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GREEN INFORMATION SYSTEMS IMPLEMENTATIONS, GREEN SUPPLY CHAIN MANAGEMENT PRACTICES, AND BUSINESS SUSTAINABILITY IN A DEVELOPING COUNTRIES CONTEXT: AN EMPIRICAL STUDY

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Abstract*: While extensive literature examines the individual roles of green information systems (GIS) and green supply chain management (GSCM) in improving firm performance, there is a notable scarcity of studies exploring their combined impacts on business sustainability (BS) in developing nations. This study addresses this gap by investigating the direct connection between GIS implementations and BS in small- and medium-sized enterprises (SMEs) in Palestine. It also explores the mediating role of GSCM practices in this relationship. Data on GIS implementations, GSCM practices, and factors related to BS were collected through a survey and analyzed using partial least squares structural equation modeling (PLS-SEM). The results demonstrate that GIS implementations have a positive and significant impact on GSCM practices and BS. Moreover, the relationship between GIS implementations and BS is significantly mediated by GSCM practices. This research is distinctive in its examination of the effects of GIS and GSCM on BS within the context of a developing country, providing the valuable*

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insights to the literature and presenting new perspectives on achieving sustainable performance in complex business environments.

***Keywords**: Green Supply Chain Management, Green Information System, Business Sustainability, Small and Medium-Sized Enterprises, Developing Countries.*

1. Introduction

The prevention of environmental degradation have emerged as pivotal concerns for manufacturing businesses in industrialized nations, as emphasized by (Baah et al., 2021). However, in emerging nations, these issues have not received sufficient attention due to the absence of ecological business strategies, as pointed out by Khan et al., (2021) Consequently, manufacturing firms in these regions are facing increasing pressure from customers to adopt GSCM practices in order to mitigate their environmental impacts, as underscored by Liu et al, (2021).

Several research studies have underscored the significance of recognizing crucial improvement programs that come before the adoption of GSCM practices, like total quality GIS implementations (Tseng et al., 2019; Tseng et al., 2018). As noted by (Lembcke et al., 2021), GIS plays a substantial and vital role in facilitating sustained, purposeful real-world endeavors. Once a company commits to sustainability as a strategic objective, it requires a monitoring system to assess the efficacy of its environmental initiatives, including GIS implementations (Khan et al., 2021).

The significance of GIS in the realm of SCM is paramount, especially in light of the heightened environmental awareness among eco-conscious manufacturers. Consequently, these manufacturers should augment their investments in green technology, as advocated by (Wang et al., 2020). Green information systems should prioritize the enhancement of technological integration across the entirety of the operational SCM process, as underscored by (Liu et al., 2021). When formulating supply chain strategies with the aid of GIS, energy conservation and the pursuit of carbon neutrality should be central considerations, as emphasized by (Wang et al., 2021).

Recent scholarly research has noted an increasing trend in firms incorporating GIS into their operations (Tseng et al., 2019). Nevertheless, the precise degree to which GIS can have a beneficial effect on the profitability of firms that implement GSCM practices remains inadequately understood (Gholami et al., 2013; Yang et al., 2018). Scholars have identified a challenge related to information asymmetry in communication between firms and their suppliers concerning environmental sustainability requirements and standards. This challenge arises because suppliers frequently possess more extensive environmental information about the materials and products moving through the supply chain.

Effective information-sharing capabilities are essential for addressing information asymmetry. Robust information systems help firms track environmental activities throughout the supply chain, leading to better identification and resolution of environmental issues. This, in turn, enhances the effectiveness of GSCM practices and improves overall performance (Esfahbodi et al., 2023). We propose the contingent relationship between GSCM practices, GIS implementation, and BS within green supply chains, a unique context. In the manufacturing sector, aligning the adoption of GIS with existing GSCM practices enhances BS (Esfahbodi et al., 2023). BS involves pursuing profitability while considering social development and environmental impacts. It benefits stakeholders, improves lives, and supports environmental protection. Sustainability comprises three dimensions: social (people and society), environmental (Earth and natural resources), and economic (financial aspects), often referred to as the "Triple Bottom Line" (TBL) (Khokhar et al., 2022; Shahzad et al., 2020).

The mediating role of GSCM practices betweenGIS and BS in a structural model has not been studied yet (Yang et al., 2018). This study seeks to bridge this gap by investigating the connections between GIS, GSCM practices, and their impact on BS in SMEs in Palestine. It specifically examines the potential advantages of GIS adoption in the presence of robust GSCM practices and delves into how GSCM practices mediate the GIS-BS relationship. Palestine was chosen as a case study due to its status as a developing nation, characterized by suboptimal employee skills, low motivation, and an inefficient organizational structure that poses challenges to addressing environmental sustainability issues (Zaid & Sleimi, 2021). This study aims to enhance the existing knowledge by investigating how GIS and GSCM practices jointly influence business sustainability (BS) in Palestine. It strives to provide valuable insights for SMEs to enhance their sustainability performance. Notably, this research is one of the limited empirical studies that explore the connection between GIS, GSCM practices, and BS in Palestine, effectively addressing a recognized gap in the literature.

