Received: 21 February 2025 | Accepted: 04 June 2025 | Published: 30 June 2025

Sustainable Trends & Business Research

Vol. 03 | Issue 01 | Pages 49-61 |

Research Article

Green Servitization and Sustainability in Manufacturing: The Mediating Role of Circular Economy Practices and the Moderating Effect of Environmental, Social, and Governance Compliance in Jordan

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Declaration of Interests

The authors declare no competing financial or personal interests.

Abstract

As environmental concerns and stakeholder expectations continue to grow, manufacturers are under increasing pressure to adopt sustainable practices. Green servitization involves integrating environmentally friendly services into traditional product offerings, has emerged as a promising strategy to support both economic and environmental objectives. However, little is known about how green servitization contributes to sustainability performance in emerging economies, particularly when considering the roles of circular economy practices and environmental, social, and governance compliance. This study investigates these relationships within the Jordanian manufacturing sector. Drawing on the natural resource-based view, the study examines whether circular economy practices mediate the relationship between green servitization and sustainability performance, and whether environmental, social, and governance compliance moderates this relationship. Data were collected from 214 manufacturing firms and analyzed using structural equation modeling. The findings reveal that green servitization positively influences sustainability performance both directly and indirectly through circular economy practices. Furthermore, the positive impact of green servitization on sustainability is stronger in firms with higher levels of environmental, social, and governance compliance. These results highlight the importance of aligning strategic innovation, operational circularity, and institutional responsibility to achieve meaningful sustainability outcomes in resource-constrained industrial contexts such as Jordan.

Keywords: Green servitization; Circular economy practices; Environmental social and governance compliance; Sustainability performance; Structural equation modeling.

How to Cite this Work:

Barhoom, F.N., Almetrami, R.A., & Alsakarneh, G.K.S. (2025), "Green Servitization and Sustainability in Manufacturing: The Mediating Role of Circular Economy Practices and the Moderating Effect of Environmental, Social, and Governance Compliance in Jordan", *Sustainable Trends and Business Research*, Vol. 05 No. 01, pp. 48-61.

1 INTRODUCTION

Sustainability has become a defining priority in global manufacturing strategies, not just as a matter of compliance but as a central tenet of long-term competitiveness (Johl et al., 2024). The industrial sector faces mounting challenges stemming from climate change, resource depletion, environmental degradation, and growing social expectations (Johl et al., 2024; Kumar et al., 2024). These pressures are reshaping the strategic agenda of firms and urging them to embed sustainable thinking into the core of their operations (Borland, 2009). In particular, manufacturers in resource-constrained and import-reliant economies, such as Jordan, confront a dual imperative, like maintaining industrial productivity while aligning with sustainability goals (Chen & Wang, 2024). This requires more than incremental adjustments—it demands systemic shifts in how products and services are designed, delivered, and governed (Koilo, 2025). Among the emerging paradigms is the concept of green servitization, which involves integrating environmentally sustainable services, such as maintenance, reverse logistics, and eco-oriented product support, into traditional manufacturing models (Oyelakin et al., 2025; Yang et al., 2023). Complementing this shift is the increasing adoption of circular economy practices, grounded in principles of reuse, recycling, and resource optimization (Zhang et al., 2022). In parallel, global investors and regulatory bodies are placing stronger emphasis on environmental, social, and governance (ESG) compliance, now seen as a benchmark for responsible corporate behaviour and long-term value creation (Kumar et al., 2024). While each of these approaches has been studied in isolation, their interconnected impact on sustainability performance remains underexplored.

Green servitization has been examined in technologically advanced economies e.g., (Kumar et al., 2024), its uptake and effect in middle-income nations with constrained technical and regulatory infrastructures are still unclear. Additionally, although the natural resource-based view (NRBV) provides a useful theoretical lens by linking environmental resource management to competitive advantage (Hart, 1995), few empirical studies apply NRBV to simultaneously test the influence of green servitization and circular economy mechanisms in such contexts. Moreover, ESG has emerged as a critical external pressure shaping corporate sustainability pathways. Yet, its moderating effect, specifically, how ESG strengthens or weakens the translation of internal green strategies into performance outcomes has not been adequately addressed in the literature (Kumar et al., 2024; Zhang et al., 2022). This oversight is especially important for Jordanian firms, which are increasingly under pressure to meet international ESG benchmarks, especially when accessing foreign markets and investment channels.

Although Jordan has taken initial policy steps toward green industrial transformation—such as the Green Growth National Action Plan—there remains a lack of empirical evidence on how firms actually operationalize these commitments at the firm level. Green servitization holds potential as a strategic tool, but its isolated implementation may fall short without supporting circular practices (Chen & Wang, 2024; Oyelakin & Johl, 2022). Likewise, ESG frameworks are often adopted symbolically rather than systematically. As a result, Jordanian manufacturers may struggle to integrate these components effectively, limiting their ability to generate meaningful and measurable sustainability outcomes. This gap in understanding underscores the need for an integrated framework that can evaluate how green servitization, circular economy practices, and ESG compliance collectively influence sustainability performance.

