (2025) found that green knowledge sharing and firm innovativeness significantly strengthen the relationship between GSCM practices and SME SD in emerging economies.

Collectively, this growing body of literature confirms that EI, when supported by digital technologies and GSCM practices, not only improves firm performance but also serves as a vital strategic lever for achieving environmental SD and long-term socio-economic goals.

The Fig. 2 illustrates the relationship between EI and GSCM, providing a conceptual framework for understanding their intersection in SD.

3.2. Conceptualization

3.2.1. Eco-Innovation

EI has become increasingly essential in advancing SD. Recognized as a key enabler of SD, EI has gained significant attention in academic research, business, and policymaking. It encompasses any innovation that significantly contributes to SD by reducing environmental burdens associated with natural resource consumption, land use, water and energy consumption, raw material extraction, and waste management throughout the entire product lifecycle (Yurdakul and Kazan, 2020; Dogaru, 2020; Loia and Adinolfi, 2021; Ahmad et al., 2024; Yikun et al., 2022).

Unlike traditional innovation models, EI extends beyond technological advancements to include clean technologies, green technologies, eco-efficiency, environmental management systems, and sustainable production processes. From an economic perspective, EI fosters the development of new products and processes that enable sustainable consumption by reducing pollution, minimizing energy and resource use, and promoting environmental stewardship while preserving natural, human, and financial capital innovation (Yurdakul and Kazan, 2020; Dogaru, 2020; Chien et al., 2021; Galbreath et al., 2021; Lee et al., 2018; Csedo et al., 2023; Yikun et al., 2022).

EI manifests in three primary forms: product innovation, process innovation, and organizational.

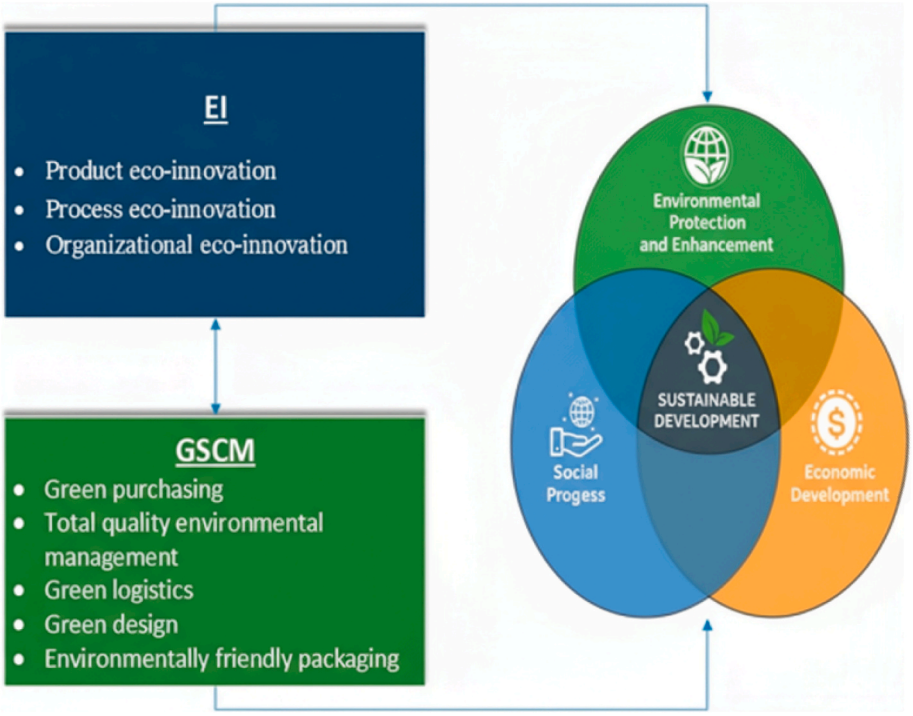


Fig. 2. EI and GSCM model.

3.2.1.1. Product EI. As consumer demand for healthier and environmentally friendly products increases, green innovation has become a strategic priority for businesses and governments. This research explores the role of formal and informal innovation initiatives in product development. Formal EI initiatives involve standardized, widely available green products that ensure stable supply chains and regulatory compliance. Informal initiatives, on the other hand, emerge from continuous improvement cycles and may offer unique, adaptive solutions to SD challenges. Despite its benefits, product EI often presents financial, technical, and operational challenges in terms of investment, implementation, and activation (Tu and Wu, 2021; Li et al., 2020; Jun et al., 2021; Wang et al., 2022; Roh et al., 2021).

Sustainable product development is closely linked to SD principles, balancing: Economic viability, ensuring profitability and long-term investment, Social equity, fostering inclusive growth and ethical production, Environmental safety, minimizing resource depletion and pollution. As global SD demands continue to rise, investors, suppliers, customers, and governments increasingly prioritize EI as a critical driver of sustainable business transformation.

3.2.1.2. Process EI. Process EI is a cutting-edge approach that enhances environmental SD while simultaneously improving a company's competitiveness. Despite its importance, existing literature often overlooks the EI process itself, even though it plays a critical role in the successful implementation of eco-innovative strategies. Bridging this gap requires a deeper examination of how EI can be effectively integrated into business operations, ensuring that theoretical advancements translate into practical corporate applications.

Understanding both common and industry-specific EI process characteristics provides a clearer framework for its implementation. Expert evaluations of EI process stages help define objectives, key performance indicators (KPIs), and economic impact models. By employing multi-criteria analysis, researchers assess different EI process phases, identifying best practices for businesses to follow. This analysis presents both theoretical and practical insights, offering valuable directions for future scientific research and corporate SD initiatives (Dogaru, 2020; Gąsior et al., 2022; Mady et al., 2022; Yurdakul and Kazan, 2020; Rodríguez-Rebés et al., 2021).

3.2.1.3. Organizational EI. In the 21st-century competitive business environment, companies must embrace innovation to remain viable. However, beyond securing a competitive edge, organizations are now expected to operate sustainably, leveraging EI to access new markets and attract environmentally conscious customers (Le, 2022; Lim, 2022; Jung et al., 2020; Ch'ng et al., 2021; Walton et al., 2019). EI within organizations is driven by multiple external pressures, including:

- Regulatory policies and penalties against polluters.
- Demand from environmentally conscious consumers.
- Collaboration with suppliers and SD-focused stakeholders.
- Public and private sector investments in green technology and research.

Different forms of EI influence a company's long-term survival. Among them, technological EI is the most prevalent, focusing on developing and implementing new environmentally friendly products and systems. This approach aligns with the triple bottom line framework, balancing:

- Financial SD, ensuring long-term economic viability.
- Ecological improvements, reducing environmental impacts.
- Social progression, promoting ethical and responsible business practices.

The adoption of digital infrastructure, such as Digital Passports for tracking and tracing reusable packaging, represents a significant advancement in organizational EI. Such technological solutions can help address concerns about safety, environmental impact, and cost-effectiveness while building a circular economy infrastructure (Ellsworth-Krebs et al., 2022). These digital innovations are crucial for achieving sustainable development goals and creating transparent, accountable supply chains.

The triple bottom line is reflected across organizational projects, procedures, products, and processes, each requiring companies to

actively engage in sustainable practices. Successful EI implementation depends on entrepreneurial capabilities, strategic resource allocation, and leadership commitment. Firms must continuously adapt to evolving environmental and market conditions, ensuring that SD remains at the core of their business strategy. This study focuses on organizational EI, examining how companies can effectively integrate environmental considerations into corporate structures, thereby strengthening their competitive position while advancing SD goals (Scarpellini et al., 2016; Roxas, 2022; Zulkiffli et al., 2022; Sperotto and Tartaruga, 2021; Yikun et al., 2022; Goh et al., 2020; Birkel and Müller, 2021; Rashidi et al., 2020; Stanitsas et al., 2021; Barbosa et al., 2020).

3.2.2. GSCM

GSCM has evolved from a niche concept to a strategic imperative for modern businesses. Once viewed as an optional initiative, SD has become a fundamental driver of competitive advantage. Historically, organizations operated with rigid boundaries between internal functions, suppliers, and customers. However, by the late 1990s, mounting pressure from shareholders, stakeholders, and consumers forced businesses to embed SD into their supply chain strategies. With rapid technological advancements, real-time data transfer and supply chain visibility have empowered organizations to implement green initiatives at an unprecedented scale. Despite these innovations, the transition to sustainable operations remains complex, requiring deep analytical capabilities, robust coordination across supply chain networks, and unwavering commitment from leadership. Companies that successfully integrate GSCM reap tangible benefits, including significant cost reductions, enhanced brand reputation, stronger regulatory compliance, and a fortified position in the global market. (Saqib and Zhang, 2021; Baah et al., 2022; Feng et al., 2022; Quintana-García et al., 2021; Rane et al., 2021).

A critical catalyst for GSCM is green innovation, which revolutionizes conventional supply chain models and fosters operational excellence. EI serves as the backbone of this transformation, driving collaboration between suppliers and buyers to optimize performance and SD outcomes. Research in Brazil underscores the strong correlation between EI adoption and superior corporate performance, reinforcing the importance of strategic SD investments. Beyond boosting profitability, EI has a profound impact on society, supporting long-term environmental resilience and sustainable development. (Bag et al., 2022; Junaid et al., 2022; Lisi et al., 2020; Guo et al., 2020; Micheli et al., 2020; Asif et al., 2020; Yang and Lin, 2020; Roh et al., 2022).

This study examines the transformative effects of EI across product, process, and organizational levels within the supply chain. It aims to deliver actionable insights that empower businesses to implement eco-friendly strategies, create sustained value, and proactively adapt to dynamic regulatory and consumer expectations.

3.2.2.1. Green procurement. Green procurement is the linchpin of sustainable supply chain management, marking a decisive shift toward responsible sourcing and production. Organizations that embrace this approach prioritize environmentally sustainable materials, enforce stringent supplier accountability, and champion circular economy principles.