The subsequent sections of this article are structured as follows: Section 2 offers a literature review and the formulation of hypotheses. Section 3 outlines the methodological procedures employed. Section 4 covers data analysis and the evaluation of the proposed model. Section 5 provides a discussion of the results. Section 6 concludes with final remarks, including theoretical and managerial contributions, along with addressing limitations and future research opportunities. The subsequent sections of this article are structured as follows: Section 2 offers a literature review and the formulation of hypotheses. Section 3 outlines the methodological procedures employed. Section 4 covers data analysis and the evaluation of the proposed model. Section 5 provides a discussion of the results. Section 6 concludes with final remarks, including theoretical and managerial contributions, along with addressing limitations and future research opportunities.

2. Literature Review and Hypotheses Development

2.1 Theoretical Background

The current research paradigm is built upon (Hart, 1995) Natural-Resource-Based View (NRBV) hypothesis. According to NRBV theory, a company's environmental friendliness is contingent on its capacity to reduce pollution during product use, sustain products for minimal environmental impact during usage, and adopt clean technologies to reduce polluting materials and encourage eco-friendly practices (Deng & Ji, 2015). Similarly, GIS integration facilitates the delivery of clean, eco-friendly products and services to supplant non-green alternatives, fostering product stewardship (PS), pollution reduction, and renewable energy utilization (Cooper & Molla, 2017).

NRBV posits that sustainable development (SD), PS, and pollution prevention (PP) are the three key strategic competencies, each influenced by unique environmental factors, reliant on specific critical resources, and gaining competitive advantage from different sources (Hart & Dowell, 2011). NRBV underscores environmental outcomes (Tate & Bals, 2018). Furthermore, examining how green technologies can be harnessed to attain sustainability objectives in global network linkages provides a broader perspective on sustainable SCM (Leme et al., 2018). Prior research in the field of sustainability has primarily concentrated on sustainable supply networks, as exemplified by studies like (Kanan, 2023; Kanan et al., 2022). The NRBV framework regards environmental activities as fundamental for substantial organizational profitability. (Hart, 1995) also contends that the attributes of environmental strategies, such as PP, PS, and SD, share characteristics with general resources in being valuable, non-substitutable, firm-specific, and challenging to replicate, necessitating integration into capabilities to perform specific value-added activities. also contends that the attributes of environmental strategies, such as PP, PS, and SD, share characteristics with general resources in being valuable, non-substitutable, firm-specific, and challenging to replicate, necessitating integration into capabilities to perform specific value-added activities.

2.2 Green Information Systems and Business Sustainability

Information system technology is a significant energy consumer, resulting in elevated carbon emissions and detrimental effects on the environment (Chuang & Huang, 2018). Green technology mitigates a company's environmental footprint, enabling manufacturing firms to improve their products, processes, and services for SD (Khan et al., 2021). (Liu et al., 2018) discovered a strong connection between GIS and sustainability performance, enhancing information-processing capabilities to support firms' ecological strategic focus.

New methodologies demonstrate that environmental concerns have a significant influence on the competitive landscapes of businesses. Companies equipped with technology to develop eco-friendly products addressing environmental challenges gain a competitive advantage (Antoni et al., 2020). GIS can enhance business operations by promoting environmentally friendly innovations and processes, offering a competitive edge, improving firm outcomes, and creating challenges for competitors to emulate. GIS deployment facilitates the exchange of information regarding environmental activities (Khan et al., 2017). Embracing green practices directly and positively affects the infrastructure's competitiveness and capabilities, thus enhancing firm outcomes (Wang et al., 2015). GIS is also associated with improved environmental performance. (Chuang & Huang, 2018) affirmed a robust link between GIS and a firm's sustainability performance, underscoring the increasing emphasis on environmental sustainability and green management. Consequently, we propose the first hypothesis:

H1: *The implementation of GIS positively affects BS in Palestinian manufacturing SMEs.*

2.3 Green Information Systems and Green Supply Chain Management

Information technology-driven developments that support sustainable development (SD) internally encompass GSCM and green information technology. Moreover, information technology solutions designed to enhance sustainability within the broader SCM context have found applications in diverse settings (Yang et al., 2018). Environmental technology can fortify both operational activities and the efficiency of a company's green supply chain in delivering environmentally friendly products and processes (Alananzeh et al., 2023; Alhaj et al., 2023; Binsaddig et al., 2023; Hatamlah et al., 2023; Jahmani et al.,

2023) Previous research primarily concentrated on how GSCM processes directly influenced technological innovation (Lee et al., 2014). Furthermore, multiple scholars have established that organization-specific resources provide a flexible and effective foundation for the successful adoption of information technology-enabled environmental innovations (Al-Hosaini et al., 2023; Al-Rawashdeh et al., 2023; Al Tarawneh et al., 2023).