To address the identified gaps, this study proposes and empirically tests a conceptual framework that links green servitization to sustainability performance, with circular economy practices as a mediating mechanism and environmental, social, and governance compliance as a moderating factor. Grounded in the natural resource-based view, the study conceptualizes sustainability as a function of strategic capability (green servitization), operational transformation (circular economy practices), and institutional alignment (ESG compliance). This research is significant for several reasons. Theoretically, it contributes to sustainability and servitization literature by integrating strategic, operational, and institutional dimensions within a unified framework, applied in an underexplored emerging market context. It also extends the natural resource-based view by incorporating external legitimacy factors, such as ESG compliance, as contingent enablers of sustainable outcomes. Practically, the study aims to offer actionable insights to policymakers, manufacturing leaders, and sustainability practitioners in Jordan and other resource-constrained economies. By clarifying how green servitization works in tandem with circular and ESG practices, the research supports the development of coherent, scalable strategies for industrial sustainability.

The rest of the paper is structured as follows. The next section presents the literature review and theoretical foundation, followed by hypothesis development. After that, the methodology and data analysis approach are explained. The final sections provide results, discussions, implications, and future research direction.

2 LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

2.1 Theoretical Foundation

This study is underpinned by the NRBV theory developed by (Hart, 1995), which extends the classical Resource-Based View (RBV) by incorporating environmental considerations. NRBV suggests that firms can achieve competitive advantage and long-term success by building internal capabilities that align with environmental sustainability (Russo & Fouts, 1997; Solovida & Latan, 2017). These capabilities include pollution prevention, product stewardship, and sustainable development. In the context of green servitization, NRBV provides a valuable lens to understand how environmental strategies, such as integrating eco-friendly services and circular practices, can improve sustainability performance (Aragón-Correa & Sharma, 2003). Green servitization is not merely a tactical change in operations, but a strategic resource when guided by strong internal competencies and supported by external legitimacy mechanisms like ESG compliance (Borland, 2009; Koilo, 2025). Therefore, this study uses NRBV to frame green servitization as a strategic approach that enhances sustainability through circular economy practices.

2.2 Green Servitization and Sustainability Performance

Green servitization refers to the strategic integration of environmentally friendly services into traditional manufacturing offerings (Alkaraan et al., 2025). This includes services such as green product design, eco-maintenance, remanufacturing, and digital technologies that reduce environmental harm across the product lifecycle (Malik et al., 2024; Marić & Opazo-Basáez, 2019; Oyelakin et al., 2025). Unlike conventional servitization, which is primarily focused on economic differentiation, green servitization explicitly aims to align with sustainability objectives by minimizing waste, lowering emissions, and improving resource efficiency (Rabetino et al., 2024). Numerous studies have emphasized the positive relationship between green servitization and sustainability performance. For example, Miao et al. (2023) showed that firms adopting service-based environmental solutions achieved not only improved ecological outcomes but also greater customer loyalty and innovation capacity. Similarly, Oyewale and Johl (2021) found that green servitization fosters stronger alignment with sustainability goals, especially in resource-scarce economies, by enabling firms to rethink product use, lifecycle extension, and after-sales support through a sustainability lens. Recent research also highlights that green servitization contributes positively to all three dimensions of the triple bottom line: economic (e.g., reduced operating costs, increased market share), environmental (e.g., lower emissions and material usage), and social (e.g., improved stakeholder engagement and corporate responsibility) (Johl et al., 2024; Marić & Opazo-Basáez, 2019; Oyewale & Johl, 2021). The integration of smart technologies like IoT and predictive maintenance into green servitization further enhances firms' ability to track, report, and optimize their environmental performance (Sui et al., 2024). Hence, based on both theoretical insights and empirical findings, it is hypothesized that:

H1: Green servitization has a positive effect on sustainability performance.

2.3 Green Servitization and Circular Economy Practices

While green servitization establishes the intent to operate sustainably, CEPs translate that intent into action (Mark-Herbert et al., 2025). CEPs focus on minimizing waste and maximizing resource efficiency through practices such as reuse, recycling, and remanufacturing (Han et al., 2020). These practices are particularly important in manufacturing, where material efficiency is directly linked to environmental impact. Research has shown a strong connection between green servitization and circular economy implementation. Bressanelli et al. (2024) argue that green servitization promotes service-based business models that are inherently circular, as they emphasize performance and lifecycle over volume. Oyewale and Johl (2021) also confirmed that firms adopting green product-service systems (PSS) were more likely to engage in circular activities. In emerging economies, Mondal et al. (2023) observed that green servitization serves as a gateway for transitioning from linear to circular business models. In the Jordanian manufacturing sector, where raw materials and energy are limited, firms can benefit significantly by aligning green servitization with circular economy strategies, hence, the following hypothesis proposed.

H2: Green servitization has a positive effect on circular economy practices.

2.4 Circular Economy Practices and Sustainability Performance

The link between circular economy practices and sustainability has been well established in the literature (Yin et al., 2023). CEPs are seen as essential for operationalizing sustainability because they directly reduce environmental impact, support cost reduction, and enhance product life cycles (Chowdhury et al., 2022; Le et al., 2024). Through practices such as closed-loop manufacturing, resource recovery, and sustainable packaging, firms can align operational efficiency with ecological responsibility. In a manufacturing context, circular economy practices also contribute to improved economic performance by reducing raw material dependency and waste disposal costs (Han et al., 2020; Johl et al., 2024; Koilo, 2025). Rodríguez-Espíndola et al. (2022) argued that circularity provides a more measurable path toward sustainability than abstract strategic goals alone. Obeidat et al. (2023) focusing on MENA industrial firms, found that applying circular principles improved social responsibility and long-term competitiveness. For Jordanian manufacturers, integrating circular economy practices could significantly enhance environmental and economic resilience, making sustainability a more achievable goal.