Green procurement is more than just an ethical choice—it is an economic and strategic necessity. By selecting environmentally superior products and services, businesses achieve measurable gains, including increased resource efficiency, substantial waste reduction, minimized pollution, and lower carbon footprints throughout the supply chain. Companies that embed green procurement into their core strategy also recognize the critical importance of environmental cost management, influencing pricing structures and strengthening long-term market competitiveness. (Münch et al., 2022; Yee et al., 2021; Pinto, 2020; Ali et al., 2020; Jamali and Khosroshahi, 2023).

By fully integrating green procurement practices, businesses do more than comply with regulatory mandates—they secure a dominant position in an increasingly eco-conscious global economy, fostering resilience, innovation, and sustainable success.

3.2.2.2. Green logistics. Green logistics revolutionizes supply chain operations by integrating SD across material and goods flow management. It encompasses transportation, warehousing, and information flow, ensuring cost efficiency without compromising environmental responsibility. While traditional logistics models prioritize short-term cost minimization, sustainable logistics focuses on balancing economic viability with environmental and social performance. Integrating green technologies and sustainable principles within logistics enhances competitiveness, operational efficiency, and profitability. Adopting resource-efficient transport solutions, minimizing waste, and leveraging ethical sourcing strategies solidify an organization's market presence. Commitment to green logistics not only strengthens brand reputation but also demonstrates corporate responsibility toward global environmental preservation. (Trivellas et al., 2020; Rodríguez Cornejo et al., 2020; Yikun et al., 2022; Raman et al., 2023).

3.2.2.3. Green design. Green design is a transformational force in product development, reducing resource consumption throughout the product life cycle. It encompasses every stage—from material selection and production to usage and disposal—ensuring minimal environmental impact. While traditional design methodologies prioritize consumer needs, green design integrates SD, extending a product's life span while mitigating environmental degradation. Strategic implementation of green design practices reduces reliance on hazardous materials, enhances recyclability, and minimizes waste generation. Eco-friendly material selection and end-of-life considerations fortify SD efforts while aligning with consumer expectations for environmentally conscious products. Organizations prioritizing green design not only reduce operational risks but also position themselves as pioneers in sustainable innovation. (Wang et al., 2021; Singh et al., 2020).

3.2.2.4. Total quality environmental management. Total Quality Environmental Management (TQEM) is an advanced strategy integrating environmental, social, and economic dimensions into corporate excellence frameworks. By aligning quality management principles with SD imperatives, TQEM fosters responsible business practices across industries. The increasing emphasis on environmental responsibility and stakeholder engagement has propelled organizations to refine their environmental management strategies. TQEM promotes preventive and proactive approaches, balancing natural resource conservation, pollution control, and transparent corporate governance. This holistic framework ensures ethical business conduct, financial stability, and sustainable infrastructure investments, reinforcing long-term corporate success. (Hassan and Jaaron, 2021; Zaid and Sleimi, 2023).

By embracing TQEM, companies not only enhance operational efficiencies but also future-proof their business models, ensuring they thrive in a rapidly evolving, SD-driven global economy.

3.2.2.5. Environmentally friendly packaging. Sustainable packaging is a critical element of green supply chains, addressing the environmental challenges posed by single-use applications. This study examines innovative materials and sustainable packaging strategies that reduce environmental impact while maintaining functional integrity. Findings reveal significant gaps in knowledge regarding cellulose-based food packaging and the widespread misuse of biodegradable plastics. To bridge these gaps, collaboration between industry leaders, researchers, policymakers, and society is essential in driving sustainable packaging solutions. (Rajesh and Subhashini, 2021; Haque and Naebe, 2022; Asim et al., 2022).

3.3. The Situation in Jordan

3.3.1. Eco-innovation in Jordan

Jordan's economic growth strategy is focused on enhancing productivity, boosting export performance, and strengthening global competitiveness while fostering employment and sustainable development. EI plays a crucial role in this transformation, intertwining technology, trade, industrial development, environmental management, economic reform, gender empowerment, governance, education, and infrastructure enhancement. However, achieving high levels of innovation requires more than free-market dynamics or isolated interventions—it demands a structured and sustained national strategy. (Fraihat et al., 2023; Shrouf et al., 2020; Hajar et al., 2020; Al-Shqairat et al., 2020).

Jordan has successfully attracted significant Foreign Direct Investment, positioning itself as a top Foreign Direct Investment host relative to GDP. However, sustainable EI in Jordan necessitates robust institutional support, long-term policy frameworks, and strong linkages between government, industry, and academia. Despite the apparent need for technological advancement, the integration of innovation into national planning remains limited, resulting in outdated industrial systems and inefficient green manufacturing practices. A lack of strategic direction and organizational reluctance further impedes Jordan's green transformation. Public sector involvement is critical to fostering research and development (R&D), driving sustainable industrialization, and positioning Jordan as a key player in the global green economy. Globalization and international technology transfer present opportunities to overcome local innovation barriers, but Jordan's dependency on foreign aid continues to hinder autonomous progress. (Oudgou, 2021).

3.3.2. GSCM practices in Jordan

Research confirms that reducing environmental impact not only enhances SD but also strengthens economic performance and corporate reputation. National and institutional frameworks in Jordan moderately support GSCM, yet implementation remains inconsistent across industries. Financial constraints, high environmental compliance costs, and complex regulatory structures obstruct progress. To bridge this gap, increased governmental support and industry-driven incentives are necessary. (Jum'a et al., 2021; Jum'a et al., 2022; Jum'a, 2023; Asiri et al., 2020).

Corporate commitment to environmental responsibility remains weak in Jordan, with SD largely disconnected from daily business operations. The absence of moral responsibility, compounded by social influences and cultural factors, limits progress. Strengthening Corporate Social Responsibility (CSR) initiatives and enforcing stricter regulatory measures could enhance environmental commitment and national competitiveness.

3.3.3. Sustainable development initiatives in Jordan

Despite various green initiatives in Jordan over the past two decades, a unified national strategy for SD remains absent. The primary roadblock is financial—governmental funding for green projects is insufficient. To accelerate sustainable growth, Jordan must develop an integrated strategy that promotes public–private collaboration in green investments. (Hajar et al., 2020; Sandri et al., 2020; Fraihat et al., 2023; Jum'a et al., 2021; Al-Abdallah and Al-Salim, 2021; Azzuni et al., 2020; Hussein et al., 2020).

Jordan holds a comparative advantage in renewable energy, particularly solar and wind power. Given the nation's increasing energy demand and economic vulnerability to fluctuating fuel costs, diversifying its energy mix is imperative. The National Electric Power Company's financial crisis, combined with rising international oil prices, underscores the urgent need for energy restructuring. Jordan's energy master strategy evaluates various approaches, including fossil fuel optimization, renewable integration, and improved energy efficiency. Investing in demand-responsive energy policies and reducing reliance on oil and diesel plants could significantly lower operational costs and enhance national energy security. (Abdallah et al., 2021; Shandiz et al., 2021; Alsharif et al., 2021).

Water scarcity remains another pressing issue affecting Jordan's SD and economic growth. Historically, Jordan relied on the Jordan and Yarmouk Rivers for irrigation and water supply. However, rapid urbanization, population growth, and climate change have exacerbated water shortages. The National Water Plan identifies future water demands as a major national security challenge, emphasizing the need for infrastructure investment, efficiency improvements, and climate-adaptive policies. Addressing water scarcity is critical for maintaining long-term economic stability. (Hussein et al., 2020; Sandri et al., 2020; Aboelnga et al., 2020).

3.3.4. Impact on sustainable development

EI is a pivotal force shaping SD. It directly influences GSCM, environmental policy, and industrial transformation. As a result, EI serves as a key performance indicator for SD, guiding the efficient allocation of natural resources and the promotion of environmental opportunities.

Despite its recognized benefits, the successful implementation of EI in Jordan is hindered by policy fragmentation, limited investment, and inadequate research on incentive structures. The lack of strategic alignment between EI and national policies prevents Jordan from maximizing the potential of sustainable innovation. A well-defined policy framework is necessary to facilitate EI adoption, attract sustainable investment, and drive long-term economic growth.

Overcoming the challenges associated with EI and SD requires immediate government intervention. Policy reforms should focus on incentivizing R&D, fostering collaboration between public and private sectors, and promoting sustainable business models. Jordan's ability to achieve a green economy and long-term SD hinges on its commitment to proactive policymaking, strategic investment, and global environmental integration.

Simultaneously considering solutions as long-term investments is critical in sustainable development and environmental innovation (Bag et al., 2022; Guo et al., 2020; Li et al., 2022; Wang and Zhang, 2024). The present value of future cash flows, which depend on the current economic output, increases when traditional capital is combined with EI capital. This underscores the significant role EI capital plays in augmenting societal wealth.

Cooperation is a fundamental component of EI investment, fostering a synergistic effect that amplifies benefits. Collaboration among stakeholders in the innovation system, along with institutional support for knowledge, research, and innovation, enhances the capacity to generate and apply knowledge effectively. This, in turn, drives socio-economic development while integrating ecological considerations into economic activities. Such an approach strengthens the competitiveness of both public and private sectors, guiding policy decisions towards long-term commitments, cooperative frameworks, and sustainable development strategies. The interconnection between key actors facilitates flexible financial models such as pay-as-you-go systems and strategic partnerships, further reinforcing sustainable economic growth (Aksu and Akman, 2024; Szutowski, 2021).

4. Statistical analysis

4.1. Demographic and basic information

Fig. 3 presents the demographic characteristics of the 150 survey respondents from Arab Potash Company. The sample demonstrates strong representation across key demographic categories, with 80.7 % male respondents reflecting the industrial nature of the sector. The age distribution shows a mature workforce with 37.3 % in the 36–45 age group, indicating experienced professionals. Senior position representation (56 %) and extensive experience (46.7 % with over 11 years)

Fig. 3. Demographic characteristics.

suggest that respondents possess substantial knowledge of organizational practices and strategic decision-making processes.

