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Green Logistics Practices Toward a Circular Economy: A Way to Sustainable Development

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Abstract
This research investigates the effects of green logistics practices on the sustainability performance of manufacturing enterprises in Oman, with a particular focus on the mediating role of circular economy practices. Analyzing data from 220 manufacturing companies through the PLS-SEM method, the findings reveal that green logistics management significantly enhances an organization's sustainability and adherence to circular economy principles. Notably, while supply chain trackability greatly impacts circular economy practices, it does not moderate the relationship between sustainable performance and green logistics. This study enhances the understanding of how green logistics can support sustainable development and the implementation of circular economy practices in the manufacturing sector.

Keywords
Green Manufacturing; Green Logistics; Circular Economy; Sustainable development; Manufacturing companies.

Introduction

This study explores the integration of environmentally friendly logistics operations within the framework of a circular economy in Oman to promote sustainable development. It highlights the importance of adopting sustainable logistics practices that reduce environmental impact, improve resource efficiency, and support economic sustainability (de Souza et al., 2022). This approach involves rethinking traditional logistics and supply chain management to prioritize waste reduction, recycling, and resource reuse, aiming to establish a closed-loop system (Kirchherr et al., 2017) that minimizes resource consumption and environmental degradation, thereby advancing sustainable development goals (Younis et al., 2016).

Despite the recognized importance of green logistics in achieving a circular economy and sustainable development, significant implementation gaps persist (Korhonen et al., 2018a). Many industries face challenges in effectively integrating green logistics practices (Cheng et al., 2023) due to economic, technological, and infrastructural constraints (Geng et al., 2017). These gaps hinder the transition to a circular economy, where waste is minimized, and resources are reused, threatening the broader objective of sustainable development (Hung Lau, 2011). This underscores the urgent need for innovative, scalable solutions to balance economic growth with environmental stewardship and social responsibility (Seroka-Stolka, 2014).

The purpose of this study is to examine the implementation of green logistics practices in Oman within a circular economy framework (El-Kassar & Singh, 2019) and to assess their impact on sustainable development. It aims to identify barriers and facilitators to adopting these practices, evaluate their effectiveness in reducing environmental impact, and propose actionable strategies for businesses and policymakers (Abdel-Basset et al., 2021). This study seeks to contribute to the body of knowledge on sustainable logistics and provide insights that can drive the transition to more sustainable, circular economy practices in the logistics sector (Rogers & Tibben-Lembke, 2001).

This study identifies several key areas requiring further investigation, leading to the development of specific research questions and hypotheses. The surveyed entities, as detailed in Table 1, primarily consist of various companies across Oman. The research questions for this study are as follows:

RQ1: What are the main barriers to implementing green logistics practices in the context of a circular economy?

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RQ2: How do green logistics practices contribute to sustainable development goals?

RQ3: What role does technology play in facilitating the transition to green logistics and a circular economy?

RQ4: How do regulatory frameworks influence the adoption of green logistics practices?

This study's significance lies in its potential to promote environmental sustainability by integrating green logistics practices within a circular economy framework. It aims to address critical gaps in existing logistics and supply chain management strategies, offering insights into overcoming barriers to sustainable development (Schroeder et al., 2021). By identifying effective practices and recommending actionable strategies (Kalmykova et al., 2018), the research could influence policy-making, guide corporate decision-making towards sustainability, and foster broader adoption of circular economy principles, benefiting the environment, society, and the economy (Cerqueira-Streit et al., 2021).

Literature review

Logistics is traditionally described as efforts to minimize costs and increase revenues, typically referenced in professional settings such as business and financial reports. However, over time, the term "logistics" has been paired with "green", creating "green logistics", which refers to costs not shown on financial statements but impact society and the environment. According to (Rodrigue, 2012), green logistics involves environmentally friendly materials handling, waste management, packaging, and transportation-focused supply chain management strategies aimed at minimizing the environmental and energy impacts of freight distribution (Dornfeld, 2014).