H3: Circular economy practices have a positive effect on sustainability performance.

2.5 The Mediating Role of Circular Economy Practices

While green servitization introduces the strategic intent, and sustainability is the desired outcome, circular economy practices often serve as the “missing link” that enables this transformation (Le et al., 2024; Oyewale & Johl, 2021; Yang et al., 2023). Past studies have explored this mediating role. For example, Cuevas-Pichardo et al. (2025) found that circular economy mechanisms mediated the relationship between environmental management strategies and environmental performance in manufacturing. Zhang et al. (2022) showed that CEPs led to significant improvements in ecological outcomes, even without direct economic gain, when firms adopted sustainability-driven strategies. Johl et al. (2024) argue that green servitization must be reinforced by tangible actions, i.e., CEPs, to realize sustainable performance. Without this, the servitization strategy may remain superficial or ineffective (Rodríguez-Espíndola et al., 2022; Shaukat & Ali, 2023). Thus, CEPs not only enhance the direct impact of green servitization but also serve as an operational mechanism to achieve sustainability in practice (Oyewale & Johl, 2021; Sui et al., 2024; Yin et al., 2023). In Jordan, where the industrial sector is under pressure to optimize waste and material use, the mediating role of CEPs may be particularly vital.

H4: Circular economy practices mediate the relationship between green servitization and sustainability performance.

2.6 The Moderating Role of ESG Compliance

As companies strive to improve their environmental and social responsibility, ESG compliance has emerged as a key framework for evaluating and guiding sustainable business behaviour (Alodat et al., 2025). ESG compliance refers to a company’s adherence to environmental regulations, ethical labour practices, community engagement, and transparent governance structures (Chouaibi et al., 2021; Kumar et al., 2024). Increasingly, ESG performance is used not only for investor decision-making but also to assess operational maturity and long-term viability (Okhmatovskiy & David, 2012). In the context of green servitization, ESG compliance may play a significant moderating role. While green servitization provides the strategic intent and resource alignment for sustainability, its effectiveness can depend on how well a firm integrates ESG principles into its operational and governance systems (Bux et al., 2024; Kumar et al., 2024; Truong et al., 2023). Firms that maintain higher ESG standards are likely to implement green strategies more rigorously and are better positioned to convert them into sustainability outcomes (Johl et al., 2024; Oyewale & Johl, 2021). Recent research supports this notion. Kumar et al. (2024) found that ESG compliance strengthens the impact of Industry 4.0 and green practices on green servitization outcomes. Similarly, Chouaibi et al. (2021) observed that ESG policies increase the likelihood that green innovations lead to improved environmental and social performance. In emerging markets, ESG frameworks often act as a form of institutional legitimacy, helping firms overcome barriers related to regulatory uncertainty, limited consumer awareness, or investor pressure (Alodat et al., 2025; Kumar et al., 2024; Solovida & Latan, 2017). Based on this, we propose that the relationship between green servitization and sustainability is stronger for firms with higher ESG compliance.

H5: ESG compliance positively moderates the relationship between green servitization and sustainability performance.

Figure 1 below presents the graphical representation of the theoretical framework of the study, where green servitization is positioned as the independent variable, CEPs act as the mediating variable, and sustainability performance is the dependent variable. ESG compliance is depicted as a moderating variable influencing the relationship between green servitization and sustainability performance.

