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When green supply chains meet innovation and talent: Pathways to sustainable performance

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Background: Sustainability has become a strategic focus for industrial companies as the intensity of environmental pressures, regulatory requirements and stakeholders' expectations continues to grow. Based on the Resource-Based View and the Dynamic Capabilities Theory, green supply chain practices (GSCP) are increasingly recognised as important drivers of sustainable performance (SP), particularly in developing industrial contexts.

Objectives: The study focuses on GSCP and their influence on SP in the Jordanian industry, and evaluates the functions of green innovation (GI) and green human resource management (GHRM).

Method: A quantitative research design was used, and a sample of 300 managers working in industrial firms in Jordan was used to collect data. The proposed research model was implemented using partial least squares structural equation modelling (PLS-SEM) with software.

Results: The results show that customer environmental collaboration and sustainable innovation have strong positive impacts on SP, and GI is the most powerful indicator of sustainability outcomes. Green purchasing (GP) and GHRM, on the other hand, show a strong negative direct effect on SP. The results show that GHRM has a strong moderating influence on the relationship between innovation and SP.

Conclusion: The results highlight the importance of GI and environmental collaboration in achieving SP, while indicating that GP and GHRM may entail short-term challenges despite their strategic relevance.

Contribution: This study has added to the existing literature on green supply chain and sustainability by providing a more subtle, capability-based description of how green practices operate in a developing industrial setting.

Keywords: green supply chain practices; sustainable performance; green innovation; sustainable innovation; green human resource management; Jordanian industrial sector.

Introduction

Amid increasing environmental laws, stakeholder pressure, and the increasing concern about climate change and resource shortage, sustainability has become a strategic priority of the industrial organisation (Alzubi & Akkerman 2022; Jum'a 2023). Industrial supply chains are some of the biggest polluters of the environment, using extensive quantities of energy and generating waste products. As a result, companies are increasingly expected to incorporate environmental considerations when planning their supply chain approaches to achieve long-term sustainability and rivalry (Diab, Al-Bourini & Abu-Rumman 2015). In response to these increasing environmental pressures and stakeholder expectations, the concept of green supply chain practices (GSCP) has emerged as a vital organisational strategy for sustainable performance (SP) across economic, environmental and social dimensions.

Green supply chain practices involve the strategic application of environmental management concepts to supply chain operations, which include green purchases, sustainable innovation (SI) and working with environmentally responsible customers (Alshura & Awawdeh 2016).

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The existing literature suggests that GSCP can enhance the efficiency of operations, reduce the risk to the environment, and increase the strength of the corporate image, which results in high-performing firms (Alshura & Awawdeh 2016; Jum'a, Zimon & Ikram 2021). However, despite the growing body of literature, empirical evidence on the direct effect of GSCP on SP remains inconclusive, especially in emerging economies. This discrepancy highlights the fact that the underlying mechanisms that GSCP produces sustainability results should be studied (Albhirat et al. 2023).

One of the primary ways in which GSCP can affect SP is the Green Innovation (GI), which is understood as the creation and application of environmentally friendly products, processes and technologies (Al-Ghwayeen & Abdallah 2018). Green innovation allows companies to influence the improvement of performance in relation to the environment through the promotion of cleaner production, eco-design and optimisation of resources (Mughal 2019).

Although the significance of GI has already been recognised, little has been done to validate its mediating capacity between GSCP and SP, especially in the example of an industrial environment in the developing world (Jum'a et al. 2022).

Besides innovation competencies, the effectiveness of green practices depends primarily on organisational and human-related aspects. Green human resource management (GHRM) has also been considered as a bi-faceted facilitator of environmental strategies following the creation of awareness, competencies and organisational commitment among employees to the sustainability goals (Jum'a, Alkhodary & Mandahawi 2025). Green human resource management can enhance the application of GSCP and increase the effectiveness they have on organisational outcomes through green recruitment, green training, performance appraisal and reward systems (Al-Madi 2017). Nevertheless, few empirical studies have investigated the contextual role of GHRM in the development of sustainability-related relationships, particularly within the supply chain management literature.

Contextually, the Jordanian industrial sector is an attractive environment for exploring these relationships. The Jordanian industries face major environmental and operational issues, such as the scarcity of natural resources, high energy prices and the growth of environmental regulation, in order to meet the criteria of sustainability (Abdellatif & Graham 2019). Although society and institutions are increasingly focusing on sustainable industrial development, there is little empirical data on the role of GSCP in achieving SP in Jordan. The majority of the previous research has concentrated on developed economies, which limits the relevance of results to the emerging industrial environment, like that of Jordan (Abuzawida, Alzubi & Iyiola 2023; Al-Abbadi 2024).

To fill these gaps, this study will analyse how GSCP can influence SP in Jordan's industrial sector. This research makes three significant contributions to the literature by incorporating GI as a mediating mechanism within the broader organisational context of sustainability practices. Firstly, it takes GSCP research to an under-researched environment of an emerging economy. Secondly, it contributes to theoretical knowledge by elucidating the role of GI in transforming supply chain practices into SP. Thirdly, it provides practical information for managers and policymakers who want to formulate effective sustainability strategies to improve long-term performance in the industrial sector.