The successful integration of GIS throughout the entire supply chain has the potential to enhance business efficiency, enabling more effective resource allocation, particularly in the context of environmental sustainability performance (Daugherty et al., 2005). Efficiently managing supply chains using GIS can promote an optimal logistics system, ultimately reducing the energy required for goods transportation within supply chain management (Watson et al., 2008). Furthermore, GIS can facilitate the coordination and integration of sustainable activities across the entire supply chain (Liu et al., 2018). It revolves around the firm's information system vision, addressing GIS challenges and information system activities in support of long-term plans (Antoni et al., 2020). The information system improves the predictability of a recoverable manufacturing system's supply chain operations and indirectly influences the firm's environmental performance (de Camargo Fiorini & Jabbour, 2017). Therefore, we propose the second hypothesis:

H2: *GIS implementation positively affects GSCM practices in Palestinian manufacturing SMEs.*

2.4 Green Supply Chain Management and Business Sustainability

Numerous studies have established a substantial connection between GSCM practices and business sustainability (BS), supported by evidence from manufacturing firms (Farradia et al., 2019; Khan et al., 2021). These studies demonstrate that various GSCM practices are associated with significant improvements in BS outcomes, including reductions in pollutants and green costs, ultimately contributing to enhanced organizational competitiveness (Shahzad et al., 2021). Likewise, (Kittisak et al., 2019) have identified a positive association between GSCM and firm BS. GSCM practices encompass collaborating with suppliers to cut costs by encouraging raw material reuse, reducing the generation of harmful waste, and enhancing resource efficiency. Numerous scholars have underscored the favorable influence of GSCM initiatives on environmental performance, with advantages including decreased waste generation and reduced energy and material consumption (Famiyeh et al., 2018). Considering the discussions above, it is expected that GSCM practices will positively enhance BS (Kalyar et al., 2019). These considerations give rise to the third hypothesis:

H3: *GSCM practices positively affect Palestinian manufacturing SMEs.*

2.5 Relationship Between Green Information Systems, Green Supply Chain Management, and Business Sustainability

This research suggests that exploring the connection between GIS implementation and GSCM practices can help uncover the mechanisms by which they impact BS. In the GSCM literature, various studies focus on the mediating role of efficient GSCM activities in the link to business sustainability (Kittisak et al., 2019). Suppliers play a crucial role in influencing supply chain speed and facilitating information exchange (Jawabreh et al., 2023; Nawaiseh et al., 2022; Shan et al., 2022). Enhancing visibility in manufacturing organizations benefits from information sharing and supply chain resources (Dubey et al., 2018). This also holds true for the interplay between GIS and GSCM. For instance, (Jimenez-Jimenez et al., 2019) found that supply chain involvement indirectly mediates the link between technical information technology and technological innovation. It's been shown that technology information supports SCM deployment, leading to improved SCM outcomes and, consequently, boosting organizational performance. Additionally, scholars have underscored the significance of information technology practices for the efficacy of SCM techniques (Thöni & Tjoa, 2017). Yang et al. (2022) investigated the effects of GSCM and green information technology on green performance and found substantial support for the research model. The two factors considered, information technology resources and quality characteristics, are pertinent to E-GSCM practices, which in turn influence BS and company competitiveness. (Yang et al., 2020) conducted research using empirical data from Chinese companies to investigate the interaction between efficiency-oriented GSCM and technology-driven GIS on firm sustainability. (Gholami et al., 2013) established a robust and significant link between GIS implementations and environmental sustainability performance in Malaysian manufacturing organizations. They contend that GIS can lower energy consumption and promote waste recycling, ultimately leading to improved environmental sustainability performance. Consequently, the final hypothesis can be summarized as follows:

H4: *GSCM practices mediate the relationship between GIS implementation and BS in Palestinian manufacturing SMEs.*

The model, as depicted in Figure 1, outlines GIS implementations, GSCM practices, and their impacts on BS.

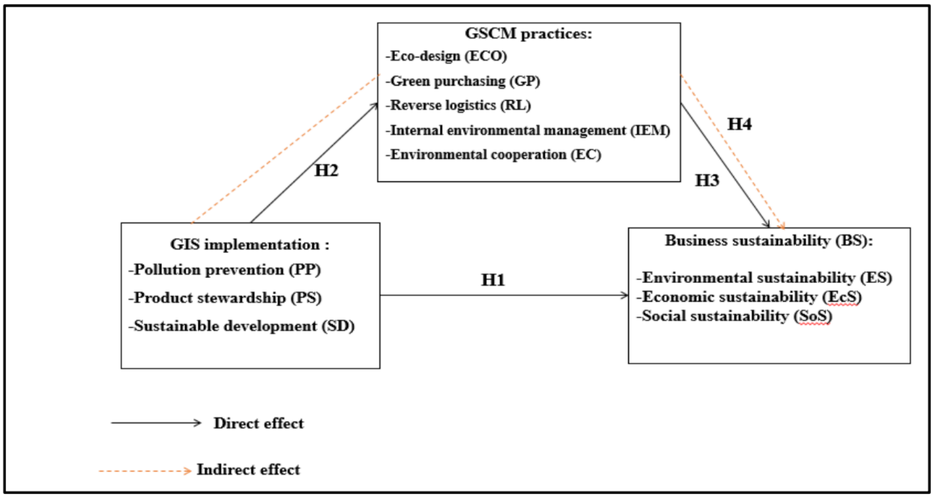

Figure 1. Conceptual Research Model

3. Methodology

3.1 Population of the Study

This research is specifically centered on manufacturing firms situated in the West

Bank region of Palestine, with a strong focus on SMEs. These SMEs represent the primary population under investigation, as the West Bank region hosts the majority of the country's manufacturing SMEs (Mohtar & Rajiani, 2016). The study's sample comprises exclusively SMEs that incorporate green practices into their operations and supply chains to achieve their objectives.