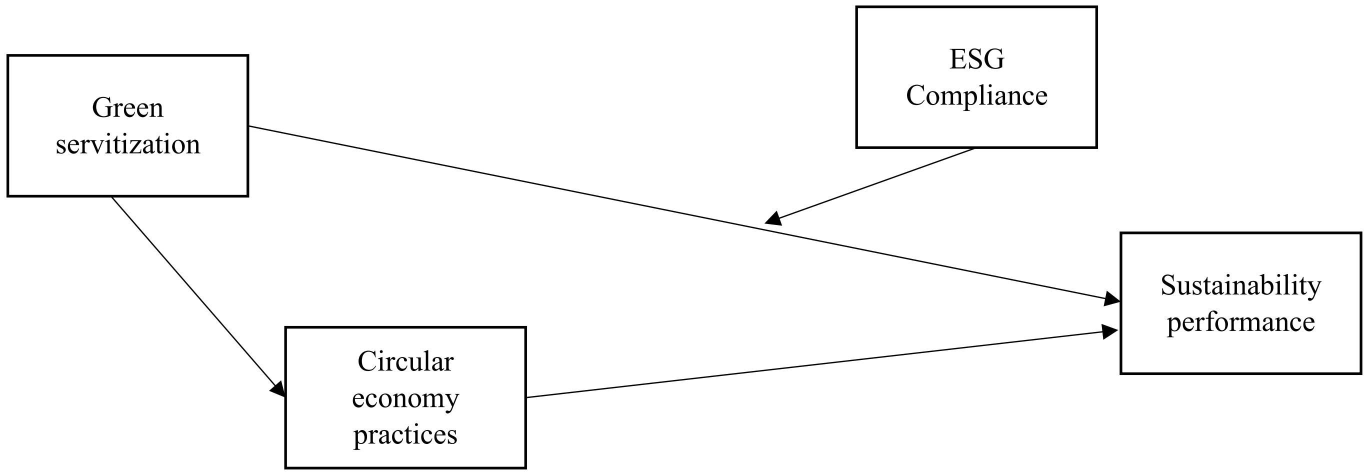

Figure 1. Framework of the study

Source(s): *Authors' Own Work.*

3 METHODOLOGY

3.1 Population, Sampling, and Data Collection

The target population for this study consisted of manufacturing firms in Jordan, particularly in environmentally intensive sectors such as pharmaceuticals, chemicals, food processing, and packaging. These industries were selected for their strategic relevance to Jordan's national sustainability goals and their potential to benefit from circular and green innovation. A purposive sampling approach was employed to target managerial-level professionals (e.g., sustainability officers, production managers, and operations supervisors) who are knowledgeable about their firms' sustainability and innovation practices. Of the 450 distributed surveys, 214 valid responses were received and used for final analysis.

To ensure adequacy of the sample size, G*Power 3.1 was used to calculate the minimum required number of respondents based on the model structure. Using an F-test for linear multiple regression, with a medium effect size ($f^2 = 0.15$), $\alpha = 0.05$, power = 0.80, and 3 predictors, the minimum recommended sample size was 77. Even accounting for additional interaction terms and potential control variables, the required size did not exceed 92. Therefore, the obtained sample of 214 participants is statistically adequate, ensuring sufficient power (>0.95) to detect hypothesized relationships and structural effects (Amir et al., 2024; Hair et al., 2019). Data collection was carried out over a period of three months, with logistical support from industrial chambers and manufacturing associations across Jordan. Ethical clearance was obtained from the researchers' affiliated institution, and all participants were informed about the confidentiality and voluntary nature of their participation.

3.2 Measures and Instrument design

The measurement items for all constructs were adapted from previously validated scales in sustainability and servitization literature. A 5-point Likert scale was used for all items, ranging from 1 (strongly disagree) to 5 (strongly agree). Before full-scale deployment, the questionnaire was reviewed by academic experts and industry professionals to ensure content validity and contextual relevance for Jordan's manufacturing sector. Green servitization was measured using three items adapted from Johl et al. (2024). Items captured firm activities related to offering green maintenance services, integrating digital technologies for environmental efficiency, and providing eco-friendly product-service solutions. CEP was assessed using five items based on Johl et al. (2024). These items focused on the firm's efforts to minimize waste, reuse materials, enhance recycling processes, and recover resources during or after production. ESG compliance was measured using three items adapted from (Kumar et al., 2024). The items evaluated the extent to which firms comply with environmental standards, uphold social responsibility (e.g., employee and community welfare), and maintain transparent and ethical governance practices. Sustainability performance was operationalized using five items aligned with the (Johl et al., 2024; Oyewale & Johl, 2021). Items assessed outcomes related to environmental improvements (e.g., emissions reduction), economic performance (e.g., cost efficiency), and social contributions (e.g., employee well-being). All items were modified slightly to fit the manufacturing context in Jordan, and pilot testing confirmed strong clarity and comprehension among respondents. The final instrument demonstrated robust psychometric properties as detailed in the measurement model results.

3.3 Data Analysis Procedure

Data analysis followed a two-step SEM approach using SmartPLS 4. The first step involved evaluation of the measurement model through confirmatory factor analysis to assess construct validity and reliability. All item loadings exceeded 0.70, and Cronbach's alpha and composite reliability values were above the 0.70 threshold, confirming internal consistency. Average Variance Extracted (AVE) values were all above 0.50, indicating convergent validity. Discriminant validity was confirmed using the HTMT ratio. Variance Inflation Factors (VIF) were below the recommended cutoff of 5.0, indicating no multicollinearity issues. In the second step, the structural model was assessed to test the hypotheses. Direct and indirect effects were analysed using a bootstrapping procedure with 10,000 subsamples. The mediation effect of CEP in the relationship between GS and SP was tested through the indirect path coefficient. The moderating effect of ESG was tested by constructing an interaction term (GS × ESG) in SmartPLS.

3.4 Common Method Bias Assessment

Given the self-reported and single-source nature of the data, the study took both procedural and statistical steps to address potential common method bias. Procedurally, respondents were assured of anonymity and confidentiality, items were randomized throughout the survey, and predictor and outcome variables were placed in separate sections to reduce priming effects, as recommended by Podsakoff et al. (2003). Statistically, Harman's single-factor test was conducted by entering all measured items into an unrotated exploratory factor analysis. The results indicated that the first factor accounted for only 29.4% of the total variance, which is well below the 50% threshold, suggesting that no single factor dominated the variance and that common method bias is unlikely to be a major concern (Podsakoff et al., 2003).