Literature review and hypothesis development

Customer environmental collaboration and sustainable performance

Customer environmental collaboration (CEC) is characterised by firms interacting closely with their customers on environmental issues, communicating sustainability information, and jointly developing environmentally friendly solutions. This cooperation can enhance each other in their understanding of the environmental demands and lead to the incorporation of the sustainability goal in their product design and supply (Rashid, Rasheed & Altay 2025b; Sharma et al. 2025). The joint environmental programmes help the firms become more efficient with their resources, reduce waste, and enhance their image of environmental friendliness, all of which are steps towards more SP.

Empirical studies have shown that environmental collaboration between customers is one of the most influential factors in obtaining sustainability effects, especially in an industrial supply chain where the expectations of customers and regulatory demands are becoming closer to the concept of environmental responsibility (Rashid et al. 2025a). The incorporation of customer input and environmental needs enables firms to enhance their environmental and economic performance by responding to both at the same time. In this regard, the hypothesis of the proposed study is as follows:

H1: Customer environmental collaboration has a positive effect on sustainable performance.

Green human resource management and sustainable performance

Green human resource management is a set of human resource (HR) practices that help promote the environmental awareness, skills and commitment of the employees, including green recruitment, green training, green performance appraisal and green reward systems (Nguyen & Nguyen 2025). These are necessary practices that would imbue organisational culture with a sustainability mindset and ensure the successful execution of environmental strategies.

Previous studies show that GHRM has the potential to influence organisational sustainability outcomes significantly and positively by motivating employees to participate in environmental practices and supporting the implementation of green practices in the functional areas (Hu, Xu & Yang 2025; Hussein et al. 2023). The role of human capital has become paramount in industrial contexts, where operational activities have a pronounced impact on the environment. As such, the hypothesis is as follows:

H2: GHRM has a significant effect on sustainable performance.

Green innovation and sustainable performance

The concept of GI refers to the creation and implementation of environmentally sound products, processes and technologies that are aimed at reducing the environmental footprint and increasing the efficiency of operations (Martínez Falcó et al. 2025). It enables firms to achieve sustainability goals by integrating environmental issues into innovation efforts, including eco-design, cleaner production and optimisation of processes.

The existing literature once again confirms that GI can boost SP by reducing emissions, minimising waste and improving resource use, while simultaneously strengthening long-term economic competitiveness (Hosen et al. 2025). It also enhances social sustainability in industrial sectors by improving workplace safety and compliance with environmental regulations. As a result, the hypothesis of the present study is:

H3: Green innovation has a positive effect on sustainable performance.

Green purchasing and sustainable performance

Green purchasing (GP) involves selecting suppliers and materials in accordance with the ecological standards and promoting the use of non-polluted inputs and the use of environmentally friendly production methods (Yaputra et al. 2023). Through GP, organisations can reduce the environmental risks associated with upstream supply chain operations and improve overall sustainability performance.

Empirical data show that GP has the potential to supplement SP by decreasing the amount of waste disposal, increasing material efficiency and strengthening environmental compliance (De Oliveira Lima et al. 2024). However, the impact of GP can vary across situations, particularly in emerging economies where supplier capacities and environmental policies differ. Despite these contextual variations, GP still remains a central aspect of the GSCP. As such, the hypothesis presented below is given:

H4: Green purchasing has a significant effect on sustainable performance.

Sustainable innovation and sustainable performance

Sustainable innovation is a type of innovation process that aims to meet economic, environmental and social goals. In contrast to traditional innovation, SI is focused on long-term value creation by means of environmentally friendly and socially inclusive solutions (AL-khatib & Ramayah 2025; Hosen et al. 2025).

Available literature suggests that SI can improve SP as it helps firms to create green products, to optimise and streamline the production process, and to react appropriately to the sustainability demands of the stakeholders (Shan, Li & Shi 2020). In industrial contexts, SI helps to ensure resilience and competitiveness in the long run. Resting on this argument, the following hypothesis is created:

H5: Sustainable innovation has a positive effect on sustainable performance.

Green purchasing and green innovation

Green purchasing can also be an important driver of GI, as it motivates suppliers to adopt clean technologies and practices. By selecting suppliers and partnering in an environmentally oriented manner, firms have access to external knowledge and competencies to support GI efforts (Sarfraz et al. 2022).

Empirical studies show that companies that are involved in GP are more likely to invest in green product and process development because cooperation with suppliers can be used to spread green technologies (Rasheed, Rashid & Ngah 2024). In this regard, the proposal of the study is:

H6: Green purchasing has a significant effect on green innovation.

Sustainable innovation and green innovation

Sustainable innovation and GI are closely related concepts, as they both emphasise the development of value that is responsible towards the environment. Sustainable innovation provides a strategic direction that supports the green product and process development, and consequently enhances the GI capabilities of firms (Alqarni et al. 2023; Correia et al. 2024).

According to the existing literature, companies with a strong SI have a more advantageous position to develop and adopt GIs that can boost the environmental and operational performance (Singh & Maheswaran 2024). In that regard, the hypothesis below is postulated:

H7: Sustainable innovation has a positive effect on green innovation.

The moderating role of green human resource management

The development of GI is expected to positively impact SP, but this effect may also depend on the context. The moderating role of GHRM is critical, as it enhances staff capacity and desire to support innovation-based sustainability programmes. With the help of specific training programmes, performance incentives and environmental awareness programmes, GHRM enhances the adoption of GI approaches (Correia et al. 2024; Ibrahim & Eitah 2025).

Green human resource management is bound to influence the success of innovation initiatives in industrial companies, where the efficient use of GI often requires cross-functional collaboration and employee involvement. In line with this, this study hypothesises:

H8: GHRM moderates the relationship between green innovation and sustainable performance.