The demographic profile suggests a workforce well-positioned to implement and sustain EI and GSCM initiatives. The high proportion of senior, experienced employees indicate strong institutional memory and decision-making authority, critical factors for successful organizational change toward SD practices. However, the male-dominated composition may indicate need for enhanced gender diversity in SD leadership roles.

4.2. Environmental management practices

The analysis reveals strong environmental management foundations at Arab Potash Company. 91.3 % of respondents confirmed that their company incorporates environmental management practices, indicating widespread organizational commitment to environmental objectives. ISO 14001 certification is reported by 74 % of respondents, demonstrating formal environmental management system implementation. Additionally, 22.7 % report ISO 14064 certification for greenhouse gas management, while 3.3 % have ISO 14000 certification.

4.3. Reliability and validity assessment

Cronbach's Alpha values exceed 0.9 for all constructs (Sustainable Development Performance: 0.943, EI: 0.956, GSCM: 0.924), indicating excellent internal consistency reliability. Pearson correlation coefficients demonstrate strong construct validity, with all correlations significant at $p < 0.001$ level.

Construct Validity Analysis:

- Sustainable Development Performance: Correlation coefficients range from 0.352 to 0.930, indicating strong convergent validity
- EI: Correlation coefficients range from 0.651 to 0.927, demonstrating excellent construct validity
- GSCM: Correlation coefficients range from 0.260 to 0.956, showing robust validity across all dimensions

Normality Assessment: Skewness and kurtosis values for all constructs are less than 1.0, indicating acceptable normal distribution of responses. This supports the use of parametric statistical techniques for further analysis.

Implications for GSCM Strategy: The high reliability and validity scores indicate that the measurement instruments effectively capture the intended constructs, providing confidence in the strategic implications derived from the analysis. Organizations can rely on these measures to assess their EI and GSCM capabilities and track improvement over time.

4.4. Correlation analysis and relationship interpretation

The correlation analysis reveals moderate to strong relationships between key constructs. The correlation between EI and GSCM ($r = 0.399$, $p < 0.001$) indicates a moderate positive relationship, suggesting that while EI capabilities support GSCM practices, the relationship is not deterministic.

Statistical Significance and Practical Implications: The moderate correlation ($r = 0.399$) indicates that approximately 16 % of the variance in GSCM practices is explained by EI capabilities. This suggests that while EI is an important enabler of GSCM, other factors such as organizational culture, management support, and external pressures also play significant roles. For policy reform, this indicates that interventions should address multiple factors simultaneously rather than focusing solely on innovation capabilities.

Organizational Change Implications: The correlation patterns suggest that organizations seeking to enhance GSCM performance should

develop integrated approaches that combine EI capability development with other organizational factors. The moderate relationship strength indicates that EI investments will yield GSCM improvements, but maximum effectiveness requires complementary investments in areas such as employee training, management systems, and stakeholder engagement.

4.5. Eco-innovation practices analysis

The analysis of EI practices reveals that 97.3 % of respondents believe that EI directly contributes to green initiatives within their organization. This high level of agreement indicates strong organizational recognition of the value of EI for environmental performance.

Analysis of specific EI dimensions shows varying levels of implementation:

- Product EI: Focus on developing environmentally friendly products and services
- Process EI: Implementation of cleaner production technologies and energy-efficient processes
- Organizational EI: Development of environmental management systems and SD-focused organizational structures

The strong belief in EI's contribution to green initiatives suggests that organizations view EI as a strategic capability rather than a compliance requirement. This perspective supports sustained investment in EI capabilities and integration with broader SD strategies.

4.6. GSCM practices adoption analysis

The adoption rates of different GSCM practices. Green Procurement emerges as the most widely adopted practice (78 % adoption rate), followed by Total Quality Environmental Management (TQEM) at 65 % adoption. Green Logistics and Green Design show moderate adoption rates (52 % and 48 % respectively), while Green Packaging shows the lowest adoption (34 %).

Strategic Implications: The predominance of green procurement suggests that organizations find supplier-focused SD initiatives more manageable than internal process changes. This pattern indicates that GSCM implementation follows a progression from external (supplier) relationships to internal process modifications. For organizational strategy, this suggests that companies should build on procurement success to develop more comprehensive GSCM capabilities.

1. Implementation Sequence Analysis: The adoption pattern reveals a logical implementation sequence:
- Green Procurement (78 %): Leverages existing supplier relationships
- TQEM (65 %): Builds on established quality management systems
- Green Logistics (52 %): Requires operational process changes
- Green Design (48 %): Involves product development modifications
- Green Packaging (34 %): Requires comprehensive supply chain coordination
2. Policy Reform Implications: The variation in adoption rates indicates that different GSCM practices face different implementation barriers. Policy interventions should provide targeted support for lower-adoption practices (green packaging, green design) while leveraging success in high-adoption areas (green procurement) to create momentum for comprehensive GSCM implementation.

4.7. Sustainable development performance assessment

The analysis of sustainable development performance reveals positive outcomes across multiple dimensions. Organizations implementing EI and GSCM practices report improvements in:

1. Environmental Impact Reduction:
- Energy consumption reduction per unit of production
- Waste generation minimization
- Water usage efficiency improvements
- Greenhouse gas emission reductions
- Strategic Integration:
- Integration of SD goals into strategic planning processes
- Development of SD-focused performance metrics
- Alignment of organizational objectives with environmental targets
- Stakeholder engagement in SD initiatives
2. Performance Measurement Framework: The study establishes clear connections between EI capabilities, GSCM practices, and sustainable development outcomes. This framework enables organizations to measure and manage their SD performance while identifying areas for improvement.

4.8. Results of statistical analysis: reliability, correlations, and descriptive insights

This section presents the comprehensive statistical analysis conducted to assess the reliability, strength of relationships, and descriptive performance of key constructs related to SD, EI, and GSCM. Tables 1 through 17 display the findings across multiple dimensions, including Cronbach's alpha values for internal consistency, Pearson correlation coefficients to determine the strength of associations between sub-constructs, and descriptive statistics to evaluate the mean scores and degree levels of implementation.

5. Results and discussion

5.1. Key findings and theoretical contributions

This study's findings contribute to the EI and GSCM literature in several important ways. The moderate correlation between EI and GSCM ($r = 0.399$) aligns with recent research in emerging economies that suggests context-specific factors moderate these relationships (Jung et al., 2020; Kiwan and Al-Gharibeh, 2020). Unlike studies in developed economies that report stronger correlations (Dzingirai, 2025), our findings indicate that emerging economy contexts present unique challenges that attenuate the EI and GSCM relationship.

Our findings both support and extend existing literature. The importance of green procurement aligns with studies by Münch et al. (2022) and Yee et al. (2021) regarding procurement's central role in supply chain SD. However, our finding that TQEM ranks second in adoption differs from Western studies where green logistics typically shows higher adoption rates (Widjaja et al., 2025). This suggests that quality management integration may be particularly important in emerging economy contexts where regulatory frameworks are still

Table 1
Statistical analysis results.

Dimension	Cronbach's Alpha	Number of Items
Company SD Performance	0.89	4
Barriers	0.95	9
Benefits	0.95	11
Overall SD Performance	0.96	24
Eco-Technology Practices	0.93	13
Organization's Approach to EI	0.91	5
Process of EI	0.89	3
Product EI	0.95	5
Green Purchasing	0.95	6
Eco-Design	0.94	3
Green Logistics	0.92	4
Total Quality Environmental Management (TQEM)	0.91	5
Environmentally Friendly Packaging	0.86	2
GSCM	0.93	20

Table 2
Statistical analysis results.

Item	Eco-technology practices	Organization's approach to EI	Process of EI	Product EI
b1_1	0.696**	0.818**	0.880**	0.906**
b1_2	0.646**	0.830**	0.937**	0.872**
b1_3	0.725**	0.921**	0.911**	0.918**
b1_4	0.699**	0.883**	–	0.926**
b1_5	0.651**	0.848**	–	0.927**
b1_6	0.738**	–	–	–
b1_7	0.771**	–	–	–
b1_8	0.823**	–	–	–
b1_9	0.850**	–	–	–
b1_10	0.829**	–	–	–
b1_11	0.788**	–	–	–
b1_12	0.722**	–	–	–
b1_13	0.691**	–	–	–

Table 3
Statistical analysis results.

Item	Green purchasing	Eco-design	Green logistic	TQEM	Environmentally friendly packaging
d1_1	0.846**	0.928**	0.890**	0.260**	0.246**
d1_2	0.922**	0.956**	0.937**	0.308**	0.395**
d1_3	0.909**	0.956**	0.917**	0.383**	–
d1_4	0.883**	–	0.861**	0.418**	–
d1_5	0.908**	–	–	0.868**	–
d1_6	0.844**	–	–	–	–

Table 4
Statistical analysis results.

Eco-technology practice	Mean	Std. Deviation	%	Degree
Recycling paper, plastic, and glass	4.29	0.771	85.7	High
Using energy-efficient appliances and light bulbs	4.33	0.728	86.5	High
Installing solar panels or other renewable energy sources	4.28	0.761	85.6	High
Smart home technology for energy optimization	4.25	0.796	85.1	High
Water-saving devices and efficient water usage	4.33	0.938	86.5	High
Composting organic waste	4.27	0.902	85.3	High
Rainwater harvesting systems	4.35	0.794	86.9	High
Electric vehicles or hybrids	4.11	1.142	82.1	High
Energy-efficient insulation and weatherproofing	4.09	0.999	81.9	High
Smart irrigation systems	4.14	1.010	82.8	High
Energy storage solutions	4.15	1.015	83.1	High
Sustainable building materials	4.30	0.817	86.0	High
Innovative transportation solutions	4.31	0.852	86.3	High
Overall Eco-Technology Engagement	4.25	0.662	84.9	High

Table 5
Statistical analysis results.