The researchers compiled a pool of 298 SMEs using mailing lists provided by the Palestinian Federation of Industries in the West Bank region of Palestine. They employed snowball and cluster sampling techniques and gathered data through mail and email questionnaires. Out of the 298 SMEs contacted, 183 responses were received, resulting in a response rate of 61.4%. Notably, all these respondents confirmed using information systems for green purposes.

Among the valid responses, 84% were contributed by operational/middle managers, while the remaining 16% came from top management personnel. As most of the respondents held managerial positions in supply chain-related domains (such as manufacturing, procurement, and logistics), they were well-positioned to provide accurate information. Throughout the data collection process, respondents were assured that there were no right or wrong answers, and their responses would be treated as confidential and kept anonymous. Table I indicates that 38.8% of the respondents had been involved in business for over 15 years. The remaining respondents were evenly distributed between younger and older age groups. Consequently, the data used in this study were provided by experienced individuals well-acquainted with green practices in their respective organizations. This reinforces the credibility and quality of the gathered information.

Table 1: Profiles of firms

Characteristics	Frequency	% (N=183)
Industry		
Food industry	109	59.6%
Chemical industry	60	32.7%
Pharmaceutical industry	8	4.4%
Others	6	3.3%
Number of employees in the organization		
5–19	10	5.5%
20–49	71	38.8%
50 and over	102	55.7%
Experience (Years in business)		
2–5 years	22	12%
6–10 years	54	29.5%
11–15 years	36	19.7%
Above 15 years	71	38.8%

To evaluate the possible existence of non-response bias, the researcher conducted Chi-square tests to compare the characteristics of the SMEs included in the study, such as their experience and size, between two groups: the onsite interview group, with a response rate of over 85%, and the online survey group, with a response rate of around 55%. The findings indicate that none of the tests reached statistical significance at the 0.05 level. The similarity in the profiles of the participating SMEs across different data collection methods, despite varying response rates, suggests no evidence of non- response bias in the observations.

3.2 Measures

In this study, a formative model was utilized for GIS implementations with first- order dimensions, as depicted in Figure 2. This approach aligns with the model employed by (Yang et al., 2020), where each construct had first-order dimensions. Initially, the GIS implementation construct encompassed three dimensions: PP, PS, and SD, totaling 11 items. These items were originally derived from a review of prior questionnaires and research literature, including contributions from (Gholami et al., 2013) and (Daugherty et al., 2005).

In contrast, a reflective model was adopted for GSCM practices, comprising 20 items that encompassed eco-design, green purchasing, reverse logistics, internal environmental management, and environmental cooperation. These items were developed based on prior research by (Zhu et al., 2013) Similarly, a reflective model was employed for BS, featuring 15 items (i.e., EP, EcP, and SoP) drawn from (Zhu et al., 2013) Each item was rated on a 5-point Likert scale, ranging from 1 (very low extent) to 5 (very high extent). The adapted measurements for the GIS, GSCM, and BS items utilized in this study are provided in the Appendix.

To counter potential response bias, the questionnaire initiated with a list of typical activities linked to GSCM and GIS. Respondents could specify whether these activities were implemented in their SMEs. This inclusion of both objective and subjective items serves to mitigate the methodological bias often associated with survey-based research.The questionnaire was originally crafted in English and subsequently translated into Arabic by assistants of lecturers and business professionals. This choice was made because Arabic is the native language in Palestine, with the expectation that the Arabic version would be more accessible to respondents, potentially enhancing their willingness to participate. To ensure user-friendliness, the Arabic questionnaire underwent proofreading by two business professionals. Any identified errors were corrected, and the questionnaire was then subjected to review by experts proficient in both Arabic and English for back translation into English. The final version was compared to the original to make any necessary adjustments, ensuring linguistic clarity (Somasundaram et al., 2021).

4. Results

4.1 Data Analysis

The main statistical method utilized to test the hypotheses in this study was partial least squares structural equation modeling (PLS-SEM). This choice was made because PLS-SEM can handle multidimensional parameters effectively (Hair Jr et al., 2014). The study utilized SmartPLS 3.9.2 software for implementing PLS-SEM. To assess the incremental explanatory power of subsequent variables and account for the influences of prior variables, an incremental PLS-SEM approach was employed. Unlike other covariance-based methods, PLS-SEM does not have limitations in the interaction techniques used for mediation testing. Therefore, PLS-SEM is a valuable choice for evaluating their effects. Furthermore, PLS-SEM enables the evaluation of complex models involving effect chains, including mediation and other intricate interactions (Hair et al., 2019). Unlike some other methods, PLS can be applied to both reflective and formative measurement models and demands fewer data points (Hair et al., 2019). Hence, PLS was selected in this study to assess the proposed research framework.

SmartPLS analysis comprises two primary components: the measurement model and the structural model. The measurement model encompasses construct reliability, validity, and discriminant validity assessments. In contrast, the structural model employs bootstrap procedures to establish significant relationships among the model parameters.