Traditional industries are rapidly evolving, leading to social and environmental issues like the depletion of natural resources and environmental pollution (Mishrif & Khan, 2023). Balancing economic growth with environmental preservation has become a serious global challenge (Jayaraman et al., 2012). In a highly competitive global marketplace (Awan et al., 2021), economic factors directly influence a firm's growth and future business prospects. Consequently, many firms face substantial challenges in identifying ideal long-term partners to enhance corporate performance while reducing carbon dioxide (CO2) emissions (Wang et al., 2017). The adverse effects of logistics operations create interconnected economic, environmental, and social difficulties, necessitating more sustainable logistics practices (Jayarathna et al., 2022).

The European Green Deal aims for carbon neutrality in Europe by 2050, suggesting that broad adoption of a circular economy could reduce greenhouse gas emissions by 50%. Since supply chains account for four-fifths of these emissions, practitioners, policymakers, and academics must focus on transitioning from linear to circular systems (Vrchota et al., 2020) and effectively implementing these circular systems (Montag et al., 2023). Scientists are increasingly concerned about natural resource depletion due to high consumption levels over the past decades. Pandemics like COVID-19 highlight the global impact of local actions, emphasizing the urgent need to rethink production, marketing, distribution, usage, and recovery methods (Cerqueira-Streit et al., 2021).

Circular processes fall into eight categories: Redesign, Reduce, Use and Reuse, Resale, Refurbish, Remanufacture, Recycling, Recovery, and Recirculate. Research has identified considerable confusion and overlap between circular process indicators and circular effect indicators. Clarifying these categories can significantly improve circular economy (CE) assessment tools and processes (Garcia-Saravia Ortiz-de-Montellano & van der Meer, 2022). The relatively new concept of the circular economy (CE) aims to maximize economic, environmental, and social aspects of enterprises to create a more sustainable society with the participation of all relevant stakeholders. The cornerstone of the CE idea is "the regenerative cycle, which facilitates the efficient reuse of products, parts, and materials, thereby increasing profitability and reducing environmental impact." Numerous studies have discussed the benefits and challenges of implementing the circular economy in businesses (Abdul-Rashid et al., 2017).

Researchers predict that adopting a circular economy significantly influences a company's sustainability (Asif et al., 2016). Studies have shown that adopting a circular economy enhances sustainability-focused innovation and leads to sustainable development. Recent research suggests that green logistics can be viewed as an organizational element that supports the circular economy (Choi & Hwang, 2015). A growing body of research highlights the importance of green logistics in enhancing a company's sustainable development (Setyadi, 2019). While some academics report a connection between green logistics and overall sustainability development, others confirm the relationship between green logistics and various sustainability aspects (Ansari et al., 2019). Conflicting results in the literature show that some studies argue there isn't always a direct correlation between sustainable development and green logistics (Graczyk-Kucharska, 2023).

While some research has found a negligible correlation, others have revealed a significant relationship between green logistics and sustainable development. Thus, the role of the circular economy in the relationship between sustainable development and green logistics must be investigated. Since the implementation of the circular economy depends on green logistics, which in turn promotes enterprises' sustainability development (Nasir et al., 2016), the researcher hypothesizes that the circular economy successfully mediates the effects of green logistics on sustainability development (Calzolari et al., 2021). Additionally, researchers suggest that supply chain monitoring moderates the green logistics-circular economy connection and positively impacts organizations' circular economies.

Green Manufacturing (GM)

Businesses are under increasing pressure to adopt "greener" practices and become more environmentally friendly. Concepts such as green management, green marketing, green manufacturing, and green innovation are being developed to address environmental pollution. To achieve sustainable development, businesses must reinvent their products and integrate new technologies into their operations (Sezen & Çankaya, 2013). Many companies are now developing the next generation of clean technologies to support future economic growth. In recent years, there has been a shift towards more environmentally conscious behaviors to meet consumer demand for compliant and eco-friendly service items (Ford & Despeisse, 2016). This can be achieved by promoting green innovation, which Jayaraman et al. (2012) defined as the development of environmentally beneficial green products. According to estimates of the current market share for eco-friendly items, green products can increase environmental awareness and enhance demand (Ritter et al., 2015).