Conceptual framework

The theoretical approach of this research is based on Resource-Based View (RBV; Barney 1991) and Dynamic Capabilities Theory (Teece, Pisano & Shuen 1997, 2009) that serve as a good theoretical background in explaining the contribution of GSCP to the SP of industrial companies.

Resource-based view holds that sustainable competitive advantage is attained when firms succeed in their acquisition and utilisation of valuable, rare, inimitable and non-substitutable resources and capabilities (Barney 1991). Green supply chain practices, including GP, SI and CEC, may be viewed as strategic organisational capabilities in the context of sustainability, allowing companies to minimise the risks to the environment, enhance the efficiency of their operations and increase the SP in the long term (Agyabeng-Mensah et al. 2021; Jazairy & Von Haartman 2020).

In addition, the framework recognises the significance of human capital in transformation based on sustainability. The concept of GHRM is introduced to the organisation as a set of capabilities that help improve the environmental awareness, skills and commitment of employees by means of green recruitment, training, performance appraisal and reward systems (AlKetbi & Rice 2024; Correia et al. 2024). Green human resource management enhances the effectiveness of GI initiatives and the successful implementation of sustainability-oriented strategies by promoting a pro-environmental organisational culture. Green human resource management is therefore hypothesised to have a moderate effect on the relationship existing between GI and SP.

All in all, the conceptual framework suggests that GSCP has a direct effect on SP and indirectly contributes to sustainability results through facilitating GI. It also indicates that GI can be effective in improving SP, depending on the extent to which GHRM practices are institutionalised within the organisation. This unified model provides an overall account of sustainability value creation in the industrial sector.

Research model

The current research is based on the conceptual framework and available empirical data, and develops a research model to investigate the interrelationships among GSCP, GI, GHRM, and SP in Jordan's industrial sector.

There are several direct effects outlined in the research model. The postulated hypothesis is that SP will depend directly on CEC, GP, SI and GHRM. These relationships represent the assumption that eco-friendly supply chain and organisational actions have an impact on the economic, environmental and social performance results (Agyabeng-Mensah et al. 2021; Diab et al. 2015; Saeed, Priyankara & Naotunna 2018).

Moreover, the model accounts for antecedent relationships, which assume that GP and SI are important drivers of GI. These directions highlight the contribution of environmentally responsible sourcing and strategic innovation orientation to the development of eco-friendly products and processes (Jazairy & Von Haartman 2020; Jum'a et al. 2022).

In addition, the model has a moderating effect: GHRM moderates the relationship between GI and SP. This interaction helps to argue that the effective process of GI translation into sustainability outcomes depends on the environmental competency, motivation and organisational support system of employees (Abdellatif & Graham 2019; Jum'a et al. 2022).

The research aims to generate strong evidence on how industrial firms in emerging economies can use GSCP, innovation capabilities and HR systems to improve SP. Figure 1 shows the conceptual framework of this study.

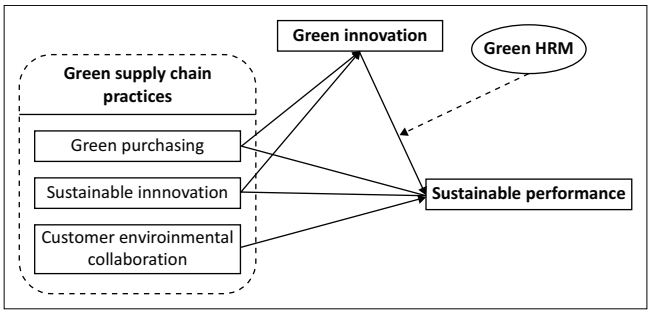
Research methods and design

Research design

The proposed study adopts a quantitative, cross-sectional design to analyse how GSCP, GI, GHRM and SP are related in Jordan's industrial sector. Quantitative research methods are needed to test the theoretically based hypotheses and evaluate the relationship among the latent constructs in a complex manner based on structural equation modelling techniques (Hair, Ringle & Sarstedt 2013). In this regard, partial least squares structural equation modelling (PLS-SEM) was used to test the proposed research model.

Population of the study

The target population for this study comprises industrial enterprises in Jordan, which include manufacturing and production-based firms across various industrial subsectors.



HRM, human resource management.

FIGURE 1: Conceptual framework.

These entities were selected because they have a high environmental impact and are increasingly subject to environmental regulations, sustainability principles and stakeholder demands.

Given that the constructs considered in the present research relate to organisational strategies and managerial practices, the unit of analysis is the organisation, and the unit of observation is the manager.

Sample size and sampling technique

The study data were collected from 300 managers working in Jordanian industrial organisations. This is a large enough sample to meet the minimum criteria of PLS-SEM and provide sufficient statistical power to reject (or accept) the hypotheses. The 10-times rule states that the maximum size of the required samples will be at least 10 times the largest number of structural paths to any endogenous variable in the model (Hair et al. 2021). The sample size is sufficient to meet this criterion.

The respondents were selected through a purposive (judgemental) sampling technique, and they had adequate knowledge and experience in supply chain management, sustainability initiatives, innovation activities and HR practices. The target population of the study was senior and mid-level managers, given their direct involvement in strategic decision-making and in implementing the green supply chain and other sustainability-related practices.