4.2 Assessment of the Measurement Model

The evaluation of a measurement model involves examining the reliability and validity of the constructs. Convergent validity is defined as the extent to which items measuring a particular construct align (Ramayah et al., 2018). Various tests can be used to assess convergent validity, including average variance extracted (AVE), factor loadings, and composite reliability (CR). The suggested values for α coefficients and factor-loading items are 0.70 or higher (Hair Jr et al., 2014). For CR, the value should surpass 0.70 (Hair et al., 2019).

In this study, the CR values for all constructs fell within the range of 0.858 to 0.897, indicating a high level of convergent validity. These results are detailed in Table II and Figure 2. Furthermore, the AVE values, which gauge the proportion of variation captured by indicators relative to measurement error, ranged from 0.564 to 0.744. This range surpasses the recommended threshold of 0.50, affirming the suitability of the concept. As a result, the entire set of latent variables met the criteria for convergent validity.

In summary, the evaluation of the measurement model focused on ascertaining the reliability and validity of the constructs. Convergent validity was established through AVE, factor loadings, and CR tests. The findings affirmed that all constructs satisfied the criteria for convergent validity, characterized by elevated CR and AVE values.

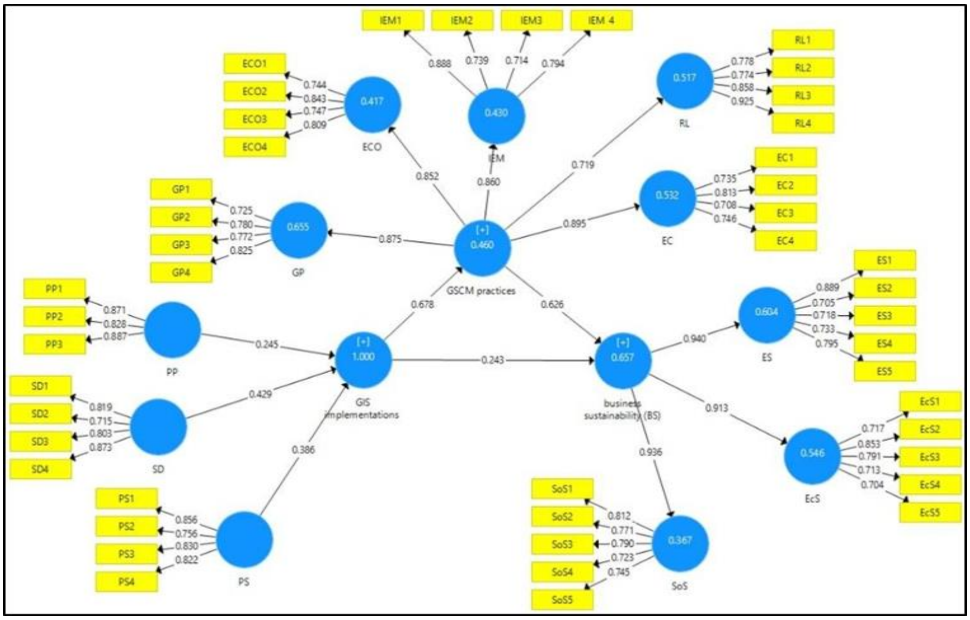

Figure 2. Measurement Model.

Table 2: Results of the Measurement Model

Reflective Variable	Construct Items	Item Loading	Cronbach's Alpha (α)	Composite Reliability (CR)	Average Variance Extracted (AVE)
Pollution prevention (PP)	PP1	0.871	**0.831**	**0.897**	**0.557**
	PP2	0.828			
	PP3	0.887			
Product stewardship (PS)	PS1	0.856	**0.816**	**0.888**	**0.667**
	PS2	0.756			
	PS3	0.830			
	PS4	0.822			
Sustainable development (SD)	SD1	0.819	**0.817**	**0.879**	**0.647**
	SD2	0.715			
	SD3	0.803			
	SD4	0.873			
Green purchasing (GP)	GP1	0.725	**0.793**	**0.858**	**0.602**
	GP2	0.780			
	GP3	0.772			
	GP4	0.825			
Eco-design (ECO)	ECO1	0.744	**0.752**	**0.866**	**0.619**
	ECO2	0.843			
	ECO3	0.747			
	ECO4	0.809			
Reverse logistics (RL)	RL1	0.778	**0.753**	**0.893**	**0.676**
	RL2	0.874			
	RL3	0.858			
	RL4	0.774			
Internal environmental management (IEM)	IEM1	0.888	**0.722**	**0.865**	**0.618**
	IEM2	0.739			
	IEM3	0.714			
	IEM4	0.794			
Environmental cooperation (EC)	EC1	0.735	**0.761**	**0.838**	**0.564**
	EC2	0.813			
	EC3	0.708			
	EC4	0.746			
Environmental sustainability (ES)	ES1	0.889	**0.761**	**0.879**	**0.743**
	ES2	0.705			
	ES3	0.718			
	ES4	0.733			
	ES5	0.795			
Economic sustainability (EcS)	EcS1	0.717	**0.734**	**0.870**	**0.718**
	EcS2	0.853			
	EcS3	0.791			
	EcS4	0.713			
	EcS5	0.704			
Social sustainability (SoS)	SoS1	0.812	**0.766**	**0.878**	**0.738**
	SoS2	0.771			
	SoS3	0.790			
	SoS4	0.723			
	SoS5	0.745			

As a supplementary approach to assess discriminant validity, the study utilized the

Fornell Larcker criteria. This method involves calculating the square root of the AVE values for each construct and comparing them to the correlations between the latent variables. A common guideline suggests that each construct's AVE should exceed its highest correlation with any other construct. The empirical findings presented in Table III demonstrate that the study adhered to the Fornell–Larcker discriminant validity criteria.