The industrial supply chain and manufacturing processes are among the most harmful issues, necessitating prompt legislative change and industrial action. Emphasizing green practices in business operations is crucial for building organizational capabilities for sustainable manufacturing, which goes beyond merely producing goods with minimal energy and natural resource use and maximizing profit to include economic and social dimensions (Kazakova & Lee, 2022).

As a result, the following hypotheses are proposed:

H1: Green Manufacturing (GM) has a positive and significant effect on Sustainable Development (SD).

H2: Green Manufacturing (GM) positively and significantly affects the Circular Economy (CE).

Green Logistics (GL)

Green logistics plays a crucial role in the development of the circular economy (CE). The term "circular economy" refers to a system where all material flows within an economy are completely closed. "Green logistics" connects resources to commodities and subsequently to consumers' needs through products. According to Seroka-Stolka (2014), green logistics is essential for completing the cycle of the circular economy. Zaman & Shamsuddin, (2017) note that supply chain logistics operations significantly deplete resources and contribute to environmental pollution. Jayarathna et al. (2022) highlight that the negative impacts of logistics operations create interconnected economic, environmental, and social issues, necessitating stronger sustainability initiatives from the logistics industry. Accordingly, the following hypotheses are proposed:

H3: Green Logistics (GL) positively and significantly affects the Circular Economy (CE).

H4: Green Logistics (GL) has a positive and significant effect on Sustainable Development (SD).

Sustainable Development (SD)

The issue of sustainable development (SD) has become a top priority due to the global shortage of resources, climate change, and rising resource consumption. The circular economy (CE) has garnered significant interest for its potential to contribute to sustainable development Knäble et al. (2022). Policymakers, businesses, and governments are focusing on the CE to achieve the Sustainable Development Goals (SDGs) established by the United Nations (UN) in 2015 (Stahel, 2016), particularly in Europe and China (McDowall et al., 2017).

The context of European nations provides an opportunity to examine the impact of the CE on SD. These countries have started implementing CE practices earlier than others, aiming to enhance resource availability, and the effects of these policies can be assessed. Furthermore, various European nations are at different stages of implementing CE programs (Knäble et al., 2022). Therefore, the following research hypothesis are proposed:

H5: The Circular Economy (CE) has a positive and significant effect on Sustainable Development (SD).

Supply chain tracking (SCT)

Supply chain track and trace is used to monitor the movement of products along the supply chain (Del

Giudice et al., 2021). This capability allows enterprises to track and trace items from their origin to their destination through a combination of software, hardware, and procedures (Dietrich et al., 2022). This approach enables companies to monitor the movement of goods in real-time, allowing them to identify and address any delays or issues promptly, thereby enhancing their efforts to promote environmental, social, and business sustainability. Technological advancements facilitate the acquisition of precise and reliable data, enabling firms to save significant amounts of money and resources (Addo-Tenkorang et al., 2012).

Trackability significantly increases product mobility, streamlining logistics processes overall. Reducing a company's harmful environmental impacts within the supply chain is essential for improving green supply chain processes and procedures, as well as its sustainable performance (Nandi et al., 2021). Thus, the proposed hypotheses are:

H6: Supply chain tracking (SCT) positively and significantly affects the Circular Economy (CE).

H7: Supply chain tracking (SCT) mediates the relationship between Green Logistics and the Circular Economy.

Based on the literature review, the following conceptual framework was developed (Fig. 1).

Hypothesis H7 is labeled differently from the other hypotheses (Fig. 1) because it explores a distinct relationship. Specifically, H7 examines the moderating effect of Supply Chain Tracking (SCT) on the relationship between Green Logistics (GL) and the Circular Economy (CE), rather than assessing a direct effect or influence like the other hypotheses.