In addition, the marker variable technique was applied by including a theoretically unrelated marker variable to statistically assess common method variance. The inclusion of this marker variable led to minimal changes in key path coefficients, with a 0.06 change in the path to sustainability performance and a 0.04 change in the indirect mediation path. These marginal differences support the robustness of the model and indicate that common method bias did not materially affect the results (Chin et al., 2013). Taken together, both Harman's test and the marker variable technique confirm that common method variance is not a serious threat to the validity of this study's findings.

4 EMPIRICAL ANALYSIS

Table 1 presents the demographic characteristics of the 214 respondents from Jordan's manufacturing sector. The sample included 56.1% male and 43.9% female participants. Most respondents were aged 31–35 (36.9%) and held postgraduate (33.2%) or master's degrees (42.1%), reflecting a well-educated workforce.

Table 1. Demographic profile of the study' respondents

Variable	Category	Frequency	Percentage (%)
Gender	Male	120	56.1
	Female	94	43.9
Age	Less than 25 years	34	15.9
	26–30 years	51	23.8
	31–35 years	79	36.9
	More than 35 years	50	23.4
Education	Graduation	35	16.4
	Post-Graduation	71	33.2
	Master's Degree	90	42.1
	Other	18	8.40
Work Experience	Less than 3 years	39	18.2
	3–5 years	58	27.1
	6–10 years	67	31.3
	More than 10 years	50	23.4
Department	Production/Operations	79	36.9
	R&D/Engineering	42	19.6
	Sustainability/CSR	45	21.0
	Administration/Other	48	22.4

Source(s): *Authors' Own Work.*

Work experience was diverse, with 58.4% having over five years of industry experience. The majority of respondents worked in production/operations (36.9%), followed by sustainability/CSR (21.0%) and R&D (19.6%). This distribution ensures that insights were drawn from individuals directly involved in strategic and operational sustainability initiatives. The demographic mix reflects a strong foundation for exploring the impact of green servitization, circular economy practices, and ESG compliance on sustainability. The presence of educated, mid-career professionals in relevant departments adds robustness and contextual relevance to the study's findings, ensuring that responses are grounded in practical organizational experience within Jordan's industrial landscape

4.1 Measurement Model Assessment

Convergent validity of the constructs was assessed by examining the standardized factor loadings of individual items. All loadings exceeded the recommended threshold of 0.70, indicating that each item was strongly associated with its underlying construct. CEP demonstrated particularly strong factor loadings, with items CEP3 to CEP5 loading above 0.84. ESG compliance items also loaded highly (0.758–0.892), reflecting strong construct representation. Similarly, GS items ranged from 0.759 to 0.850, and SP items ranged from 0.698 to 0.840, confirming reliable measurement. Multicollinearity was assessed using VIF values. All indicators had VIF values well below the threshold of 5.0, ranging from 1.32 to 3.37, suggesting that multicollinearity was not a concern in the model. These results confirm that the constructs demonstrate strong convergent validity and are not affected by multicollinearity, providing a solid foundation for the subsequent structural model analysis.

Table 2. Factor Loadings and VIF Values for Reflective Constructs

Item	CEP	ESG	GS	SP	VIF
CEP2	0.720				1.47
CEP3	0.841				2.720
CEP4	0.873				3.366
CEP5	0.863				2.766
CEP6	0.714				1.481
ESG1		0.758			1.321
ESG2		0.825			2.042
ESG3		0.892			2.355
GS1			0.850		1.386
GS3			0.759		1.548
GS4			0.813		1.557
SP1				0.833	2.176
SP2				0.839	2.274
SP3				0.840	2.383
SP5				0.713	2.455
SP6				0.698	2.415

Note. *GS = Green Servitization; CEP = Circular Economy Practices; ESG = Environmental, Social, and Governance Compliance; SP = Sustainability Performance; VIF = Variance Inflation Factor, all factor loadings > 0.70. All VIF values < 5.0, indicating no multicollinearity.* ***Source(s):*** *Authors' Own Work.*

4.2 Reliability and Validity Assessment

To ensure the reliability and validity of the measurement model, internal consistency was evaluated using Cronbach's alpha and CR, while convergent and discriminant validity were assessed through AVE. As shown in Table 3, all constructs demonstrated satisfactory internal consistency, with Cronbach's alpha values exceeding the recommended threshold of 0.70.

Table 3. Reliability, Convergent Validity, and Discriminant Validity

Construct	Cronbach's α	Composite Reliability	AVE	CEP	ESG	GS	SP
CEP	0.862	0.864	0.648	-			
ESG	0.766	0.766	0.684	0.475	-		
GS	0.744	0.785	0.653	0.296	0.497	-	
SP	0.848	0.869	0.619	0.494	0.573	0.384	-

Note. *CEP = Circular Economy Practices; ESG = Environmental, Social, and Governance Compliance; GS = Green Servitization; SP = Sustainability Performance. AVE = Average Variance Extracted.* ***Source(s):*** *Authors' Own Work.*

Specifically, green servitization (α = 0.744), circular economy practices (α = 0.862), ESG compliance (α = 0.766), and sustainability performance (α = 0.848) all showed strong reliability. Similarly, composite reliability values for each construct ranged from 0.766 to 0.869, further confirming consistent measurement across items. Convergent validity was established through AVE values, which were all above the minimum acceptable threshold of 0.50. Circular economy practices (AVE = 0.648), ESG compliance (AVE = 0.684), green servitization (AVE = 0.653), and sustainability performance (AVE = 0.619) demonstrated that a substantial portion of variance was explained by the underlying constructs. Discriminant validity was confirmed using the HTMT, as all values were found to be below the conservative threshold of 0.85, as recommended by Henseler et al. (2015), indicating that each construct is empirically distinct from the others in the model. This provides stronger evidence of discriminant validity compared to traditional criteria like the Fornell–Larcker test.