The managers were selected as key informants because they could provide more precise evaluations of practices and performance outputs at the firm level than non-managerial employees. This strategy finds wide application in the research on the green supply chain and sustainability (Hosen et al. 2025).

Data collection procedure

A structured, self-administered questionnaire was distributed to managers of industrial enterprises to collect data. The questionnaire was distributed in both electronic and printed versions to increase response rates. The instrument was reviewed by academic scholars and industry practitioners before the main data collection to ensure it was clear and relevant to the industrial environment in Jordan. The survey was completely voluntary, with respondents being guaranteed confidentiality and anonymity. All responses were collected, analysed, and used solely for academic research, in accordance with ethical research standards.

Measurement of variables

To ensure content validity and measurement reliability in the present study, all constructs were measured with multi-item scales based on prior studies. All measurement items were rated by participants on a 5-point Likert scale, from 1 (strongly disagree) to 5 (strongly agree). The evaluation of CEC was conducted using items adapted from Hutomo et al. (2020), and the evaluation of GP was conducted using scales developed by De Oliveira Lima et al. (2024). Operationalisation of SI was measured using items adapted from Atieh and Abushaega (2025), whereas GI was measured using validated scales from Hosen et al. (2025). Green human resource management was assessed using adaptions of the items used by Novitasari and Agustia (2021), thereby representing green practices in recruitment, training and performance management. Finally, SP was theorised as a multidimensional construct encompassing economic, environmental and social performance dimensions, and was measured using items adapted from previous sustainability-performance studies (Miller, Pawloski & Standridge 2010).

Data analysis techniques

The SmartPLS software (SmartPLS GmbH, Monhein am Rhein, Germany) was used to analyse the obtained data using the PLS-SEM method. The analysis was done in two major steps. To begin with, internal consistency reliability, convergent and discriminant validity of the measurement model were assessed using Cronbach's alpha, composite reliability (CR), average variance extracted (AVE) and Fornell–Larcker criterion (Hair et al. 2019).

Secondly, the structural model was tested using path coefficients, *t*-values, *p*-values, and the coefficient of determination (R^2). The relationship hypotheses were tested using a bootstrapping process with 5000 resamples to check their statistical significance. In addition, an interaction term between GHRM and GI was created to explore their moderating impact on SP.

Common method bias

To reduce the risk of common method bias, a number of procedural remedies were implemented, including ensuring respondent anonymity, improving the clarity of the scales, and isolating the predictor and criterion variables in the questionnaire. Moreover, statistical assessments were conducted as per the guidelines of Podsakoff et al. (2003).

Results

The following section presents the findings of the data analysis performed using PLS-SEM with SmartPLS software. The analysis was conducted in two steps, as it is suggested in earlier methodological research (Hair & Alamer 2022). Firstly, the measurement model was tested in order to determine the reliability of the indicators (i.e. measurement reliability and internal consistency reliability), convergent validity and discriminant validity. Secondly, the model was tested to validate the hypothesised relationships using path coefficients, *t*-values, *p*-values, the coefficient of determination (R^2), and the moderating effect, based on a structural model.

The findings present empirical evidence concerning the links between GSCP, GI, GHRM and SP in Jordan's industrial sector.

Measurement model assessment

The measurement model was tested to assess the reliability and validity of the latent constructs before structural testing. According to the suggestions provided (Hair & Alamer 2022), the evaluation included indicator reliability, internal consistency reliability, conversant validity and discriminant validity.

The reliability of the indicator was evaluated by measuring the item loadings of the measurement model. According to Table 1, all factor loadings are above the recommended factor of 0.70, indicating that the indicators are a good representation of their constructs.

Cronbach's alpha and CR were used to measure internal consistency. The findings show that Cronbach's alpha values range from 0.818 to 0.897, all above the acceptable level of 0.70. Similarly, CR scores range from 0.878 to 0.922, indicating a high degree of internal consistency across all constructs.

The coefficient of convergent validity was evaluated using the AVE criterion. The AVE values for all constructs exceed the recommended level of 0.50, ranging from 0.619 to 0.716, indicating that the constructs explain more than half of the variance in their indicators.

As illustrated in Figure 2, the results demonstrate that the measurement model has satisfactory indicator reliability, internal consistency reliability and convergent validity, thereby justifying the sufficiency of the measurement scale and allowing further analysis of the structural model.

Discriminant validity

The Heterotrait–Monotrait ratio (HTMT) was used to evaluate discriminant validity as it is considered a reliable criterion in variance-based structural equation modelling. All the HTMT values, as indicated in Table 2, are below the conservative threshold of 0.85, and this means that each construct is empirically distinct from the others. These findings support the fact that the measurement model has proper discriminant validity, which justifies the uniqueness of the constructs used in the study. The Fornell–Larcker criterion was also used to further assess discriminant validity. The square root of the AVE (diagonal values) of each construct, as shown in Table 3, is more than its respective correlations with other constructs. This implies that each construct has greater variance with its indicators than with those of other constructs in the model, thereby showing sufficient discriminant validity.

These findings, along with the HTMT results presented in Table 2, indicate that the measurement model has strong discriminant validity.

Structural model assessment

The structural model was tested to determine the hypothesised correlations among the study's constructs. The path coefficients were found to be important through a bootstrapping process of 5000 resamples, where standardised path coefficients (β), *t*-values and *p*-values were analysed (Hair & Alamer 2022).