Materials & Methods

This article investigates the adoption of sustainable practices within the logistics industry, particularly in the context of a circular economy, focusing on companies in Oman. Many of these companies have been significantly impacted by the COVID-19 pandemic. Data for this study were provided by companies that have implemented green measures to improve sustainability performance. These entities were selected due to their operation in a volatile environment where the adoption of green practices is critical for ecological stability.

The methodology involved a self-administered questionnaire, allowing respondents to fill it out independently without the interviewer's direct involvement (Yu et al., 2013) within these Omani companies (https://yellowpages.om/). This method can reduce potential bias that might occur with interviewer-led approaches. Initially, a pilot survey was conducted with 25 participants, including 19 business owners and six academics. Based on their feedback, slight modifications were made to the survey questions.

The main survey was distributed to 220 companies, accompanied by a cover letter outlining the study's

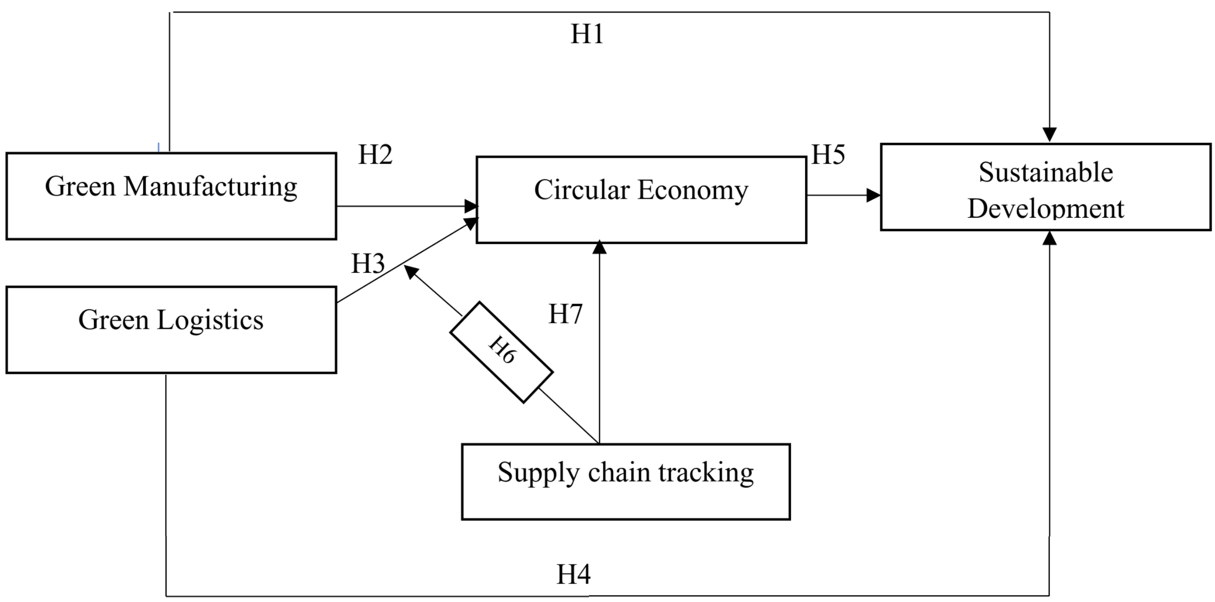


Fig. 1. Conceptual Framework

objectives and assuring voluntary participation. The confidentiality of the data was emphasized, with assurances that the information would be used solely for academic purposes. A remarkable 97% response rate was achieved, with 215 complete questionnaires collected. The researchers attained this high level of engagement through transparent and effective communication methods when approaching these companies. They detailed the study's importance, demonstrated how the results could benefit the companies, and explained how the outcomes would support broader environmental and economic objectives aligned with the companies' goals. Additionally, follow-up reminders via emails or phone calls effectively maintained the survey's visibility among respondents and motivated timely participation before the deadline.

The sample included random selections from various companies across Oman engaged in manufacturing, service provision, and retail sectors, all dependent on imported materials. The questionnaire (Table 2), designed for top executives and business managers with deep knowledge of their operations and performance, comprised two parts. Data collected through the questionnaire were analyzed using both exploratory and descriptive statistical tools, and hypotheses were tested using inferential statistics and Partial Least Squares Structural Equation Modeling (PLS-SEM).