These results confirm that the measurement model is both reliable and valid, supporting the robustness of the indicators used to represent green servitization, circular economy practices, ESG compliance, and sustainability performance. With these psychometric properties established, the model is suitable for testing the hypothesized structural relationships in the next stage of analysis.

4.3 Hypothesis Testing and Structural Model Results

To examine the structural relationships proposed in the research framework, path coefficients were evaluated using the bootstrapping procedure with 10,000 resamples. Table 4 presents the results, including path coefficients, standard errors, t-values, p-values, and confidence intervals.

Table 5. Hypothesis Testing Results (Structural Model Assessment)

Hypothesis	Path	Coefficient (β)	Std. Error	t-value	p-value	95% CI (Lower–Upper)	Decision
H1	GS → SP	0.134	0.069	1.949	0.026	0.013 – 0.241	Accepted
H2	GS → CEP	0.236	0.067	3.514	0.000	0.107 – 0.332	Accepted
H3	CEP → SP	0.283	0.066	4.319	0.000	0.169 – 0.386	Accepted
H4	GS → CEP → SP	0.067	0.026	2.577	0.005	0.028 – 0.111	Accepted
H5	GS × ESG → SP	0.128	0.055	2.337	0.010	0.040 – 0.220	Accepted

Note. *GS = Green Servitization; CEP = Circular Economy Practices; ESG = Environmental, Social, and Governance Compliance; SP = Sustainability Performance.* ***Source (s):*** *Authors' Own Work.*

The results of the structural model provide strong support for the proposed relationships in this study. First, green servitization was found to have a direct and statistically significant positive effect on sustainability performance (H1: $\beta = 0.134$, $p = 0.026$). This means that when firms integrate environmentally friendly services into their offerings—such as green maintenance, eco-design, or digital efficiency tools—they see a meaningful improvement in their overall sustainability outcomes. In addition, green servitization showed a significant influence on circular economy practices (H2: $\beta = 0.236$, $p < 0.001$), indicating that firms adopting green servitization are more likely to implement practices like reuse, recycling, and resource recovery. These circular practices themselves had a strong positive impact on sustainability performance (H3: $\beta = 0.283$, $p < 0.001$), reinforcing their role as a key operational mechanism for driving sustainable results.

The analysis also confirmed a partial mediation effect (H4: $\beta = 0.067$, $p = 0.005$), meaning that circular economy practices help explain how green servitization leads to better sustainability. In other words, it's not just the adoption of green services that matters, but also how well those services are supported by circular strategies within the firm. Finally, the study found that ESG compliance significantly moderated the relationship between green servitization and sustainability (H5: $\beta = 0.128$, $p = 0.010$). This means that the positive effect of green servitization on sustainability is stronger in firms that are more committed to ESG principles—such as having transparent governance, social responsibility programs, and environmental policies.

Figure 2 illustrates the structural model developed for this study, depicting the hypothesized relationships among green servitization, circular economy practices, ESG compliance, and sustainability performance. the model highlights both the direct and indirect paths, including mediation and moderation effects, as tested through structural equation modelling.