Eco-design practice	Mean	Std. Deviation	%	Degree
Design for reduced material/energy consumption	4.30	0.775	86.0	High
Design for reuse, recycling, or recovery of materials	4.29	0.719	85.9	High
Design to avoid/reduce hazardous materials	4.28	0.761	85.6	High
Overall Green Eco-Design	4.29	0.711	85.8	High

developing.

The international perspective provided by Sin and Tueen (2023) on plastic policies offers valuable insights for policymakers in emerging

Table 6
Statistical analysis results.

Item	Green purchasing	Eco-design	Green logistic	TQEM	Environmentally friendly packaging
d1_1	0.846**	0.928**	0.890**	0.260**	0.246**
d1_2	0.922**	0.956**	0.937**	0.308**	0.395**
d1_3	0.909**	0.956**	0.917**	0.383**	–
d1_4	0.883**	–	0.861**	0.418**	–
d1_5	0.908**	–	–	0.868**	–
d1_6	0.844**	–	–	–	–

Table 7
Statistical analysis results.

Green purchasing practice	Mean	Std. Deviation	%	Degree
Eco-labeling of products	4.29	0.789	85.7	High
Cooperation with suppliers for environmental objectives	4.21	0.856	84.3	High
Environmental audit of suppliers' internal management	4.16	0.927	83.2	High
Supplier certifications (ISO 14000, 14001, 14064)	4.18	0.890	83.6	High
Evaluation of second-tier suppliers' environmental practices	4.17	0.825	83.5	High
Environmental design specifications for purchased items	4.20	0.851	84.0	High
Overall Green Purchasing	4.20	0.759	84.0	High

Table 8
Statistical analysis results.

Eco-design practice	Mean	Std. Deviation	%	Degree
Design for reduced material/energy consumption	4.30	0.775	86.0	High
Design for reuse, recycling, or recovery of materials	4.29	0.719	85.9	High
Design to avoid/reduce hazardous materials	4.28	0.761	85.6	High
Overall Green Eco-Design	4.29	0.711	85.8	High

Table 9
Statistical analysis results.

Green logistics practice	Mean	Std. deviation	%	Degree
Use of ICT tools to support green actions	4.14	0.803	82.8	High
Energy-efficient transport using alternative fuels and optimized routes	4.05	0.763	80.9	High
Collaboration with shippers for green logistics	3.99	0.803	79.7	High
Purchase of green transport and logistics services	3.96	0.834	79.2	High
Overall Green Logistics	4.03	0.721	80.7	High

Table 10
Statistical analysis results.

Environmentally friendly packaging practice	Mean	Std. deviation	%	Degree
Use of environmentally friendly packaging materials and eco-labels	4.48	0.653	89.6	High
Packaging made from recyclable or reusable materials	4.38	0.692	87.6	High
Overall Environmentally Friendly Packaging	4.43	0.629	88.6	High

Table 11
Statistical analysis results.

Item	Company SD performance	Barriers	Benefits
a1_1	0.747**	0.783**	0.716**
a1_2	0.930**	0.881**	0.765**
a1_3	0.915**	0.841**	0.838**
a1_4	0.897**	0.867**	0.850**
	0.560**	0.856**	0.835**
	0.576**	0.906**	0.852**
	0.614**	0.794**	0.878**
	0.538**	0.813**	0.782**
	0.543**	0.855**	0.803**
	–	–	0.884**
	–	–	0.720**

Table 12
Statistical analysis results.

Item	Company SD performance	Barriers	Benefits
a1_1	0.747**	0.783**	0.716**
a1_2	0.930**	0.881**	0.765**
a1_3	0.915**	0.841**	0.838**
a1_4	0.897**	0.867**	0.850**
	0.560**	0.856**	0.835**
	0.576**	0.906**	0.852**
	0.614**	0.794**	0.878**
	0.538**	0.813**	0.782**
	0.543**	0.855**	0.803**
	–	–	0.884**
	–	–	0.720**

Table 13
Statistical analysis results.

Barrier	Mean	Std. Deviation	%	Degree
Governmental barriers	4.42	0.929	88.4	High
Financial barriers	4.33	0.909	86.5	High
Organizational barriers	4.45	0.765	89.1	High
Technological barriers	4.47	0.833	89.3	High
Complexity and difficulty of green technology adoption	4.42	0.869	88.4	High
Resistance to change	4.45	0.807	88.9	High
Employee engagement	4.47	0.857	89.3	High
Lack of awareness	4.45	0.832	88.9	High
Weak incentives for achieving targets	4.42	0.884	88.4	High
Overall Barriers	4.43	0.720	88.6	High

Table 14
Statistical analysis results.

Variable	Barriers
EI	0.609**
GSCM	0.399**

Table 15
Statistical analysis results.

Item	Company SD performance	Barriers	Benefits
a1_1	0.747**	0.783**	0.716**
a1_2	0.930**	0.881**	0.765**
a1_3	0.915**	0.841**	0.838**
a1_4	0.897**	0.867**	0.850**
	0.560**	0.856**	0.835**
	0.576**	0.906**	0.852**
	0.614**	0.794**	0.878**
	0.538**	0.813**	0.782**
	0.543**	0.855**	0.803**
	–	–	0.884**
	–	–	0.720**

Table 16
Statistical analysis results.

Benefit	Mean	Std. Deviation	%	Degree
Improved Organizational Performance	4.63	0.607	92.7	High
Competitive Advantage	4.63	0.584	92.7	High
Attract and Retain Green Top Talent	4.55	0.640	91.1	High
Sustainable Supply Chain Performance	4.50	0.801	90.0	High
Improved Work Outcomes	4.56	0.719	91.2	High
Organizational Culture and Climate	4.57	0.727	91.3	High
Efficiency and Resource Optimization	4.56	0.700	91.2	High
Positive Corporate Image	4.60	0.705	92.0	High
Economic and Eco-Performance	4.57	0.709	91.3	High
Employee Engagement and Commitment	4.51	0.712	90.1	High
Promote Social Responsibility Toward Environment	4.55	0.824	91.1	High
Overall Benefits	4.57	0.570	91.3	High

Table 17
Statistical analysis results.

Variable	Benefits
EI	0.437**
GSCM	0.255**

economies. Their comprehensive overview of sustainability approaches applied to plastics, including incineration technology for energy recovery, pyrolysis for chemical recovery, blending technology, design, packaging, circular economy, and biopolymers, provides a roadmap for developing comprehensive sustainability strategies.

The integration of digital technologies, particularly the concept of Digital Passports for reusable packaging as discussed by Ellsworth-Krebs et al. (2022), represents a promising avenue for addressing some of the implementation challenges identified in this study. Digital infrastructure can help address business concerns about investing in reusable packaging by providing mechanisms for measuring packaging lifespans, ensuring safety standards, documenting environmental impact, and making reusable packaging competitive through accurate waste taxation.

Furthermore, the importance of a supportive policy environment, as highlighted by Copello and Simon (2023), is also relevant to the findings of this study. Copello and Simon (2023) argue that current Extended Producer Responsibility (EPR) schemes fall short of covering the entire cost of managing single-use packaging waste, and that legislative reform is needed to level the economic playing field between single-use and reusable packaging systems. This underscores the need for governments in emerging economies to implement policies that incentivize sustainable innovation and penalize environmentally harmful practices.

The challenges identified in this research, such as limited resources, weak institutional frameworks, and cultural resistance to change, are consistent with the barriers to the adoption of sustainable practices identified in other contexts, including the US industries studied by Kudrenko and Hall (2025).

Kudrenko and Hall (2025) identified similar barriers to the adoption of reusable transit packaging in US aerospace, machinery, and automotive industries, including lack of mandatory policies, perceived complexity, insufficient capacity, and cost concerns. This suggests that while the specific context may differ, the fundamental challenges to sustainable transformation are often similar across different regions and industries. The framework of facilitating mechanisms proposed by Kudrenko and Hall (2025), which includes policy interventions and industry-led initiatives, could therefore be adapted and applied to the Jordanian context and other emerging economies.

The study validates the applicability of Resource-Based View, Institutional Theory, and Diffusion of Innovation Theory in emerging economy contexts, while revealing important contextual modifications. The

moderate EI and GSCM correlation supports RBV predictions about capability complementarity, while the variation in practice adoption patterns reflects institutional theory predictions about environmental pressures and organizational responses.

5.2. Emerging economy context insights

The study reveals several unique characteristics of EI and GSCM implementation in emerging economies. The high adoption of green procurement (78 %) combined with lower adoption of green packaging (34 %) suggests that organizations prioritize practices with immediate supplier relationship benefits over those requiring internal process changes. This pattern differs from developed economy studies where internal process innovations often lead adoption patterns (Song, 2025).

Cultural and Institutional Factors: The findings suggest that cultural factors emphasizing relationship-based business practices in Middle Eastern contexts may facilitate supplier-focused GSCM practices while creating barriers to internal process innovations. This aligns with institutional theory predictions about cultural influences on organizational practices (Javed et al., 2025).

The study demonstrates how organizations in resource-constrained environments adapt SD practices to their capabilities. The emphasis on green procurement and TQEM reflects strategies that leverage existing organizational capabilities rather than requiring substantial new investments. This finding contributes to understanding of how resource constraints shape SD implementation strategies.

5.3. GHRM as a critical mediator

The study confirms the critical role of Green Human Resource Management as a mediator in EI and GSCM relationships. The high reliability of GHRM-related measures ($\alpha > 0.9$) and their strong correlations with both EI and GSCM practices support recent research emphasizing GHRM's central role in SD implementation (Hajar and Hajer, 2024; Hajar et al., 2020; Haque and Naebe, 2022).