To ensure a representative sample and minimize duplication, retail enterprises were randomly selected and listed alphabetically from the Yellow Pages of the Oman business directory, following a method validated in similar research. After initial contacts, additional potential respondents were identified through snowball sampling. All responses were coded after reminders and follow-up calls, and the analysis was conducted using Smart-PLS version 3.3.4 and SPSS version 20.0 to evaluate the study framework. This structured approach ensures that the findings provide a valuable snapshot of the current situation, despite the inherent limitations of a cross-sectional study design.

Respondent companies were 49.8 percent big companies (workers $>$ 200), 49.8 percent medium-sized companies (employees 20 to 200), and just 4.4 percent small-sized companies (employees 20). The distribution within the survey sample appears to be heavily weighted towards larger firms, with almost equal representation of large and medium-sized companies and very few small companies. Around 55.8 percent of the sample claimed that their supply networks stretched globally, with regional and local supply chains accounting for 30 and 14 percent, respectively. Around 56.8 percent of the businesses were typical brick-and-mortar store-based walk-in merchants, 38.8 percent were multimodal (or omnichannel), and just 4.4 percent were e-commerce. Table 1 depicts the retail sector sample distribution. A whopping 96 percent of respondents had more than two years of managing experience in their respective organizations. CEOs, Chairmen, MDs, General Managers, Operations/Supply Chain/Logistics Managers, Middle Management, IT Managers, and Others were among those who answered (5.8%). With 14 percent identifying them as the key decision makers and 48 percent having a considerable engagement, almost 62 percent of respondents claimed to be involved in high-level strategic decision-making in supply chain operations. 36 percent said their level of participation was moderate.

Table 1
Sectors represented in the sample. Source: Author created. Source: Author developed

Sectors (n=215)	Frequency	Percent(%)
Takeaway, restaurant, and café	25	11.63
Grocery and supermarkets	47	21.86
Domestic items (e.g. hardware, furniture)	20	9.30
Personal items, clothing, and footwear	30	13.95
Electrical, electronic, and computer terms	20	9.30
Medicinal, cosmetic, and toiletry products	15	6.98
Automobiles and parts	10	4.65
Gas stations and convenience stores	8	3.72
Department stores	30	13.95
Other	10	4.65

Following data collection, the constructs' reliability and validity were verified using several statistical tools. The exploratory and confirmatory investigations aimed to examine the impact of green logistics (GL) on sustainable development (SD) through the circular economy (CE). To test the dataset, the research framework for PLS path modeling was evaluated. Initially, the data was filtered using SPSS to identify missing values and anomalies, perform descriptive analysis, and assess the demographic distribution of the sample. The connections between latent variables in the conceptual framework were then assessed using PLS-SEM.

PLS-SEM was chosen for its applicability in both exploratory and confirmatory research and its ability to analyze complex topics. This study framework was developed using several pre-existing theories and aimed to increase the variance of endogenous constructs as explained by exogenous variables, reflecting the experimental covariance matrix. Therefore, PLS-SEM was essential for predicting the model's latent variables.