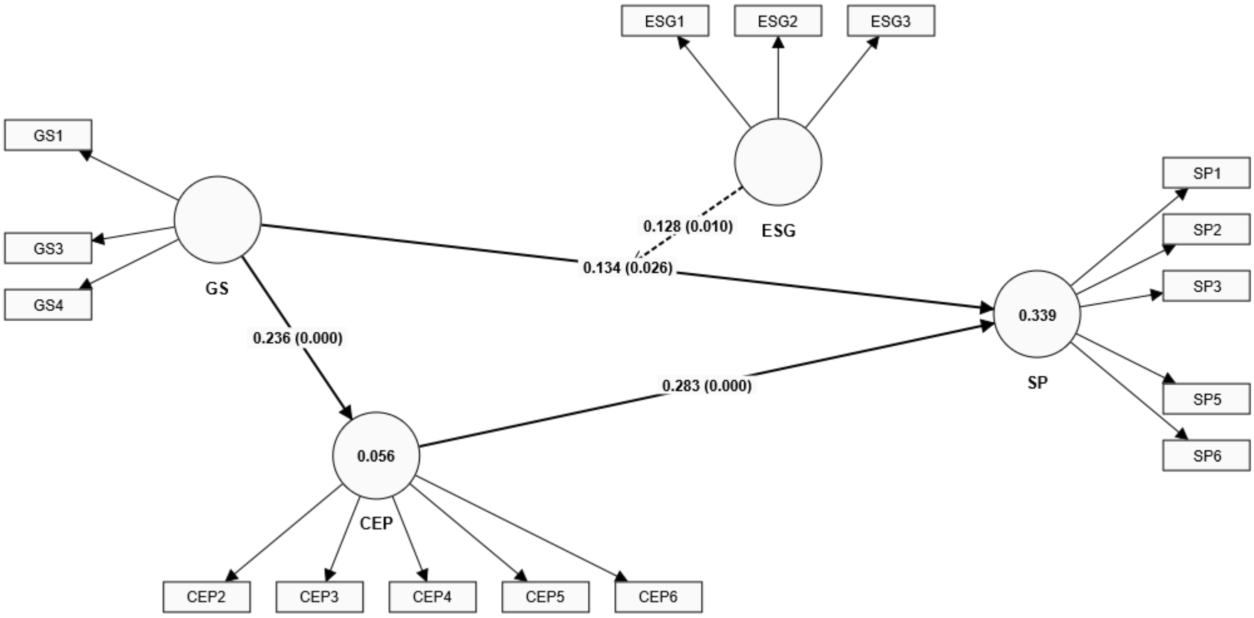

Figure 2. Structural Model.

***Source (s):** Authors' Own Work.*

Figure 3 illustrates the moderating effect of ESG compliance on the relationship between green servitization and sustainability performance. As shown in the interaction slope, the positive effect of green servitization on sustainability performance is significantly stronger when ESG compliance is high. In contrast, firms with low ESG compliance experience a weaker or flatter relationship between green servitization and sustainability. This interaction confirms that ESG practices act as a strategic amplifier to enhancing the ability of green servitization initiatives to deliver meaningful sustainability outcomes. In other words, firms that not only adopt green services but also institutionalize ESG principles are more likely to convert their strategic intent into real environmental, social, and economic impact.

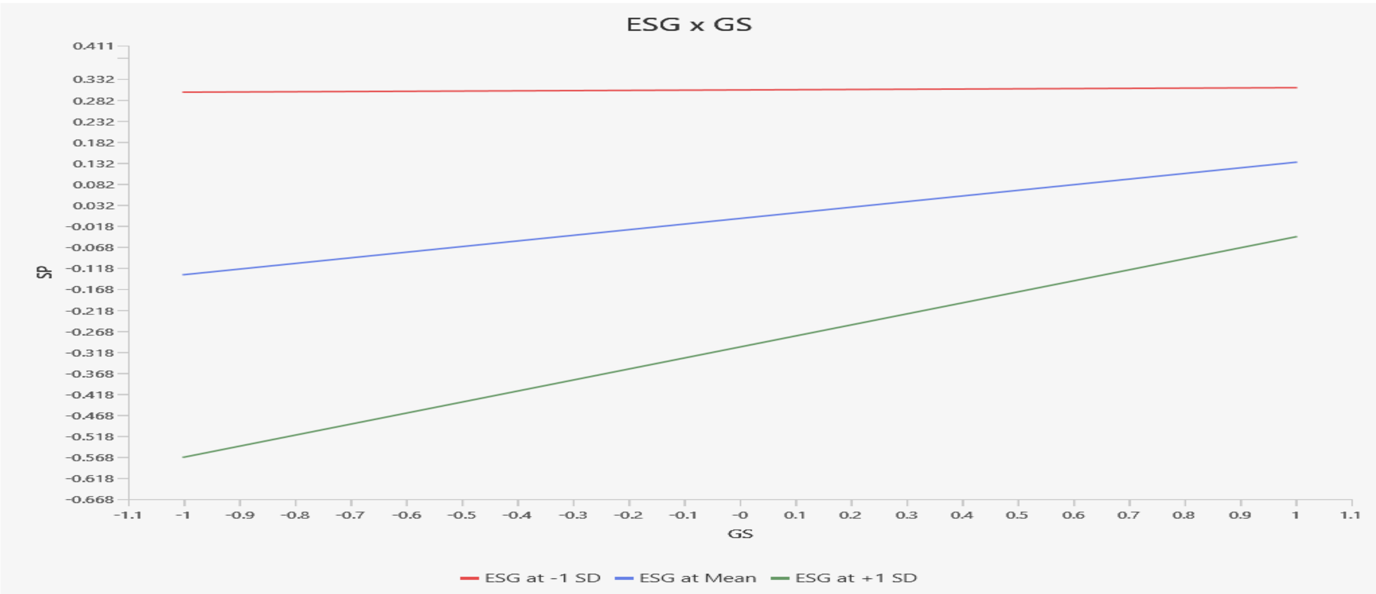

Figure 3. Interaction slop of ESG

***Source(s):** Authors' Own Work.*

4.4 Discussion on study findings

The finding that green servitization directly improves sustainability performance confirms the growing recognition that service-based, environmentally friendly innovations can support long-term value creation. This aligns with previous research e.g., (Johl et al., 2024; Marić & Opazo-Basáez, 2019; Mark-Herbert et al., 2025) which emphasized that shifting from product-oriented to service-based green models helps organizations reduce waste, enhance efficiency, and respond to stakeholder demands for environmental responsibility. In Jordan's context, where resource scarcity and environmental pressures are particularly high, this approach offers a practical pathway to balance business growth with sustainability goals.