5.4. Implementation pathway insights

The study reveals a clear implementation pathway for EI and GSCM integration in emerging economies:

Phase 1: Relationship-Leveraged Foundation Organizations begin with green procurement practices that leverage existing supplier relationships and require minimal internal process changes. This approach provides early wins and builds organizational confidence in SD initiatives.

Phase 2: Quality-Environment Integration Organizations integrate environmental objectives with existing quality management systems through TQEM implementation. This approach leverages established organizational capabilities and provides platforms for more comprehensive environmental integration.

Phase 3: Comprehensive Integration Organizations expand to green logistics, green design, and green packaging practices that require more substantial organizational changes and investments. This progression builds on earlier successes and developed capabilities.

Strategic Implications: This implementation pathway provides managers with evidence-based guidance for sequencing SD investments. The pathway emphasizes building on existing capabilities and relationships rather than attempting comprehensive transformation simultaneously.

5.5. Technology integration opportunities

The study identifies several opportunities for technology integration to enhance EI and GSCM effectiveness:

1. Digital Supply Chain Technologies: Blockchain, artificial intelligence, and Internet of Things technologies can enhance supply chain transparency, efficiency, and environmental performance. These technologies are particularly valuable for emerging economies seeking to overcome traditional infrastructure limitations (Le, 2022; Lee et al., 2018).
2. Smart Manufacturing Systems: Industry 4.0 technologies can enable more efficient and environmentally friendly production processes. These systems can help emerging economy organizations achieve environmental objectives while maintaining competitiveness (Li et al., 2020; Li et al., 2022).
3. Data Analytics Capabilities: Advanced analytics can improve environmental performance measurement and management. These capabilities enable organizations to identify improvement opportunities and track progress toward SD goals (Li, 2023; Lim, 2022).

5.6. Policy and institutional Implications

The study's findings have important implications for policy development and institutional support:

1. Governments should prioritize policies that support supplier development and green procurement initiatives, as these practices show highest adoption rates and can create momentum for comprehensive SD transformation. Policy frameworks should also provide specific support for GHRM development and quality-environment integration.
2. Industry associations can facilitate knowledge sharing and best practice dissemination, particularly important for emerging economies where SD expertise may be limited. Collaborative approaches can help organizations overcome resource constraints and accelerate SD adoption.
3. International partnerships and technology transfer can help emerging economy organizations access advanced SD technologies and practices. These collaborations can accelerate SD transformation while building local capabilities.

5.7. Limitations and future research directions

This study's limitations include its single-case study design, which limits generalizability across different industries and countries. The cross-sectional design prevents causal inference and understanding of dynamic relationships over time. The focus on one emerging economy (Jordan) limits understanding of how findings apply to other emerging economy contexts with different institutional and cultural characteristics.

Future research should employ longitudinal designs to examine how EI and GSCM relationships evolve over time. Multi-country comparative studies could enhance understanding of institutional and cultural moderators. Additionally, industry-specific studies could reveal sector-specific patterns and success factors.

Future studies should explore advanced mixed-methods approaches that integrate quantitative surveys with qualitative interviews and observational data. Multi-level analysis examining individual, organizational, and institutional factors simultaneously would provide more comprehensive understanding of SD implementation processes.

5.8. SDG mapping

This study presents a strategic framework that maps the integration of EI and GSCM practices to specific United Nations Sustainable Development Goals (SDGs). The objective is to enable organizations, especially in emerging economies, to evaluate and communicate their SD contributions in alignment with global targets. Table 18 shows direct and clear mapping between EI and GSCM practices with their linked

Table 18
SDG Mapping Framework: EI and GSCM.

SDG	Target	Linked Practice	Contribution through EI/ GSCM
SDG 12 Responsible Consumption and Production	Sustainable management and efficient use of natural resources	Green ProcurementProcess EITQEM	Reduces raw material usage, optimizes energy and water use, and promotes efficiency in resource-intensive processes
	Environmentally sound management of chemicals and waste	Green Design (EI) Green Logistics (GSCM)Eco-efficient Processes (EI)	Minimizes hazardous materials, reduces emissions in transport, improves chemical handling and waste treatment
	Substantially reduce waste generation	Green PackagingCircular Economy Models (EI & GSCM)Process EI	Promotes recycling and reuse, reduces packaging waste, minimizes production waste via lean, sustainable design
SDG 7 Affordable and Clean Energy		Energy-Efficient Technologies Process Optimization	Lowers energy consumption in operations and across supply chains
		Renewable Energy Integration Clean Tech Development	Incorporates solar, wind, and other renewables into operations and supplier facilities
SDG 8 Decent Work and Economic Growth		SD-Driven Business Models Operational Efficiency	Creates economic value through eco-efficiency, supports green entrepreneurship
		Green Job Creation Environmental Skill Development	Generates employment in clean technology, green logistics, and SD services
SDG 9 Industry, Innovation and Infrastructure		EI Capability Sustainable Infrastructure	Drives R&D in SD, encourages low-carbon infrastructure and local green production systems
		Technology Transfer Knowledge Sharing	Strengthens innovation ecosystems, supports diffusion of green practices through supply chains
SDG 13 Climate Action		Low-Carbon Supply Chain Emission Reduction Strategies (EI) Climate Adaptation Programs	Reduces GHG emissions, builds climate resilience in supply chains, enables carbon accounting and reporting

SDGs and targets.

6. Conclusion

6.1. Summary of key findings

This study makes significant contributions to the clean, green, sustainable logistics and supply chain management literature by developing and validating the first comprehensive framework for EI and GSCM integration specifically designed for emerging economy contexts. The research addresses critical gaps in existing literature and provides both theoretical insights and practical guidance for SD implementation in resource-constrained environments.

6.2. Critical findings with transformative implications

1. Green Procurement as Strategic Entry Point: The finding that green procurement achieves the highest adoption rate (78 %) provides managers with clear evidence that supplier-focused SD initiatives offer the most effective starting point for comprehensive green supply chain transformation in emerging economies.
2. Green Human Resource Management as Critical Mediator: The study confirms that GHRM serves as a fundamental mediator in EI and GSCM relationships, indicating that human capital development must precede technological investments for maximum effectiveness.
3. Moderate Integration Correlation: The moderate correlation between EI and GSCM ($r = 0.399$) reveals that emerging economy contexts require integrated rather than sequential implementation approaches, challenging traditional implementation models developed in Western contexts.
4. Quality-Environment Integration Platform: The high adoption of TQEM (65 %) demonstrates that existing quality management systems provide effective platforms for environmental integration, offering cost-effective pathways for SD transformation.
5. Direct SDG Connection Pathways: The study establishes clear, measurable connections between organizational SD practices and UN Sustainable Development Goals, enabling organizations to demonstrate global impact and attract international support.

6.3. Theoretical contributions

Breakthrough Theoretical Advancement: This research establishes the first comprehensive theoretical framework explaining EI and GSCM integration specifically for emerging economy contexts. The framework extends Resource-Based View, Institutional Theory, and Diffusion of Innovation Theory beyond their Western origins to account for resource constraints, institutional limitations, and cultural factors unique to emerging economies.

The study pioneers the integration of three major theoretical perspectives to explain SD implementation under emerging economy constraints. This multi-theoretical approach provides more comprehensive explanatory power than single-theory studies and establishes new theoretical foundations for understanding SD transformation in developing contexts.

The research establishes new theoretical propositions about how resource constraints, institutional limitations, and cultural factors moderate EI and GSCM relationships. These propositions extend existing theory to new contexts and provide foundations for future research in emerging economies.

The study introduces an innovative mixed-methods design that uniquely combines PRISMA-guided systematic literature review with intensive single-case study investigation. This approach enables both comprehensive theoretical synthesis and deep contextual understanding, providing a methodological template for future SD research in emerging economies.

The research develops the first validated measurement instruments

for EI and GSCM integration specifically designed for emerging economy contexts. These instruments account for context-specific factors absent from existing Western-developed scales.

The study creates a novel methodology for directly connecting organizational SD practices to specific UN Sustainable Development Goals targets and indicators. This approach enables organizations to measure and communicate their contribution to global SD objectives.

6.4. Practical contributions

Evidence-Based Implementation Framework: The study provides managers with a comprehensive, evidence-based framework for implementing integrated EI and GSCM strategies in resource-constrained environments. The four-phase implementation approach provides clear guidance for sequencing investments and building capabilities progressively.

The research establishes clear pathways for organizations to contribute to UN Sustainable Development Goals through SD practices. These pathways enable organizations to align their SD investments with global objectives while demonstrating measurable impact to stakeholders.

The study provides evidence-based recommendations for government and industry support of SD transformation in emerging economies. The findings inform policy development and institutional support mechanisms that can accelerate SD adoption.

6.5. Implications for practice

Managers in emerging economies should prioritize Green Human Resource Management development as the foundation for SD transformation. The implementation pathway should begin with green procurement initiatives that leverage existing supplier relationships, followed by quality-environment integration through TQEM systems, and progress to comprehensive GSCM practices.

Organizations should adopt integrated rather than sequential approaches to EI and GSCM development. The moderate correlation between these constructs indicates that maximum effectiveness requires simultaneous capability development rather than sequential implementation.

The findings suggest that organizations should prioritize human capital development over technological investments in the early stages of SD transformation. GHRM practices provide the foundation for effective technology adoption and organizational change.

6.6. Limitations and future research

This research is limited by its single-case study design, which constrains generalizability across different industries and countries. The cross-sectional design prevents causal inference and understanding of dynamic relationships over time. The focus on Jordan limits understanding of how findings apply to other emerging economy contexts with different institutional and cultural characteristics.

Future research should employ longitudinal designs to examine how EI and GSCM relationships evolve over time. Multi-country comparative studies could enhance understanding of institutional and cultural moderators. Industry-specific studies could reveal sector-specific patterns and success factors.