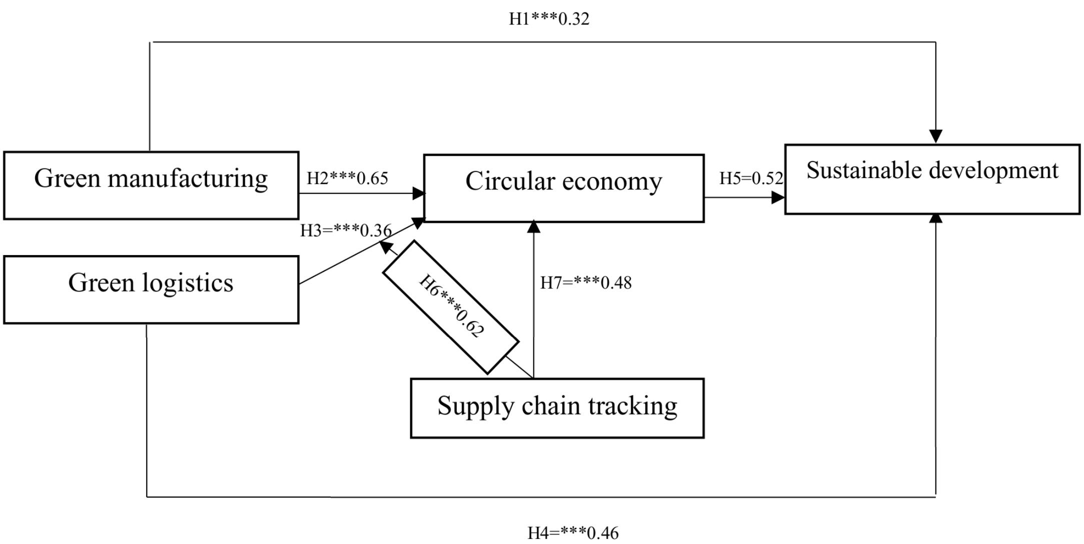
The data were evaluated twice after running PLS-SEM. First, using a total of 215 valid samples, the reliability and validity of the measurement model (the outer model) were assessed using composite reliability (CR), average variance extracted (AVE), and Cronbach's alpha (CA). In the second step, researcher identified any potential associations between these factors. Finally, researcher conducted a mediation analysis. The structural model was assessed using the relevant measurement results from this study, examining the importance and effects of the path parameters.

Results

Following data collection, the constructs' reliability and validity were verified using several studies. All constructions' Cronbach's alpha and composite reliability surpass the stipulated value of 0.7, indicating construct reliability (Hair et al., 2011) Cronbach's alpha values were more than 0.8 for all constructions. The range of the composite dependability values was 0.75 to 1. According to Hair et al. (2014), the constructs did not have issues with multicollinearity because the largest correlation between components was 0.69.

The greatest likelihood technique was used by CFA to assess each measuring scale's convergent validity (O'Leary-Kelly & J. Vokurka, 1998) Factor loadings for each indicator for the related constructs are all statistically significant (p 0.001) and more than 0.50 (Table 2), demonstrating the convergence of the theoretical constructs (Anderson & Gerbing, 1988). As a result, measuring items are strongly related to their underlying theoretical ideas. Furthermore, each construct's average variance extracted (AVE) surpasses the minimal value of 0.50 (Fornell & Larcker, 1981), indicating that the constructs have significant convergent validity. By analyzing the correlation between the construct and the square root of AVE, discriminant validity was determined. Table 3 shows discriminant validity since the square root of AVE for each construct shown along the diagonal is greater than the correlation between any two constructs (Fornell & Larcker, 1981). Included are the averages, standard deviations, and the coefficient of inter-construct correlation in Table 2.

Table 3 and Figure 2 display the results of the structural route model using AMOS 23 Hair et al. (2011). The *p*-statistic was calculated via bootstrapping with 215 instances (Qrunfleh & Tarafdar, 2014). Using 2(936)=1224.574, Bollen–Stine (B–S) method



A significant path at p=0.001***

Fig. 2. A Value Creation Model for Sustainable Development. Source: Author developed