Moreover, the significant link between green servitization and circular economy practices highlights that green strategies are most effective when backed by operational processes that close the resource loop. Green services alone may not deliver full sustainability benefits unless they are embedded within systems that promote reuse, recycling, and reduced material consumption. This confirms the operational importance of circularity, consistent with prior findings, e.g., (Oyewale & Johl, 2021; Rodríguez-Espíndola et al., 2022; Yin et al., 2023). In manufacturing sectors such as chemicals, food processing, and pharmaceuticals, this integration is especially critical for minimizing environmental footprint while improving process resilience (Ali et al., 2023). The strong effect of circular economy practices on sustainability further reinforces their value as practical tools for advancing environmental and economic performance. This is particularly encouraging for Jordanian manufacturers, many of whom are operating under tight resource constraints and increasing regulatory pressure. Implementing circular practices can reduce costs, extend material lifecycles, and create value from waste—an opportunity that aligns with both business and environmental objectives.

The study also confirmed the mediating role of circular economy practices in the relationship between green servitization and sustainability and aligned with prior studies such as (Alodat et al., 2025; Chouaibi et al., 2021; Yin et al., 2023; Zhang et al., 2022). This suggests that circular practices serve as a key mechanism that enables green servitization to translate into tangible outcomes. Without such practices, the strategic intent behind green servitization may not be fully realized. This finding bridges the gap between high-level strategic planning and day-to-day operations, providing evidence for the importance of integrating strategy and execution in sustainability initiatives. Finally, the moderating effect of ESG compliance is particularly noteworthy. Firms with higher ESG commitment were more successful in converting green servitization into sustainability performance. This suggests that ESG frameworks not only signal a firm's environmental and social responsibility but also enable better implementation of green strategies. This result aligns with the work of Sui et al. (2024) and Kumar et al. (2024), who found that ESG maturity enhances the effectiveness of green innovations. In Jordan, where ESG practices are still evolving, this finding provides a strong case for further institutionalizing ESG principles across the industrial sector.

5 CONCLUSION

This study set out to examine how green servitization contributes to sustainability performance in the Jordanian manufacturing sector. It focused on understanding the mediating role of CEPs and the moderating effect of ESG compliance. The findings confirmed that green servitization has both a direct and indirect effect on sustainability, with CEPs acting as a key operational mechanism that enhances environmental and economic outcomes. The results also demonstrated that ESG compliance strengthens the positive relationship between green servitization and sustainability, highlighting the importance of institutional commitment in maximizing the impact of green initiatives.

5.1 Theoretical and Practical Implications

From a theoretical standpoint, this study contributes to the ongoing development of the NRBV by demonstrating how green servitization operates not only as a strategic resource but also as a dynamic capability that depends on operational execution (via CEPs) and institutional framing (via ESG). By incorporating a mediator and moderator into the traditional NRBV framework, the study adds nuance to our understanding of how sustainability performance is achieved in resource-constrained environments.

Practically, the findings offer several actionable insights for managers and policymakers in Jordan and other emerging economies. For firm managers, the study highlights the importance of going beyond green product offerings and embedding circular thinking into operations—through recycling systems, reuse strategies, and material recovery. These actions are not only environmentally beneficial but also economically strategic in markets where input costs and resource availability are volatile. Additionally, firms with strong ESG frameworks—including transparent governance, ethical labour practices, and community responsibility—are more likely to reap the full benefits of green servitization.

For policymakers and regulators, the study suggests the need to support and incentivize circular business models and ESG adoption through training, tax relief, or compliance frameworks. Governments and industry associations can play a facilitative role by offering technical guidance, benchmarking tools, or financial support to firms transitioning toward green and circular models. In the Jordanian context, these insights align with the national green growth agenda and can help accelerate industrial transformation toward long-term sustainability.

5.2 Limitations

While the findings are robust, several limitations should be acknowledged. First, the study relies on cross-sectional data, which restricts the ability to assess causality or dynamic changes over time. Although the statistical relationships are significant, they do not account for how green servitization and ESG evolve or interact over extended periods. Second, data were collected only from Jordanian manufacturing firms, which may limit the generalizability of the results to other sectors (e.g., services, construction, energy) or regions with different regulatory, economic, or cultural environments. Third, the study used self-reported data gathered through surveys, which may be influenced by social desirability bias or limited awareness of respondents, especially in areas like ESG compliance or sustainability performance metrics. Fourth, some crucial factors may still be unobserved—such as firm leadership style, innovation intensity, or customer pressure—that influence the model's outcomes.

5.3 Future Research Directions

Building on these findings, several future research opportunities emerge. First, scholars could adopt longitudinal or panel data approaches to explore how green servitization and ESG evolve over time and what factors enable or hinder sustained transformation. Second, future studies could conduct comparative analyses across countries (e.g., Jordan vs. Egypt or Turkey) or industry types to understand how institutional, cultural, and regulatory contexts shape the effectiveness of circular and green strategies. Third, future work could integrate qualitative methods—such as case studies, interviews, or focus groups—to uncover deeper organizational processes, cultural barriers, or leadership practices that influence green servitization success. Fourth, researchers could explore other moderating variables, such as organizational culture, supply chain integration, digitalization level, or regulatory support, to enrich the framework and account for broader contextual influences. Finally, future studies might investigate employee-level outcomes, such as green employee behaviour, engagement, or job satisfaction, as mediating mechanisms between green practices and firm-level sustainability. Such multi-level studies would offer a more holistic view of how sustainability strategies permeate different layers of the organization.

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