Table 3: Fornell–Larcker's criteria

Construct	EC	ECO	ES	EcS	GP	IEM	PP	PS	RL	SD	SoS
EC	**0.751**										
ECO	0.145	**0.787**									
ES	0.580	0.195	**0.862**								
EcS	0.333	0.234	0.288	**0.847**							
GP	0.651	0.073	0.576	0.453	**0.776**						
IEM	0.553	0.122	0.429	0.389	0.388	**0.787**					
PP	0.510	0.206	0.642	0.229	0.572	0.437	**0.746**				
PS	0.161	0.345	0.235	0.383	0.238	0.204	0.205	**0.817**			
RL	0.490	0.096	0.556	0.448	0.388	0.610	0.627	0.160	**0.822**		
SD	0.459	0.169	0.546	0.246	0.375	0.477	0.605	0.177	0.664	**0.804**	
SoS	0.367	0.455	0.227	0.566	0.489	0.334	0.491	0.429	0.544	0.523	**0.859**

4.3 Assessment of Structural Model

In the subsequent stage, we conducted an analysis of the structural model to explore the relationships among the latent variables. Following the approach outlined by (Hair et al., 2019) we employed the significance and magnitude of the path coefficients and coefficients of determination (R^2) as assessment criteria for the PLS- SEM analysis of the structural model. The R^2 values for endogenous constructs were categorized as substantial, moderate, or weak, corresponding to 0.75, 0.50, or 0.25, respectively. The PLS algorithm calculated an R^2 value of 0.657, signifying that GIS and GSCM jointly accounted for 65.7% of the variance in BS. This value falls within the moderate category. The R^2 value for GSCM alone was 0.460, indicating that 46.0% of the variance in GSCM could be attributed to GIS, which also falls within the moderate range (see Figure 2). The Q^2 criterion, utilized to assess the model's predictive relevance for endogenous constructs, was evaluated with a cutoff value of zero. The Q^2 value can be found in Table IV.

Table 4: Predictive Relevance

Construct	SSO	SSE	Q^2 (=1-SSE/SSO)
Sustainable Performance	3,659	2,734.613	0.252
GIS Implementation	6,185	5,226.361	0.155

In the current study, the assessment of data multicollinearity was conducted using the variance inflation factor (VIF) metric. Table V displays the VIF values and outer weights of the first-order constructs for the GIS. The results show that the VIF values for all components are below the recommended threshold of 3 (Hair et al., 2019), signifying the absence of multicollinearity in the data. In line with (Dijkstra & Henseler, 2015), the model's SRMR value was under 0.08, indicating reliable results and analysis for the study model. the model's SRMR value was under 0.08, indicating reliable results and analysis for the study model.

Table5: Assessment of Formative Constructs

Second-order Construct	First-order Construct	Collinearity Statistics	
		Tolerance	VIF
GIS	PP	0.543	**1.593**
	PS	0.685	**2.587**
	SD	0.609	**1.658**

The PLS algorithm was utilized to examine the hypothesized relationships using bootstrapping. In PLS, path coefficients hold significance, and significant coefficients that align with the expected direction indicate that the tested hypothesis should not be dismissed. The empirical outcomes of the bootstrapping process, encompassing beta values, standard deviation values, t-values, and p-values for both direct and indirect relationships, were derived from 5,000 subsamples and are detailed in Table VI.

Results from the bootstrapping procedure indicate that the study's findings support H1 ($\beta = 0.243$; $t = 2.429$; $p < 0.017$), suggesting that GIS plays a pivotal role in enhancing BS. Similarly, H2 is supported, as the relationship between GIS and GSCM is significant at the 0.001 level ($\beta = 0.626$; $t = 8.779$; $p < 0.000$). Additionally, the results show that GSCM practices have a significant impact on BS ($\beta = 0.628$; $t = 6.475$; $p < 0.000$), thereby supporting H3.

Table6: Hypothesis Testing

Hypothesis		Std. Beta (β)	t-values	p-values	Decision
H1	GIS → BS	0.243	2.429	0.017	Supported**
H2	GIS → GSCM	0.678	8.779	0.000	Supported***
H3	GSCM→ BS	0.626	6.475	0.000	Supported***

A mediation analysis was conducted using the method proposed by Zhao et al. (2010), which suggests that the indirect effect (a × b) must be significant for mediation to occur. Full mediation is present when path (c-) is not significant, while complementary partial mediation occurs when paths a, b, and c̄ have similar signs. Conversely, competitive partial mediation occurs when they have different signs.

The results from the bootstrapping analysis, as displayed in Table VII, reveal that GSCM significantly mediates the relationship between GIS and BS ($\beta = 0.424$, 95% CI 0.289–0.560). The significant direct effect of c̄, coupled with the positive signs of paths a × b and c̄, indicate that GSCM functions as a complementary partial mediator. Therefore, H4 is supported.