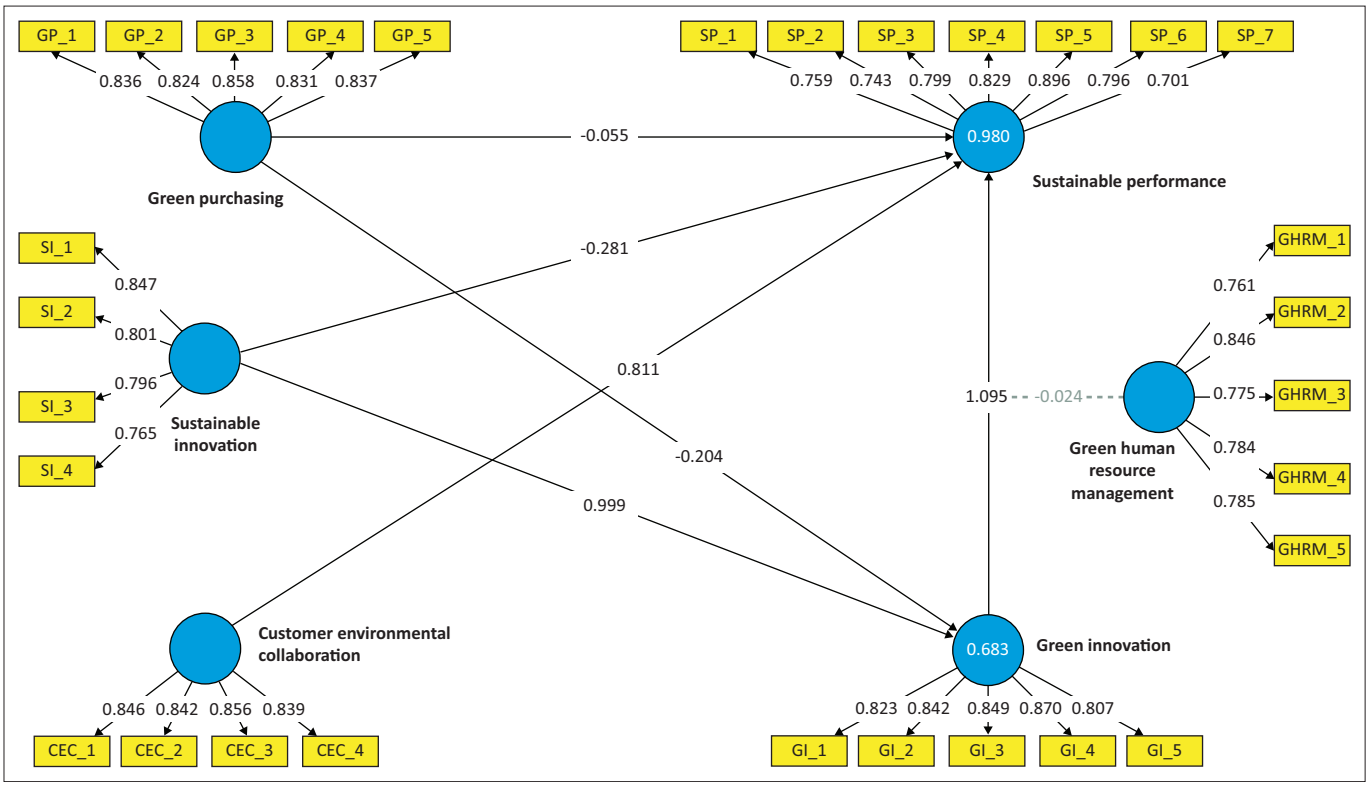
The findings showed that CEC has a significant positive impact on SP ($\beta = 0.811$, $p < 0.001$), thereby supporting H1. Green human resource management also presents a substantial impact on SP ($\beta = 0.475$, $p < 0.001$), supporting H2. This is a negative relationship, but one that is statistically significant and thus supported. In addition, GI exhibits a very significant positive effect on SP ($\beta = 1.095$, $p < 0.001$), supporting H3. Green purchasing has a considerable impact on GI ($\beta = 0.204$, $p = 0.013$) and SP

TABLE 1: Measurement model assessment (reliability and convergent validity).

Construct	Item	Factor loading	Cronbach's alpha	rho_A (ρ_a)	CR (ρc)	AVE
Green purchasing	-	-	0.894	0.898	0.921	0.701
	GP_1	0.836	-	-	-	-
	GP_2	0.824	-	-	-	-
	GP_3	0.858	-	-	-	-
	GP_4	0.831	-	-	-	-
	GP_5	0.837	-	-	-	-
Sustainable innovation	-	-	0.818	0.827	0.878	0.644
	SI_1	0.847	-	-	-	-
	SI_2	0.801	-	-	-	-
	SI_3	0.796	-	-	-	-
	SI_4	0.765	-	-	-	-
Customer environmental collaboration	-	-	0.868	0.874	0.910	0.716
	CEC_1	0.846	-	-	-	-
	CEC_2	0.842	-	-	-	-
	CEC_3	0.856	-	-	-	-
	CEC_4	0.839	-	-	-	-
Green innovation	-	-	0.894	0.897	0.922	0.703
	GI_1	0.823	-	-	-	-
	GI_2	0.842	-	-	-	-
	GI_3	0.849	-	-	-	-
	GI_4	0.870	-	-	-	-
	GI_5	0.807	-	-	-	-
Green human resource management	-	-	0.851	0.857	0.893	0.625
	GHRM_1	0.761	-	-	-	-
	GHRM_2	0.846	-	-	-	-
	GHRM_3	0.775	-	-	-	-
	GHRM_4	0.784	-	-	-	-
	GHRM_5	0.785	-	-	-	-
Sustainable performance	-	-	0.897	0.902	0.919	0.619
	SP_1	0.759	-	-	-	-
	SP_2	0.743	-	-	-	-
	SP_3	0.799	-	-	-	-
	SP_4	0.829	-	-	-	-
	SP_5	0.869	-	-	-	-
	SP_6	0.796	-	-	-	-
	SP_7	0.701	-	-	-	-