Table 2
Survey items. Source: Author created

Construct	Item number	Measurement items	References
Green Manufacturing (GM)	GM1	My company consistently uses materials that are sustainably sourced or recycled in our manufacturing processes	(Abdul-Rashid et al., 2017); (Cheng et al., 2023)
	GM2	My company actively implements technologies and practices to reduce energy consumption during production	
	GM3	My company's manufacturing processes are optimized to minimize waste production and emissions	
	GM4	My company exceeds legal compliance in terms of environmental regulations related to manufacturing."	
Green logistics (GL)	GL1	My company prioritizes the use of eco-friendly transportation methods (e.g., electric or hybrid vehicles, optimized delivery routes) to minimize environmental impact	(Del Giudice et al., 2021); (Kazakova & Lee, 2022)
	GL2	We regularly evaluate and improve our packaging processes to increase the use of recyclable or biodegradable materials and reduce overall material usage	
	GL3	My company's logistics operations are structured to actively reduce our carbon footprint through various initiatives such as carbon offsetting and improved load planning	
Circular economy (CE)	CE1	My company actively designs products to be repairable, upgradeable, or modular to extend their life cycle	(Awan et al., 2021); Cerqueira-Streit et al., 2021)
	CE2	We have established systems in place for the recovery and recycling of materials from end-of-life products	
	CE3	My company's business practices are oriented towards significantly reducing resource consumption and waste generation through the entire production process	
Supply chain tracking (SCT)	SCT1	My company has comprehensive visibility into our supply chain operations from raw material sourcing to final delivery	(Qrunfleh & Tarafdar, 2014); (Cheng et al., 2023)
	SCT2	We have real-time access to data across our entire supply chain, allowing for immediate response to logistics challenges	
	SCT3	My company supply chain utilizes advanced tracking technologies (e.g., GPS, RFID) to monitor the movement and condition of goods throughout the supply chain	
	SCT4	The tracking systems we use ensure high accuracy in inventory management, reducing losses and inefficiencies.	

Table 2 continued on the next page

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Construct	Item number	Measurement items	References
Sustainable development (SD)	SD1	My company actively pursues practices that ensure economic viability while promoting social equity	(Younis et al., 2016); (Knäble et al., 2022); (Choi & Hwang, 2015)
	SD2	My organization is committed to reducing our environmental impact across all areas of operation	
	SD3	We engage with local communities to ensure our business practices have a positive impact on their well-being	

Table 3
Validity of the constructs

Construct	No. of items	GM	GL	SCT	CE	SD	Mean	SD	Cr. Alpha (α)	CR	AVE
Green manufacturing (GM)	7	0.77					4.83	1.26	0.92	0.86	0.56
Green logistics (GL)	8	0.65	0.76				4.73	1.33	0.91	0.88	0.57
Supply chain trackability (SCT)	8	0.63	0.71	0.77			4.51	1.36	0.94	0.87	0.62
Circular economy (CE)	7	0.58	0.65	0.68	0.76		4.73	1.34	0.88	0.84	0.58
Sustainable development (SD)	8	0.67	0.62	0.62	0.62	0.71	4.64	1.44	0.76	0.77	0.53

The diagonal values for each construct represent the retrieved AVE squared. Alpha stands for Cronbach's alpha, whereas SD stands for standard deviation. CR stands for composite reliability. Every correlation coefficient below the diagonal is significant at $p < 0.001$

$p = 0.093$, $2/df = 1.324$, SRMR = 0.0771, RMSEA = 0.037, CFI = 0.943, and TLI = 0.957, the structural model provided an overall satisfactory fit. The goodness-of-fit indices are all above or near the acceptable cut-off marks, indicating that the provided model properly represents the hypothesized link between all components. As a result, the data support the suggested theoretical model.

Tables 3 and 4 shows how the five hypotheses are supported. The path's standardized beta coefficients and t-statistics are also shown.

Discussion

This study reveals that implementing green logistics practices within a circular economy framework significantly enhances sustainable development. It demonstrates that such practices not only contribute to environmental sustainability by reducing waste and emissions but also offer economic benefits through resource efficiency and innovation like de Souza et al., (2022), who found similar reductions in logistics-related carbon emissions and cost savings through green practices. The research highlights the critical role of technology, policy support, and stakeholder collaboration in overcoming barriers to green logistics adoption, suggesting that a holistic approach is essential for transitioning towards more sustainable logistics and supply chain models like those by Cerqueira-Streit et al. (2021), who discuss the importance of legislative frameworks. The empirical results showed that GM and GL promoted environmentally friendly and sustainable production and encouraged businesses to employ CE like the work by Younis et al. (2016) who suggested that medium-sized firms possess unique agility that facilitates more effective implementation of these practices. Results showed that GM strongly influenced CE and SD (= 0.32 and = 0.65, respectively), supporting H1 and H2. As the green manufacturing source has a considerable impact on green raw material procurement, this increases the impact of SD and CE. Additionally,