Table7: Mediation test

Hypothesis	a	b	c̄	Point estimate	Indirect effect 95% CI		Decision
					Lower	Upper	
H4: GIS→ GSCM→ BS	0.678	0.626	0.498	0.424	0.289	0.560	Partial mediation

5. Discussion

The latest research reveals a notable association between the use of GIS and BS within Palestinian manufacturing firms. These findings align with earlier research outcomes and are consistent with trends observed in emerging economies.

Furthermore, this study furnishes compelling evidence that the adoption of GIS has a substantial impact on the practices of GSCM. The outcomes are in line with the research findings of (Esfahbodi et al., 2023) who investigated 189 manufacturing SMEs in the United Kingdom, as well as those of (Yang et al., 2018) in Chinese manufacturing SMEs. The overarching inference is that GIS have become an essential asset for promoting sustainable business operations. This encompasses the facilitation of eco-friendly initiatives, the improvement of interdepartmental communication, and the enhancement of operational efficiency and management capabilities among manufacturing SMEs (Wang et al., 2020).

Hence, manufacturing SMEs that adopt environmental efficiency strategies can heighten their ecological endeavors. This is achieved by enhancing their data processing capabilities and ensuring smooth data integration across diverse functional units, including SCM. Furthermore, the PS strategy enhances an organization's sustainability initiatives, as observed by (Nishant et al., 2017). Consequently, managers may perceive GIS as a viable approach to amplify the sustainability efforts of their firms.

Moreover, the study emphasizes a significant link between GIS adoption and GSCM practices, consistent with (Fiorini et al., 2022) research on Brazilian manufacturing SMEs. They found that GIS implementations are crucial for advancing eco-friendly practices in SCM. The fusion of GIS and GSCM can drive a company's environmental strategy, underscoring GIS as a key element in developing valuable GSCM capabilities and achieving superior firm performance.

Another key finding of this research is the substantial link between GSCM practices and BS in manufacturing SMEs, consistent with the work of (Tseng et al., 2019). (Tseng et al., 2018) affirmed that GSCM serves as an avenue to enhance BS and can be seen as a strategic asset that elevates a firm's sustainability, as indicated by (Choi & Hwang, 2015) Supply chain operations have both direct and indirect environmental impacts. Direct impacts occur when a business utilizes procedures or resources that generate significant waste during handling, processing, use, or disposal (Kalyar et al., 2020). In contrast, indirect effects stem from the actions of upstream suppliers. Nonetheless, the adoption of GSCM processes strengthens companies' capacity to address sustainability concerns stemming from both direct and indirect consequences (Das, 2017).

This study delves into the interplay among GIS implementations, GSCM practices, and BS within Palestinian manufacturing SMEs. Consequently, it enhances the existing body of knowledge by exploring how GIS and GSCM complement each other in the context of BS, offering unique insights from an emerging country. The empirical findings from this research suggest that GSCM practices act as intermediaries in the relationship between GIS implementations and BS. Thus, it is crucial for manufacturing companies in Palestine to formulate GIS strategies that seamlessly integrate environmental sustainability with interactions with suppliers and clients (Shahzad et al., 2020).

Moreover, the roles of GIS implementations involve monitoring environmental aspects and results of supply chain operations, including identifying the origins of raw materials, identifying hazardous components in procured goods, supervising production procedures, reclaiming recyclable materials, and monitoring sustainability performance across the supply chain (Bai &

Sarkis, 2020). Consequently, embracing both GIS and GSCM can cultivate sustainable capabilities and provide competitive advantages for manufacturers in Palestine.

6. Final Remarks

6.1 Theoretical Implications

The present research holds significant theoretical implications as it explores the interrelationships among GIS, GSCM, and BS. By addressing the necessity of investigating the combined effects of GIS and GSCM practices on BS and identifying factors contributing to enhanced organizational capabilities, this study can be seen as a contribution to the literature on the Natural Resource-Based View (NRBV) theory, as previously discussed by (Choi & Hwang, 2015), (Nishant et al., 2017) and (Yang et al., 2019). Drawing from prior NRBV and information systems literature, this empirical inquiry enhances our comprehension of the connection between environmental practices and information systems in the context of BS. Additionally, it delves into how the alignment of environmental practices with Supply Chain Management impacts BS (Darmody & Bendis, 2021).

This research provides evidence that adopting GIS is a viable strategy for improving GSCM, ultimately benefiting BS. It not only confirms but also extends existing knowledge. It empirically supports the idea that combining environmental management with information systems and SCM strengthens BS, building upon earlier studies that show how GIS and GSCM activities enhance the competitiveness of manufacturing SMEs (Deng and Ji, 2015). This research aligns with findings suggesting that GIS can enhance BS, emphasizing the importance of integrating GIS with SCM efforts to enhance competitiveness and promote sustainability effectively.

6.2 Managerial Implications

This empirical study has several practical implications. Managers should assess GIS implementations by considering their capacity to deliver immediate environmental advantages. The findings indicate that GIS is crucial for businesses as it enables the creation of information-sharing tools, reducing information imbalances. The exchange of information and the traceability of GSCM practices are key attributes of GIS, as highlighted by (Yang et al., 2018).