Note: Factor loadings above 0.70 indicate satisfactory indicator reliability. Cronbach's alpha and composite reliability (ρA and ρC) values exceeding 0.70 confirm internal consistency reliability. Average variance extracted values greater than 0.50 demonstrate adequate convergent validity.

GP, green purchasing; SI, sustainable innovation; CEC, customer environmental collaboration; GI, green innovation; GHRM, green human resource management; SP, sustainable performance; CR, composite reliability; AVE, average variance extracted.



GP, green purchasing; SI, sustainable innovation; CEC, customer environmental collaboration; GI, green innovation; GHRM, green human resource management; SP, sustainable performance.

FIGURE 2: Partial least squares structural equation modelling results for the measurement and structural model.

TABLE 2: Discriminant validity assessment using the Heterotrait–Monotrait ratio criterion.

Variable	Customer environmental collaboration	GHRM	Green innovation	Green purchasing	Sustainable innovation	Sustainable performance	GHRM and Green innovation
Customer environmental collaboration	-	-	-	-	-	-	-
GHRM	0.785	-	-	-	-	-	-
Green innovation	0.787	0.683	-	-	-	-	-
Green purchasing	0.777	0.636	0.745	-	-	-	-
Sustainable innovation	0.630	0.701	0.627	0.750	-	-	-
Sustainable performance	0.520	0.429	0.370	0.455	0.415	-	-
GHRM × Green innovation	0.271	0.397	0.534	0.237	0.317	0.471	-

GHRM, green human resource management.

TABLE 3: Discriminant validity assessment (Fornell–Larcker criterion).

Constructs	CEC	GHRM	GI	GP	SI	SP
CEC	0.846†	-	-	-	-	-
GHRM	0.718	0.791†	-	-	-	-
GI	0.699	0.773	0.839†	-	-	-
GP	0.647	0.691	0.671	0.837†	-	-
SI	0.633	0.602	0.620	0.676	0.803†	-
SP	0.618	0.610	0.764	0.772	0.688	0.787†

AVE, average variance extracted; CEC, Customer environmental collaboration; GHRM, Green human resource management; GI, Green innovation; GP, Green purchasing; SI, Sustainable innovation; SP, Sustainable performance.

†, Diagonal elements represent the square root of AVE, while off-diagonal elements represent inter-construct correlations.

(β = 0.278, p = 0.003), thereby supporting H4 and H6, respectively. The results also show that SI has a large positive impact on GI (β = 0.999, p < 0.001) and SP (β = 0.812, p < 0.001), thereby supporting H5 and H7. These findings highlight that SI plays a central role in promoting innovation and achieving performance-based sustainability outcomes. Regarding the moderating effect, the interaction between GHRM and GI was statistically significant (β = 0.024, p = 0.027), indicating that GHRM moderates the relationship between SP and GI. Altogether, the findings of the structural model provide strong empirical evidence for the proposed research model, confirming that GSCP, innovation capacities and human-resource-related aspects are crucial to improving SP in the Jordanian industrial sector (Table 4).

Coefficient of determination (R^2)

The significance of the structural model was assessed using the coefficient of determination (R^2). Table 5 demonstrates that the model explains 68.3% of the variability in GI, indicating significant predictive accuracy. This implies that GP and SI both have strong explanatory strength for GI.

Besides, the model explains SP with 98.0% accuracy, indicating an incredibly high degree of explanatory power. This means that customer environmental

TABLE 4: Structural model results and hypothesis testing.

Path	β (O)	t	p	Result
CEC → SP	0.811	14.984	0.000	Supported
GHRM → SP	-0.475	11.617	0.000	Supported
GI → SP	1.095	33.142	0.000	Supported
GP → GI	-0.204	2.490	0.013	Supported
GP → SP	-0.278	2.933	0.003	Supported
SI → GI	0.999	13.731	0.000	Supported
SI → SP	0.812	9.243	0.000	Supported
GHRM × GI → SP	-0.024	2.207	0.027	Supported

Note: β indicates standardised path coefficients. Significance was assessed using a bootstrapping procedure with 5000 resamples.

GHRM, green human resource management; CEC, Customer environmental collaboration; GHRM, Green human resource management; GI, Green innovation; GP, Green purchasing; SI, Sustainable innovation; SP, Sustainable performance.

TABLE 5: Coefficient of determination (R^2).

Endogenous construct	R^2	Adjusted R^2
Green innovation	0.683	0.680
Sustainable performance	0.980	0.980

Note: R^2 values indicate the proportion of variance explained by the predictor constructs.

collaboration, GP, SI, GI, GHRM and the interaction effect provide an immensely powerful explanation of SP in the Jordanian industrial sector.

The values of adjusted R^2 are very close to those of R^2, demonstrating the model's stability and strength and indicating that its complexity does not overstate its explanatory power.