Table 4
Results of the structural path analysis. Source: Author developed

Hypotheses	Path	Std. β	t-values	Results
H1	GM → SD	0.32**	4.287	Supported
H2	GM→ CE	0.65**	6.284	Supported
H3	GL→ CE	0.36**	3.452	Supported
H4	GL→ SD	0.46**	6.287	Supported
H5	CE → SD	0.52**	6.376	Supported
H6	GL* SCT→CE	–0.032	0.612	Not Supported
H7	SCT→CE	0.45**	4.983	Supported

** < 0.001, * $p < 0.05$. Source: Author developed

GL produced CE and SD in a way that supported H3 and H4, respectively (= 0.36 and = 0.46). The integration of SD and CE is greatly aided by green operational resources and logistical operations. A business must genuinely use best green practices, which complement SD and CE, to develop ecologically friendly products without jeopardizing the supply side interest. Additionally, SD strongly influenced CE (= 0.52), corroborating our findings with H5. Furthermore, the researcher found a positive effect of firms' SCT on their CE ($\beta = 0.45$, $t = 4.983$, $p = 0.000$), validating hypothesis H6. However, the findings depicted that the SCT had no substantial moderating effect on the relation between the GL and CE ($\beta = -0.032$, $t = 0.612$, p >0.05), invalidating H6. These results emphasized the unusual phenomenon that SD affects CE implementation both directly and indirectly. The adoption of CE might be greatly accelerated by a change in corporate green policies for SD. Competitive environmental initiatives supported by GM and GL can minimize environmental problems while also increasing stakeholder satisfaction and goodwill. It contributes to existing theories like Seuring & Müller (2008) who discuss the importance of human resource strategies in sustainability by providing empirical evidence on how such integration can lead to environmental, economic, and social benefits contrary to the constraints highlighted by (Korhonen et al., 2018b).

Conclusions

This study has significantly advanced the understanding of the intersection between green logistics practices and the circular economy, providing valuable insights for achieving sustainable development within the manufacturing sector in Oman. Through rigorous analysis and evaluation, the research highlights the integral role of green logistics in enhancing organizational sustainability and supporting the broader implementation of circular economy principles.

The implementation of green logistics practices was shown to significantly improve sustainable development outcomes, demonstrating that environmental sustainability and economic benefits can be achieved simultaneously through resource efficiency and innovation. The study's results support the notion that green manufacturing and green logistics are pivotal in promoting circular economy practices. Specifically, green manufacturing strongly influenced both circular economy initiatives and sustainable development, underscoring the critical impact of sustainable operational practices in the manufacturing sector.

Theoretically, this research enriches existing literature by providing empirical evidence on how integrating green logistics within a circular economy framework can lead to substantial environmental, economic, and social benefits. It offers a refined understanding of the dynamics between these practices and sustainable development. Practically, the study offers actionable strategies for businesses and policymakers, emphasizing the importance of technological innovation, regulatory support, and cross-sector collaboration. It advocates for a shift towards more sustainable business models, presenting a clear roadmap for companies to align with circular economy goals.

While this study provides foundational insights, it acknowledges limitations such as reliance on self-reported data, which may introduce biases. Future research could enhance generalizability by incorporating objective data sources or broader sectoral studies. Further exploration is needed to assess the long-term impacts of these practices on sustainability metrics and to explore the role of emerging technologies in facilitating the transition to green logistics and circular economies.

The study benefited greatly from the contributions of colleagues at Sohar University, Oman, whose feedback was instrumental in refining the research and enhancing its quality. Their dedication and support have been invaluable in bringing this project to fruition.

This research has laid a robust foundation for understanding how targeted green logistics practices can enhance the circular economy and foster sustainable development. It opens several avenues for future research to build upon these findings, potentially leading to more nuanced strategies that can be adopted globally to achieve sustainability and economic growth simultaneously.

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