Both practitioners and policymakers should integrate environmental considerations into their strategic planning. The NRBV theory, as highlighted by (Zhang et al., 2017) emphasizes the importance of addressing environmental issues for maintaining competitiveness and discovering new avenues for business competition (Muafi, 2017) Manufacturing firms must address environmental degradation to sustain their businesses. While enhancing GIS may be seen as a costly and long-term investment, this study's findings provide strong evidence that GIS enhances GSCM practices and BS. Managers can be assured that integrating GIS will support growth and market stability.

6.3 Conclusion

Leading firms are increasingly urged to embrace eco-friendly technologies that can counter environmental damage caused by manufacturing SMEs. This study aims to explore the impact of GIS implementations on BS and to examine how GSCM practices mediate the connection between GIS and BS in Palestinian manufacturing SMEs. The findings indicate a strong link between GIS implementations and BS. GIS helps manufacturers analyze their environmental capabilities, track emissions, and monitor raw material sources, enhancing SMEs' BS. Additionally, the statistical data demonstrate a significant impact of GSCM practices on the BS of manufacturing SMEs, improving efficiency and environmental sustainability by reducing waste, energy consumption, and resource emissions. This positively affects SMEs' BS. This study is among the few to explore how GSCM practices mediate the relationship between GIS implementations and BS in Palestinian manufacturing SMEs. The empirical findings will enrich the existing literature and provide insights for practitioners and managers seeking to enhance BS through GIS implementations. However, this study has limitations, including its single-country focus, which may restrict generalizability. Future research could refine and expand the model across various countries or sectors like healthcare or tourism. Additionally, scholars may explore other mediating variables, such as top management commitment and environmental orientations, in future studies.

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Appendix. Measurement items for constructs used in this empirical study.

Green Information Systems (GIS) Implementation

1- Pollution prevention (PP)

- ✓ The firm has a policy to reduce energy consumption by the IT infrastructure.
- ✓ GIS helps in reducing the use of harmful materials.
- ✓ GIS is employed to decrease public consumption and emissions.

2- Product stewardship (PS)

- ✓ GIS enhances sourcing ecologically.
- ✓ GIS ensures goods delivery and distribution are ecological.
- ✓ GIS improves the ecological aspects of dismantling and recycling.
- ✓ IT equipment is disposed of in an environmentally friendly manner.

3-Sustainable development (SD)

- ✓ GIS assists with environmental actions throughout firms.
- ✓ GIS contributes to management and control procedures that advocate for SD.
- ✓ GIS facilitates environmental compliance and auditing.
- ✓ Organizational policies and IT infrastructure promote the use of renewable energy sources such as solar, wind, and hydro.

GSCM practices

1- Green purchasing (GP)

- ✓ Suppliers are required to incorporate ecological design principles into the products they provide.
- ✓ Eco-friendly criteria are utilized when selecting suppliers.
- ✓ Purchased products do not contain ecologically undesirable elements, such as lead or other hazardous materials.
- ✓ Suppliers are mandated to adopt green packaging.

2- Eco-design (ECO)

- ✓ Product designs aim to reduce material and energy consumption.
- ✓ Product designs facilitate reuse, recycling, and material and component recovery.
- ✓ Designs minimize the use and production of hazardous substances.
- ✓ Life cycle assessments measure the ecological impact of goods.

3- Reverse logistics (RL)

- ✓ Remanufacturing practices are employed for obsolete products.
- ✓ Processes are established for recovering end-of-life products.
- ✓ The return of packaging materials is encouraged.
- ✓ Products are designed for future reuse.

4- Internal environmental management (IEM)

- ✓ High-level management commitment to GSCM is evident.
- ✓ Cross-functional collaboration for ecological improvements is emphasized.
- ✓ Ecological factors are integrated into the internal performance evaluation system.
- ✓ Ecological reports are produced for internal review.

5- Environmental cooperation (EC)

- ✓ Quality is prioritized when selecting suppliers.
- ✓ Collaboration with clients and suppliers on ecological design initiatives is encouraged.

- ✓ Collaboration for cleaner manufacturing practices is pursued.
- ✓ Cooperative efforts are engaged to create ecological packaging solutions with clients and suppliers.

Business Sustainability (BS)
1- Environmental sustainability (ES)

- ✓ Emissions of harmful chemicals into the air and water are decreased.
- ✓ Waste generation is reduced, and material recycling is amplified in production processes.
- ✓ Utilization of renewable energy sources and sustainable fuels is enhanced.
- ✓ Continuous improvement in the environmental stance is observed.
- ✓ Reduction in environmental incidents is targeted.

2- Economic sustainability (EcS)

- ✓ Material purchasing costs are reduced.
- ✓ A high average in sales is maintained.
- ✓ A high-profit growth rate is witnessed.
- ✓ Fees for waste treatment and disposal are minimized.

3 Social sustainability (SoS)

- ✓ The health and safety of the workforce are ensured.
- ✓ Incentives are provided, and engagement for local workers is fostered.
- ✓ Community and staff-centric social activities are implemented.
- ✓ Community health and safety are prioritized.
- ✓ Adverse effects of products and practices on local communities are minimized.