Discussion

The current work is a strong empirical study of how the combination of GSCP, innovation capability and HR-related mechanisms is able to define SP in Jordan's industrial sector. The results obtained combine views from the RBV and the Dynamic Capabilities Theory, go beyond merely describing associations, and provide a more comprehensive explanation of how sustainability-related practices are transformed into performance outcomes in the context of an emerging economy.

Customer environmental collaboration and sustainable performance

The results show that CEC and SP are strongly and positively related, meaning that companies that involve customers in environmental activities achieve better sustainability outcomes. The latter finding aligns with previous studies that highlight the significance of relationship collaboration when working in a green supply chain (Benzidia, Makaoui & Bentahar 2021; Moh'd Anwer 2025). Through the lens of dynamic capabilities, customer collaboration contributes to a firm's ability to perceive environmental needs and respond by organising sustainable behaviours.

In the Jordanian industrial environment, CEC appears to be of particular concern in light of increasing regulatory pressure and growing customer interest in environmental issues. The results contribute to the literature by demonstrating that customer-based environmental partnership remains an effective means of achieving sustainability, even in resource-constrained industrial settings.

Green human resource management and sustainable performance

The empirical results prove that GHRM has a strong but negative direct impact on SP. This observation, however, appears incompatible with the stance according to which sustainability-oriented HR practices normally involve short-term investments and organisational rebalancing before generating sustainable returns (Awwad Al-Shammari et al. 2022). In this regard, GHRM is a long-term capacity investment rather than a timely generator of performance returns from an RBV perspective.

In the context of nascent industrial environments (such as Jordan), GHRM implementation can also cause an immediate increase in operational complexity and additional training costs, or confront employees, thereby putting pressure on short-term performance results. This fact highlights the importance of considering time lags and situational variables in evaluating the performance implications of GHRM.

Green innovation as a core performance driver

The potential of GI to have a significant positive effect on SP underscores the critical role of innovation in attaining SP goals. The results can be compared to previous research that emphasises the importance of GI as an instrumental process to help companies transform environmental activities into actual performance results (Le, Vo & Venkatesh 2022; Leal-Millán et al. 2016). From the perspective of dynamic capabilities, GI enables companies to continually redesign their resources and processes in response to environmental problems.

In Jordan's industrial sector, where companies face high energy costs and scarce natural resources, the concept of GI appears to be the primary driver of sustainability performance, thereby supporting the strategic significance of sustainability through innovation.

The dual role of green purchasing

The results reveal that GP has a negative direct impact on SP but a considerable impact on GI. This two-fold role supports previous hypotheses that upstream green operations might have short-term cost liabilities but development opportunities in the long run (Lerman et al. 2022). In emerging economies, limited supplier willingness and high costs of environmentally friendly inputs may constrain performance in the early stages. However, GP enables firms to access environmentally friendly suppliers and green technologies, thereby improving their innovation capacity. This fact also suggests that GP is an indirect facilitator of sustainability through innovation, rather than a direct performance driver.

Sustainable innovation as a strategic lever

The correlations between SI and GI, and between SI and SP, are positive, highlighting the importance of a sustainability-oriented innovation mindset. This result is consistent with the previous literature that states that SI has a positive impact on firms to improve their ability to produce environmentally friendly products and processes and remain competitive (Chan et al. 2020).

Sustainable innovation is therefore a strategic basis for achieving both innovation-based and performance-based sustainability in industrial companies.

The moderating role of green human resource management

The nexus between GI and SP is moderately significant, as evidenced by the substantial GHRM, which further clarifies the role of situational human capital. This discovery is in line with the claim that the effectiveness of sustainability strategies that rely on innovation depends on the skills, motivation and organisational support system of employees (Ibrahim & Alzubi 2024). Green innovation alone in the Jordanian industrial environment might not result in significant improvements in performance unless supported by comparable HR practices. Green human resource management is therefore a capability multiplier that increases the impact of innovation on sustainability performance, rather than a performance driver.

Theoretical and practical implications

Theoretical implications

The current study has several valuable theoretical implications for the green supply chain management, sustainability and organisational capabilities literature. Firstly, the study contributes to the GSCM literature by empirically demonstrating that green practices cannot be regarded as single operational instruments but as a system of interconnected strategic capabilities. The research findings, by examining CEC, GP, SI, GI and GHRM, simultaneously reveal that SP results from the synergistic and interactive effects of supply chain, innovation and HR capabilities. This combined approach builds on prior research that has primarily investigated green practices in isolation.

Secondly, the results contribute to the RBV by showing that not every sustainability-oriented capability positively affects short-run performance. The large but negative direct influence of GP and GHRM on SP indicates that certain green capabilities are expensive, multifaceted investments whose benefits may be realised only over time or indirectly, through innovation. Such a subtlety adds value to the RBV as it illustrates the temporality and contextuality of sustainability-related resources in the emerging economies.

Thirdly, the research presents strong empirical evidence for the Dynamic Capabilities Theory, identifying GI as one of the key processes by which the firm can convert the GSCP into SP. The highly significant impact of GI on SP confirms that the capability to constantly reorganise products, processes and technologies is decisive for achieving sustainability in unstable, resource-limited industrial settings. Further, the moderating role of GHRM highlights that dynamic capabilities are not technology-driven but are deeply rooted in human and organisational systems.