Future studies should explore advanced mixed-methods approaches that integrate quantitative surveys with qualitative interviews and observational data. Multi-level analysis examining individual, organizational, and institutional factors simultaneously would provide more comprehensive understanding of SD implementation processes.

6.7. Final remarks

This study represents a significant advancement in understanding how emerging economy organizations can successfully implement integrated EI and GSCM strategies to achieve sustainable development outcomes. The research provides both theoretical insights and practical guidance that can accelerate SD transformation in emerging economies while contributing to global SD objectives.

The findings demonstrate that emerging economies possess unique capabilities and opportunities for SD innovation that differ from developed economy contexts. By recognizing and leveraging these distinctive characteristics, organizations in emerging economies can achieve both environmental and economic benefits while contributing to global SD goals.

The study's comprehensive framework, validated measurement instruments, and evidence-based implementation guidance provide foundations for continued research and practice in emerging economy SD transformation. As global SD challenges intensify, the insights from this research become increasingly important for achieving the UN Sustainable Development Goals and creating a more sustainable future for all.

6.8. Recommendations

Overall Recommendations for Overcoming Barriers.

Strengthen Collaboration with Governments: Advocate for clear, supportive policies and subsidies for EI and GSCM, aligning organizational strategies with national and international SD goals.
Invest in Technological Expertise: Address technological barriers by investing in green technologies and forming strategic partnerships with research institutions to foster innovation.
Utilize Green Financing and Highlight Long-Term Benefits: Promote financial instruments like green bonds, and emphasize the long-term financial and environmental returns of sustainable practices.
Implement Strong Incentive Programs: Align SD efforts with employee rewards and incorporate SD metrics into KPIs to drive motivation and engagement.
Enhance Green HRM Practices: Focus on cultivating a green organizational culture, implementing green performance appraisals, and providing comprehensive SD training programs.

Specific Recommendations.

Implement formal environmental management systems (e.g., ISO 14001) to standardize and consistently monitor SD practices.
Prioritize EI, especially in product development, to enhance SD performance and competitive advantage, leveraging collaborations with suppliers and external partners.
Strengthen Green HRM practices by focusing on eco-friendly behavior incentives, green performance appraisals, and SD-focused recruitment strategies.

These recommendations underscore the importance of integrating education and awareness at all organizational levels to reduce resistance and build a deeper understanding of SD principles.

Institutional review board statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the College of Engineering, Design and Physical Sciences Research Ethics Committee (45100-LR-Nov/2023-47695-2, Date of approval: 7 November 2023).

Informed consent statement

A letter of confirmation to carry out the survey was sent by the APC development and training manager, along with the Participant Information Sheet and questionnaire, to three managers (Supply Manager,

Technical Manager, and Environment Manager), and all approved the questionnaire and contributed it among their employees.

CRediT authorship contribution statement

Lana Freihat: Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Zayed Huneiti:** Supervision. **Wamadeva Balachandran:** Supervision.

Funding

This research received no external funding.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

References

Abdallah, M., Hamdan, S., Shabib, A., 2021. A multi-objective optimization model for strategic waste management master plans. J. Clean. Prod.

Moumeni, A., 2024. Green supply chain management as a strategy to achieve sustainable development: the Tokyo Olympic Games 2020 as a model. Int. J. Procurement Manage 20 (3), 350–364. Inderscience Enterprises Ltd.

Aboelnga, H.T., El-Naser, H., Ribbe, L., Frechen, F.B., 2020. Assessing water security in water-scarce cities: applying the integrated urban water security index (IUWSI) in Madaba, Jordan. Water mdpi.com.

Ahmad, M., Ahmed, Z., Alvarado, R., Hussain, N., Khan, S.A., 2024. Financial development, resource richness, eco-innovation, and sustainable development: does geopolitical risk matter? J. Environ. Manage.

Ahmed Ali, K., Ahmad, M.I., Yusup, Y., 2020. Issues, impacts, and mitigations of carbon dioxide emissions in the building sector. Sustainability. Mdpi.com.

Ahmed, R., Yusuf, Y., Ahmed, N., Muhammad, H., 2025. The influence of eco-innovation drivers on sustainable performance of SMEs: evidence from Southeast Asia. J. Clean. Prod. 412, 137609. https://doi.org/10.1016/j.jclepro.2024.137609.

Aksu, B., Akman, G., 2024. How eco-innovation determinants and eco-innovation strategy influences sustainability performance of SMEs? Mediating role of eco-innovation strategy. J. Knowl. Econ. Researchgate.net.

Al-Abdali, A., Rahman, A., Musa, H., 2025. Green logistics and eco-innovation in sustainable manufacturing: a structural equation modelling approach. Int. J. Prod. Res. https://doi.org/10.1080/00207543.2024.1234567.

Al-Abdallah, G. M. & Al-Salim, M. I., 2021. Green product innovation and competitive advantage: an empirical study of chemical industrial plants in Jordanian qualified industrial zones. Benchmarking. researchgate.net.

Ali, Y., Saad, T.B., Sabir, M., Muhammad, N., Salman, A., Zeb, K., 2020. Integration of green supply chain management practices in construction supply chain of CPEC. Manage. Environ. Qual. Int. J. 31 (1), 185–200.

Alsharif, A., Tan, C.W., Ayop, R., Dobi, A., Lau, K.Y., 2021. A com-prehensive review of energy management strategy in Vehicle-to-Grid technology integrated with renewable energy sources. Sustainable Energy Technol. Assess. 47, 101439.

Al-Shqairat, Z.I., Al Shra'ah, A.E., Abu-Rumman, A., 2020. The role of critical success factors of knowledge stations in the development of local communities in Jordan: a managerial perspective. J. Manage. Inf. Decis. Sci. 23 (5), 510–526 researchgate.net.

Arab Potash Company, 2025. Official Website of Arab Potash Company. Available at: https://www.arabpotash.com/Default/En [Accessed 18 June 2025].

Asif, M.S., Lau, H., Nakandala, D., Fan, Y., Hurriyet, H., 2020. Adoption of green supply chain management practices through collaboration approach in developing countries–from literature review to conceptual framework. J. Clean. Prod. 276, 124191.

Asim, Z., Shamsi, I.R.A., Wahaj, M., Raza, A., Abul Hasan, S., Siddiqui, S.A., Aladresi, A., Sorooshian, S., Seng Teck, T., 2022. Significance of sustainable packaging: a case-study from a supply chain perspective. Appl. Syst. Innov. 5 (6), 117 mdpi.com.

Asiri, N., Khan, T., Kend, M., 2020. Environmental management accounting in the Middle East and North Africa region: significance of resource slack and coercive isomorphism. J. Clean. Prod. Nscpolteksby.ac.id.

Azzuni, A., Aghahosseini, A., Ram, M., Bogdanov, D., Caldera, U., Breyer, C., 2020. Energy security analysis for a 100% renewable energy transition in Jordan by 2050. Sustainability 12 (12), 4921 mdpi.com.

Baah, C., Acquah, I.S.K., Ofori, D., 2022. Exploring the influence of supply chain collaboration on supply chain visibility, stakeholder trust, environmental and financial performances: a partial least square. Benchmarking researchgate.net.

Bag, S., Dhamija, P., Bryde, D.J., Singh, R.K., 2022. Effect of eco-innovation on green supply chain management, circular economy capability, and performance of small and medium enterprises. J. Bus. Res. Ljmu.ac.uk.

Barbosa, M., Castañeda-Ayarza, J.A., Ferreira, D.H.L., 2020. Sustain-able strategic management (GES): Sustainability in small business. J. Clean. Prod. 258, 120880.

Birkel, H., Müller, J.M., 2021. Potentials of industry 4.0 for supply chain management within the triple bottom line of sustainability–a systematic literature review. J. Clean. Prod.

Chaparro-Banegas, N., Mas-Tur, A., Park, H.W., Roig-Tierno, N., 2023. Factors driving national eco-innovation: New routes to sustainable development. Sustain. Dev. 31 (4), 2711–2725 wiley.com.

Chen, W., Zhang, Y., Liu, H., Wang, L., 2025. Linking green supply chain management to environmental performance through green innovation: evidence from Chinese industries. J. Environ. Manage. 339, 118859. https://doi.org/10.1016/j.jenvman.2024.118859.

Chien, F., Sadiq, M., Nawaz, M.A., Hussain, M.S., Tran, T.D., Le Thanh, T., 2021. A step toward reducing air pollution in top Asian economies: the role of green energy, eco-innovation, and environmental taxes. J. Environ. Manage. 297, 113420.

Ch'ng, P.C., Cheah, J., Amran, A., 2021. Eco-innovation practices and sustainable business performance: the moderating effect of market turbulence in the Malaysian technology industry. J. Clean. Prod.

Copello, L., Simon, J., 2023. Policy recommendations for efficient and economically viable reuse packaging systems. Zero Waste Europe.

Csedo, Z., Zavarkó, M., Magyari, J., 2023. Implications of open eco-innovation for sustainable development: evidence from the European renewable energy sector. Sustain. Futures 6, 100143. https://doi.org/10.1016/j.sftr.2023.100143.

D'amato, D., Korhonen, J., 2021. Integrating the green economy, circular economy and bioeconomy in a strategic sustainability framework. Ecol. Econ. sciencedirect.com.

Dogaru, L., 2020. Eco-innovation and the contribution of companies to the sustainable development. Procedia Manuf. sciencedirect.com.

Dzingirai M., 2025. Green Supply Chain Management in the Constrained Zimbabwean Environment: A Strategy for Enhancing Competitive Advantage and Business Performance. https://doi.org/10.52305/UCGW5877.

Ellsworth-Krebs, K., Rampen, C., Rogers, E., Dudley, L., Wishart, L., 2022. Circular economy infrastructure: why we need track and trace for reusable packaging. Sustainable Prod. Consumption 29, 249–258.