Finally, it will provide useful empirical data in an emerging-economy setting that has rarely been researched, as it targets Jordan's industrial sector. The results not only make sustainability and supply chain theories more externally valid, but also explain that their fundamental assumptions are applicable outside developed economies and also suggest crucial contextual contingencies associated with cost structures, institutional pressures and human-capital constraints.

Practical implications

The results of this research have several practical implications for industrial managers, policymakers and other decision makers who aim to improve their sustainability performance.

The findings for industry managers imply the strategic importance of engaging customers in environmental programmes. Customers should be actively involved in environmental partnerships by managers, co-designs and sustainability-related decisions, as this collaboration significantly contributes to SP. This could include mutual environmental audits, common sustainability goals and the development of products with key concerns on environmental performance.

The results also suggest that green procurement must be undertaken in a strategic approach and not symbolically. Even though green procurement can cause a temporary performance stress owing to higher costs and supplier restrictions, it is a key to promoting GI. With this in mind, green procurement is a long-term investment in innovation capacity, supplier development, long-term partnerships, and the progressive incorporation of environmental criteria into the procurement decision-making process; the managers should consider it. Concerning green human-resource management, the findings indicate that implementing green HR practices alone is not sufficient to enhance performance. It is the responsibility of managers to make ensure that GHRM systems are closely aligned with operational and innovation processes. This involves connecting environmental training to specific innovation projects, aligning performance appraisal systems with sustainability performance, and developing incentive systems that reward innovation-driven environmental performance rather than compliance.

In terms of policy, conclusions are that policymakers ought to contribute to the sustainability of industries not only by imposing regulations but also by fostering innovations and

building capacity. This can include incentives to encourage GI, supporting programmers in terms of supplier's development, investment in sustainability-based skills development and training programmers.

All in all, the study highlights that the industrial sector cannot achieve SP through isolated green efforts. Instead, it requires an integrated approach that encompasses supply-chain practices, innovation capabilities and human-resource systems into a coherent sustainability system.

Conclusion

This study investigated how the GSCP could affect the SP of the Jordanian industrial sector by integrating the roles of GI and GHRM into an overall capability-based model. Based on the RBV and the Dynamic Capabilities Theory, the results provide strong empirical support for the view that the factors driving sustainability outcomes are not a combination of solitary green efforts but the interplay of supply-chain, innovation and human-resource capabilities.

The findings demonstrate that CEC and SI are important for improving SP, whereas GI is the most effective driver of sustainability outcomes. Simultaneously, the results show that some of green practices, such as GP and GHRM, can produce a short-term adverse impact on performance impact, which underscores the high price and transitional nature of sustainability investments in non-established industrial settings. Notably, the need for human capital alignment, as moderated by GHRM, proves the fact that the transformation of innovation-based sustainability initiatives into performance outputs is imperative.

In general, this research makes a valuable addition to the body of literature on sustainability and the supply chain management, as it provides an in-depth understanding of the role of green practices as strategic capabilities in a developing economy. The study is relevant to the contextual applicability and generalisability of the previous theoretical paradigms and offers guidelines that managers and policymakers interested in long-term SP can implement, with a focus on Jordan's industrial sector.

Limitations and future research

This study, in spite of its contributions, has several limitations that need to be taken into account and overcome in future research. Firstly, the research design is cross-sectional, with limitations that it does not enable the researcher to obtain the dynamic and long-term impact of GSCP and innovation capability on SP. It is recommended that future researchers use longitudinal designs to study changes in the performance implications of green practices over time, especially given the high cost of sustainability investments.

Secondly, the respondents were only managers in Jordanian industries, which is suitable for capturing organisational practices, but it could lead to perceptual bias. The study may be improved in the future by using multi-respondent designs or by adding objective performance indicators to strengthen the measurement.

Thirdly, the research is conducted in a single-country setting and may not be generalisable to other institutional and cultural settings. Contrasting cross-country analyses would be beneficial, as they would indicate how regulatory regimes, market maturity and the availability of required resources influence the GSCP's efficacy.

Lastly, although this study analyses the most important variables in supply chain, innovation and HR, further studies may expand the model by adding more contextual variables, such as organisational culture, digital technologies, the level of environmental regulation or the practice of the circular economy. Investigating other mediating and moderating processes can also contribute to the existing knowledge of sustainability-oriented value creation.

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Competing interests

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CRediT authorship contribution

Al-Hareth M. Abu Hussein: Conceptualisation, Methodology, Project administration, Resources, Software, Validation, Visualisation, Writing – original draft. Al Montaser Mohammad: Data curation, Formal analysis, Funding acquisition, Methodology, Project administration, Software, Supervision, Writing – review & editing. Ahmad F. Alheet: Conceptualisation, Investigation, Writing – original draft. Mahmoud H. Abu Joma: Conceptualisation, Resources, Writing – original draft. Jehad Alqdeimat: Conceptualisation, Investigation, Writing – original draft. Nurul Aisyah A. Rahim: Conceptualisation, Investigation, Validation, Writing – review & editing. All authors reviewed the article, contributed to the discussion of results, approved the final version for submission and publication, and take responsibility for the integrity of its findings.

Ethical considerations

Ethical clearance to conduct this study was obtained from the Deanship of Scientific Research (No. ZU-EC-2025-087). Informed consent was obtained from all participants prior to their participation in the study. Participants were clearly informed about the purpose of the research, confidentiality of their responses, anonymity, and their right to withdraw from the study at any time without any consequences.

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Data availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Disclaimer

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