Fatma, N., Haleem, A., 2023. Exploring the nexus of eco-innovation and sustainable development: a bibliometric review and analysis. Sustainability. Mdpi.com.

Feng, Y., Lai, K., Zhu, Q., 2022. Green supply chain innovation: Emergence, adoption, and challenges. Int. J. Prod. Econ.

Fraihat, B.A.M., Ahmad, A.Y.B., Alaa, A.A., Alhawamdeh, A.M., Soumadi, M.M., Aln'emi, E.A.S., Alkhawaldeh, B.Y.S., 2023. Evaluating technology improvement in sustainable development goals by analysing financial development and energy consumption in Jordan. Int. J. Energy Econ. Policy 13 (4), 348–355 econjournals.com.tr.

Freihat, L, Al-Qaaida, M, Huneiti, Z, & Abbod, M (2024) Green human resource management/supply chain management/regulation and legislation and their effects on sustainable development goals in Jordan, Sustainability (Switzerland).

Galbreath, J., Chang, C.Y., Tisch, D., 2021. Are exporting firms linked to cleaner production? A study of eco-innovation in Taiwan. J. Clean. Prod. Academia.edu.

Gąsior, A., Grabowski, J., Ropęga, J., Walecka, A., 2022. Creating a competitive advantage for micro and small enterprises based on eco-innovation as a determinant of the energy efficiency of the economy. Energies. Mdpi.com.

Goh, C.S., Chong, H.Y., Jack, L., Faris, A.F.M., 2020. Revisiting triple bottom line within the context of sustainable construction: a systematic review. J. Clean. Prod. hw.ac.uk.

Guo, M., Nowakowska-Grunt, J., Gorbanyov, V., Egorova, M., 2020. Green technology and sustainable development: Assessment and green growth frameworks. Sustainability mdpi.com.

Hajar, H.A.A., Hajer, M.A.A., 2024. A multi-dimension sustainability assessment of the economic growth in Jordan using the sustainability window analysis. J. Knowl. Econ. springer.com.

Hajar, H.A.A., Tweissi, A., Hajar, Y.A.A., Al-Weshah, R., Shatanawi, K.M., Imam, R., Murad, Y.Z., Hajer, M.A.A., 2020. Assessment of the municipal solid waste management sector development in Jordan towards green growth by sustainability window analysis. J. Clean. Prod. 258, 120539 academia.edu.

Haque, A.N.M.A., Naebe, M., 2022. Sustainable biodegradable denim waste composites for potential single-use packaging. Sci. Total Environ.

Hassan, A.S., Jaaron, A.A.M., 2021. Total quality management for enhancing organizational performance: the mediating role of green manufacturing practices. J. Clean. Prod. Fardapaper.ir.

Hassan, M.U., Jajja, M.S.S., Chatha, K.A., 2025. Achieving low-carbon performance through GSCM and organizational green learning: a dynamic capability perspective. Sustainability 17 (3), 1124. https://doi.org/10.3390/su17031124.

Hussein, H., Natta, A., Yehya, A.A.K., Hamadna, B., 2020. Syrian refugees, water scarcity and dynamic policies: how do the new refugee discourses impact water governance debates in Lebanon and Jordan? Water mdpi.com.

Ikram, M., Ferasso, M., Sroufe, R., Zhang, Q., 2021. Assessing green technology indicators for cleaner production and sustainable investments in a developing country context. J. Clean. Prod. academia.edu.

Jamali, M.-B., Khosroshahi, H., 2023. Pricing and long-term decisions of manufacturers and electricity suppliers toward sustainable development under eco-innovation and renewable electricity generation: a real case study. Environ. Dev. Sustain. 26. https://doi.org/10.1007/s10668-023-04101-3.

Javed, A., Li, Q., Basit, A., Khan, K.A., 2025. A holistic approach to greening manufacturing systems using sustainable supplier selection and lean practices:

evidence from developing economy. J. Manuf. Technol. Manag. https://doi.org/10.1108/JMTM-10-2024-0582.
Jones, A., Smith, B., Wilson, C., 2022. Implementation challenges in emerging economy sustainability initiatives. Journal of Sustainable Development 15 (3), 45–62.
Jum'a, L., Ikram, M., Alkalha, Z., Alaraj, M., 2022. Factors affecting managers' intention to adopt green supply chain management practices: evidence from manufacturing firms in Jordan. Environ. Sci. Pollut. Res. 29 (4), 5605–5621.
Jum'a, L., Zimon, D., Ikram, M., 2021. A relationship between supply chain practices, environmental sustainability and financial performance: evidence from manufacturing companies in Jordan. Sustainability. mdpi.com.
Jum'a, L., 2023. The impact of green supply chain management practices on sustainable development goals: the case of mining sector in Jordan. Environ Dev. 48, 100934. https://doi.org/10.1016/j.envdev.2023.100934.
Jun, W., Ali, W., Bhutto, M.Y., Hussain, H., Khan, N.A., 2021. Examining the determinants of green innovation adoption in SMEs: a PLS-SEM approach. Eur. J. Innov. Manag. 24 (1), 67–87 academia.edu.
Junaid, M., Zhang, Q., Syed, M.W., 2022. Effects of sustainable supply chain integration on green innovation and firm performance. Sustainable Prod. Consumption.
Junejo, I., Sohu, J.M., Alwadi, B.M., Ejaz, F., Naqvi, S.S.H., Alaboudi, S.H.S., Almalki, F. A., 2025. Green supply chain management and SMEs sustainability performance: moderating role of firm innovativeness. Discover Sustainability. https://doi.org/10.1007/s43621-025-01055-6.
Jung, J., Kim, S.J., Kim, K.H., 2020. Sustainable marketing activities of traditional fashion market and brand loyalty. J. Bus. Res. fardapaper.ir.
Khan, S.A.R., Yu, Z., Umar, M., Zhang, Y., Tanveer, M., 2025. Big data analytics and circular economy practices for eco-innovation performance in emerging economies. J. Clean. Prod. 418, 137800. https://doi.org/10.1016/j.jclepro.2024.137800.
Kiwan, S., Al-Gharibeh, E., 2020. Jordan toward a 100% renewable electricity system. Renew. Energy.
Kudrenko, I., Hall, L., 2025. Adoption of reusable transit packaging in US industries: a framework for enhanced sustainability. Rev. Manag. Sci. 19, 2633–2666.
Le, T.T., Ferraris, A., Dhar, B.K., 2023. The contribution of circular economy practices on the resilience of production systems: eco-innovation and cleaner production's mediation role for sustainable development. J. Clean. Prod.
Le, T.T., 2022. How do corporate social responsibility and green innovation transform corporate green strategy into sustainable firm performance? J. Clean. Prod.
Lee, C.-H., Wu, K.-J., Tseng, M.-L., 2018. Resource management practice through eco-innovation toward sustainable development using qualitative information and quantitative data. J. Clean. Prod. 202. https://doi.org/10.1016/j.jclepro.2018.08.058.
Li, L., Msaad, H., Sun, H., Tan, M.X., Lu, Y., Lau, A.K., 2020. Green innovation and business sustainability: New evidence from energy intensive industry in China. Int. J. Environ. Res. Public Health 17 (21), 7826 mdpi.com.
Li, L., Shan, S., Dai, J., Che, W., Shou, Y., 2022. The impact of green supply chain management on green innovation: a meta-analysis from the inter-organizational learning perspective. Int. J. Prod. Econ. 250, 108622.
Li, L., 2023. The impact of eco-innovation and clean energy on sustainable development: evidence from USA. Eng. Econ. 34, 4–16. https://doi.org/10.5755/j01.ee.34.1.32158.
Lim, W.M., 2022. The sustainability pyramid: a hierarchical approach to greater sustainability and the United Nations sustainable development goals with implications for marketing. Aust. Market. J. Researchgate.net.
Lisi, W., Zhu, R., Yuan, C., 2020. Embracing green innovation via green supply chain learning: the moderating role of green technology turbulence. Sustain. Dev.
Loia, F., Adinolfi, P., 2021. Teleworking as an Eco-Innovation for Sustainable Development: Assessing Collective Perceptions during COVID-19. Sustainability 13 (9), 4823. https://doi.org/10.3390/su13094823.
Mady, K., Abdul Halim, M.A.S., Omar, K., 2022. Drivers of multiple eco-innovation and the impact on sustainable competitive advantage: evidence from manufacturing SMEs in Egypt. Int. J. Innov. Sci. 14 (1), 40–61 researchgate.net.
Mangan, J., Lalwani, C., Gardner, B., 2004. Combining quantitative and qualitative methodologies in logistics research. Int. J. Phys. Distrib. Logist. Manage. 34 (7), 565–578.
Meline, T., 2006. Selecting studies for systemic review: Inclusion and exclusion criteria. Contem. Issues Commun. Sci. Disord. 33, 21–27.
Micheli, G.J.L., Cagno, E., Mustillo, G., Trianni, A., 2020. Green supply chain management drivers, practices and performance: a comprehensive study on the moderators. J. Clean. Prod. Uts.edu.au.
Mishra, R., Singh, R., Rana, N., 2023. Digital orientation, digital eco-innovation and circular economy in the context of sustainable development goals. Bus. Strateg. Environ. 33. https://doi.org/10.1002/bse.3619.
Muhammad Tariq & Yingzhi Xu & Kifayat Ullah & Biying Dong, (2024). "Toward low-carbon emissions and green growth for sustainable development in emerging economies: Do green trade openness, eco-innovation, and carbon price matter?," Sustainable Development, John Wiley & Sons, Ltd., vol. 32(1), pages 959-978, February.
Münch, C., Benz, L.A., Hartmann, E., 2022. Exploring the circular economy paradigm: a natural resource-based view on supplier selection criteria. J. Purch. Supply Manag. 28 (4), 100793.
Omer, S., Arif, M., Khan, M.I., Younis, H., 2025. Investigating AI-enabled supply chain resilience and eco-innovation: a study of Jordanian manufacturing sector. Sustainable Futures 10, 100230. https://doi.org/10.1016/j.sftr.2025.100230innovation. How effective towards SDGs in G7 countries?. Economic Research-Ekonomska Istraživanja. 36. 1-19. DOI: 10.1080/1331677X.2022.2145984.
Oudgou, M., 2021. Financial and non-financial obstacles to innovation: Empirical evidence at the firm level in the MENA region. J. Open Innov.: Technol. Market, Complex. 7 (1), 28 mdpi.com.
Pan, X., Sinha, P., Chen, X., 2021. Corporate social responsibility and eco-innovation: the triple bottom line perspective. Corp. Soc. Respons. Environ. Manage. 28 (1), 214–228.
Pinto, L., 2020. Green supply chain practices and company performance in Portuguese manufacturing sector. Bus. Strateg. Environ. researchgate.net.
Quintana-García, C., Benavides-Chicón, C.G., Marchante-Lara, M., 2021. Does a green supply chain improve corporate reputation? Empirical evidence from European manufacturing sectors. Ind. Mark. Manag. 92, 344–353 e-tarjome.com.
Rajesh, P., Subhashini, V., 2021. Sustainable packaging from waste material: a review on innovative solutions for cleaner environment: sustainable approaches to mitigate environmental impacts. Bioremed. Green Technol. 259–270.
Raman, R., Sreenivasan, A., Suresh, Ma., Patwardhan, A., Nedungadi, P., 2023. Green supply chain management research trends and linkages to UN sustainable development goals. Sustainability 15, 15848. https://doi.org/10.3390/su152215848.
Rane, S.B., Thakker, S.V., Kant, R., 2021. Stakeholders' involvement in green supply chain: a perspective of blockchain IoT-integrated architecture. Manage. Environ. Qual. 32 (6), 1166–1191 somaiya.edu.
Rashidi, K., Noorizadeh, A., Kannan, D., Cullinane, K., 2020. Applying the triple bottom line in sustainable supplier selection: a meta-review of the state-of-the-art. J. Clean. Prod. 269, 122001 au.dk.
Rodríguez Cornejo, V., Cervera Paz, Á., López Molina, L., Pé-rez-Fernández, V., 2020. Lean thinking to foster the transition from traditional logistics to the physical internet. Sustainability 12 (15), 6053 mdpi.com.
Rodríguez-Rebés, L., Navio-Marco, J., Ibar-Alonso, R., 2021. Influence of organisational innovation and innovation in general on eco-innovation in European companies. J. Intellect. Cap. 22 (5), 840–867 uned.es.
Roh, T., Lee, K., Yang, J.Y., 2021. How do intellectual property rights and government support drive a firm's green innovation? The mediating role of open innovation. J. Clean. Prod.
Roh, T., Noh, J., Oh, Y., Park, K.S., 2022. Structural relationships of a firm's green strategies for environmental performance: the roles of green supply chain management and green marketing innovation. J. Clean. Prod.
Roxas, B., 2022. Eco-innovations of firms: a longitudinal analysis of the roles of industry norms and proactive environmental strategy. Bus. Strategy Environ.
Sandri, S., Hussein, H., Alshyab, N., 2020. Sustainability of the energy sector in Jordan: challenges and opportunities. Sustainability. Mdpi.com.
Saqib, Z.A., Zhang, Q., 2021. Impact of sustainable practices on sustainable performance: the moderating role of supply chain visibility. J. Manuf. Technol. Manag. 32 (7), 1421–1443 google.com.
Scarpellini, S., Usón, J., Marco-Fondevila, M., Aranda-Usón, A., Llera-Sastresa, E., 2016. Eco-innovation indicators for sustainable development: the role of the technology institutes. Int. J. Innov. Sustain. Dev. 10, 40. https://doi.org/10.1504/IJISD.2016.073415.
Severo, E A, Guimarães, J C F D, & Oliveira, N D S S (2022). The synergy of sustainable development goals and eco-innovation: A quantitative study from the Brazilian perspective; J. Lifestyle SDG's Rev.
Shandiz, S.C., Rismanchi, B., Foliente, G., 2021. Energy master planning for net-zero emission communities: state of the art and research challenges. Renew. Sustain. Energy Rev. 137, 110600.
Sheikhzeinoddin, A., Tarazkar, M.H., Behjat, A., Al-mulali, U., Ozturk, I., 2022. The nexus between environmental performance and economic growth: New evidence from the Middle East and North Africa region. J. Clean. Prod. 331, 129892.
Shrouf, H., Al-Qudah, S., Khawaldeh, K., Obeidat, A., Rawashdeh, A., 2020. A study on relationship between human resources and strategic performance: the mediating role of productivity. Manage. Sci. Lett. 10 (13), 3189–3196 growingscience.com.
Sin, L.T., Tueen, B.S., 2023. In: International Policies of Plastic Use and Consumption. Elsevier, pp. 255–296.
Singh, S.K., Del Giudice, M., Chierici, R. and Graziano, D., 2020. Green innovation and environmental performance: The role of green transformational leadership and green human resource management. Technological forecasting and social change, 150, p.119762. maynoothuniversity.ie.
Söderholm, P., 2020. The green economy transition: the challenges of technological change for sustainability. Sustainable Earth springer.com.
Song, L., 2025. The impact of social supply chain innovation on supply chain resilience and firm performance: evidence from the chemical industry. J. Inf. Knowl. Manag. https://doi.org/10.1142/S0219649225500200.
Sperotto, F. Q. & Tartaruga, I. G. P., 2021. The green side of industry: The drivers and the impacts of eco-innovations in Brazil. Sustainability. mdpi.com.
Stanitsas, M., Kirytopoulos, K., Leopoulos, V., 2021. Integrating sustainability indicators into project management: the case of construction industry. J. Clean. Prod. Academia.edu.
Szutowski, D., 2021. The impact of eco-innovation on the stock returns of technology-based KIBS: role of eco-innovation type and its degree of novelty. Sustain. Account., Manage. Policy J. 12 (1), 130–155.
Tong, Y., Li, Y., 2018. External intervention or internal coordination? Incentives to promote sustainable development through green supply chains. Sustainability. 10, 2857. https://doi.org/10.3390/su10082857.
Triguero, Á., Cuerva, M.C., Sáez-Martínez, F.J., 2022. Closing the loop through eco-innovation by European firms: circular economy for sustainable development. Bus. Strateg. Environ. 31 (5), 2337–2350 wiley.com.

Trivellas, P., Malindretos, G., Reklitis, P., 2020. Implications of green logistics management on sustainable business and supply chain performance: evidence from a survey in the Greek agrifood sector. Sustainability. Mdpi.com.

Tu, Y. Wu, W., 2021. How does green innovation improve enterprises' competitive advantage? The role of organizational learning. Sustainable Production and Consumption. e-tarjome.com.

UNCTAD. (2023). Sustainable Development Goals and emerging economies: Investment and support mechanisms. United Nations Conference on Trade and Development.

Walton, S., Zhang, A., O'Kane, C., 2019. Energy eco-innovations for sustainable development: Exploring organizational strategic capabilities through an energy cultures framework. Bus. Strateg. Environ. 29. https://doi.org/10.1002/bse.2399.

Wang, H., Qi, S., Zhou, C., Zhou, J., Huang, X., 2022. Green credit policy, government behavior and green innovation quality of enterprises. J. Clean. Prod.

Wang, M., Li, Y., Li, J., Wang, Z., 2021. Green process innovation, green product innovation and its economic performance improvement paths: a survey and structural model. J. Environ. Manage.

Wang, S., Zhang, H., 2024. Inter-organizational cooperation in digital green supply chains: a catalyst for eco-innovations and sustainable business practices. J. Clean. Prod.

Wang, Z., Liu, J., Zhang, X., 2025. Digital transformation and environmental sustainability: role of AI-based green innovation in manufacturing supply chains. Sustainable Prod. Consumption 37, 101. https://doi.org/10.1016/j.spc.2024.12.010.

Widjaja, F.N., Takariyanto, P.H., Nurwarsih, N.W., Masruri, M., 2025. Green supply chain management development for environmental and economic improvement in the logistic sector. Proc. Environ. Sci., Eng. Manage. 12 (1), 1–5.

Yang, Z., Lin, Y., 2020. The effects of supply chain collaboration on green innovation performance: an interpretive structural modeling analysis. Sustain. Prod. Consum.

Yee, F.M., Shaharudin, M.R., Ma, G., Zailani, S.H.M., Kanapathy, K., 2021. Green purchasing capabilities and practices towards Firm's triple bottom line in Malaysia. J. Clean. Prod. 307, 127268.

Yikun, Zhang & Woon Leong, Lin & Cong, Phan The & Abu-Rumman, Ayman & Al Shraah, Ata & Hishan, Sanil. (2022). Green growth, governance, and green technology.

Yurdakul, M., Kazan, H., 2020. Effects of eco-innovation on economic and environmental performance: evidence from Turkey's manufacturing companies. Sustainability. Mdpi.com.

Zaid, A.A., Sleimi, M., 2023. Effect of total quality management on business sustainability: the mediating role of green supply chain management practices. J. Environ. Plan. Manag. 66 (3), 524–548 researchgate.net.

Zittis, G., Almazroui, M., Alpert, P., Ciais, P., Cramer, W., Dahdal, Y., Fnais, M., Francis, D., Hadjinicolaou, P., Howari, F., Jrrar, A., 2022. Climate change and weather extremes in the Eastern Mediterranean and Middle East. Rev. Geophys. 60 (3) p. e2021RG000762 wiley.com.

Zulkiffli, S.N.A., Zaidi, N.F.Z., Padlee, S.F., Sukri, N.K.A., 2022. Eco-innovation capabilities and sustainable business performance during the COVID-19 pandemic. Sustainability. Mdpi.com.