THE IMPACT OF ARTIFICIAL INTELLIGENCE ON GREEN REVERSE LOGISTICS : THE MEDIATING ROLE OF SUSTAINANLE PERFORMANCE

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Abstract:
This study aims to investigate the impact of AI on reverse logistics in the construction sector, and focuses specifically on how sustainability performance plays a mediating role**.** The research is based on the RBV and DCT theories, to investigate how AI-powered processes are associated with sustainability practices; as well as reverse logistics optimization. This study collects primary data through structured questionnaires from key professionals in the construction industry. To evaluate AI, sustainability performance and reverse logistics concepts of this relation a Partial Least Squares Structural Equation Modeling (PLS-SEM) technique is used in the study. The findings reveal that AI is used to improve reverse logistics processes, while an improvement in sustainability performance is this process's most important intermediate consequence. The relationship between AI and sustainability magnifies the need to embed sustainable behaviors in AI-driven logistics strategies for better business productivity and environmental performance. The study emphasized that AI technologies must be adaptable to sustainability outcomes which can offer firms unique advantages in an increasingly complex and environmentally aware industry. This research contributes to the literature; this research seeks to contribute by providing empirical evidence concerning sustainability performance as a mediating variable explaining how AI influences reverse logistics. The content provided in this article will help industry practitioners and policymakers to benefit from AI for sustainable logistics management of construction practices.

Keywords: Reverse Logistics, Sustainability, AI-Driven Decision Support Systems (DSS), AI-Driven Customer Relationship Management (CRM) Supply Chain Visibility (SCV)

1. Introduction

Artificial Intelligence Artificial intelligence has led to the development of Green Reverse Logisticsmeasurements.Green Reverse Logisticsis also known as the process of moving goods beyond their final location back to the producer or a facility designated for retrieval, refurbishing, or recycling.Green Reverse Logisticsis one of the central sectors within supply chain management since it ligaments product paths between consumers and manufacturers. Companies that employ artificial intelligence through machine learning and predictive analytics can, therefore, measureGreen Reverse Logisticscosts more efficiently and accurately. The AI algorithms can crunch petabytes of data in real-time, generating patterns exceedingly complex in brief timeframes few humans could ever hope to unravel. That means companies can utilize artificial intelligence to route transportation between point A and point B more efficiently, manage inventory more effectively, and project product returns. In return, this will help companies to downsizeGreen Reverse Logisticscosts such as shipping costs, inventory carrying costs, and returns processing charges, which ultimately help in their streamlined cost-effective supply chain management. This research further investigates how AI-driven solutions, more specifically machine learning and automation reshape the model of reverse logistics. The most prominent elements are machine learning models that provide predictive analytics that make it possible to determine returns with high precision, which, in turn, helps companies maintain inventory and use resources more efficiently. Essentially, such models examine historical returns data to identify the most common patterns to address issues even before they impact supply chains. Additionally, automation-based technologies supported by AI help sort and process return goods more efficiently, minimizing human error and reducing costs. However, the integration of AI solutions presents certain challenges. Thus, the most common obstacles include the substantial costs of acquiring and incorporating systems, data security challenges, and the necessity for employee reskilling. Equally important, the mediating factor ofGreen Reverse Logisticstransformation is complemented by the introduction of AI. The flexibility of servicessector, with its unique challenges and requirements, has been at the forefront of adopting AI to optimize supply chain operations. The integration of AI inGreen Reverse Logisticswithin Flexibility of services supply chains has the potential to significantly reduce costs, improve efficiency, and enhance patient care. This paper will delve into the specific ways AI is being utilized to measure and manageGreen Reverse Logisticsin Flexibility of services settings, focusing on the case study of a leading Flexibility of services supply chain management system. Through this case study, we will examine the implementation of AI technologies, the challenges faced, and the outcomes achieved in terms of cost savings and operational improvements.The study will analyze the current state ofGreen Reverse Logisticsin Flexibility of services supply chains, highlighting the inefficiencies and challenges that exist. It will then explore how AI technologies, such as machine learning algorithms, predictive analytics, and automated tracking systems, are being applied to address these issues. By examining the specific case of a Flexibility of services supply chain, this paper will provide insights into how AI can be effectively integrated intoGreen Reverse Logisticsprocesses to achieve cost-effectiveness and operational excellence. The findings from this case study will contribute to the broader discourse on the role of AI in logistics and supply chain management. It will offer practical examples of how AI can be leveraged to improve reverse logistics, providing valuable lessons for other industries and sectors. Furthermore, the paper will identify areas for future research and development in the application of AI in reverse logistics, paving the way for further innovation and optimization in this critical area of supply chain management.To delve deeper into this relationship, the influence of Artificial Intelligence has been thoroughly investigated. The following research questions (RQs) are formulated based on this identified gap:

RO1: To analyses how Predictive Analytics and Quality Control affect Green Reverse Logistics Measurement in Jordanian Flexibility of services.

RO2: To examine Decision Support Systems (DSS) influence on Logistics.

The study begins with the development of the theory and a review of the literature, followed by an exploration of the research approach and technique. Subsequently, the study's key findings are discussed, along with additional details. Finally, the research concludes with an overview of its limitations." The study aims to explore the transformative potential of artificial intelligence (AI) in enhancing the efficiency and cost-effectiveness ofGreen Reverse Logisticswithin the Flexibility of services sector, focusing on Jordanian Flexibility of services. Reverse logistics, is a critical component of supply chain management, particularly in Flexibility of services where the handling of medical supplies and equipment necessitates meticulous tracking and management, including Jordanian Flexibility of services which face unique challenges in supply chain management due to the high cost of medical supplies, the need for timely delivery, and the strict regulatory environment governing the handling of medical devices. Traditional methods of reverse logistics, which often rely on manual processes and lack real-time data analytics, can lead to inefficiencies, increased costs, and potential delays in the return of supplies. This study seeks to address these challenges by examining the application of AI technologies in reverse logistics, to improve the overall performance of Flexibility of services supply chains in Jordan. Artificial intelligence, with its capabilities in data analysis, predictive modeling, and automation, offers a promising solution to the complexities ofGreen Reverse Logisticsin healthcare. AI, Flexibility of services can enhance their ability to track and manage the return of supplies more efficiently, reduce costs, and improve patient care by ensuring timely and accurate delivery of medical supplies. This study delved into the specific applications of AI in reverse logistics, and AI-driven decision-making tools for optimizing return processes. The research focused on private Jordanian Flexibility of services, providing a detailed examination of the current state ofGreen Reverse Logisticswithin the Flexibility of services's supply chain. The study explored the regulatory and ethical considerations of using AI in Flexibility of services supply chains, ensuring that the findings are applicable to Jordanian Flexibility of services regulations, and offering insights that can guide the adoption of AI technologies in reverse logistics.The objectives of this research are to explore and understand the transformative potential of artificial intelligence (AI) in the x ofGreen Reverse Logisticswithin the private Flexibility of services sector. The research is structured to achieve several key objectives, each designed to contribute to a deeper understanding of the subject matter and its practical applications. Investigate the Current State ofGreen Reverse Logisticsin Jordanian Flexibility of services: This objective involves conducting a comprehensive analysis of existingGreen Reverse Logisticsprocesses within private Jordanian Flexibility of services to identify challenges, inefficiencies, and areas for improvement. Understanding the baseline is critical for assessing how AI technologies can enhance operations. Explore the Potential of AI Technologies in Enhancing Reverse Logistics: This objective aims to evaluate the capabilities of AI technologies, such as machine learning, predictive analytics, and automation, in improving the efficiency and cost-effectiveness of reverse logistics. It seeks to understand how these technologies can streamline the return process, reduce errors, and optimize resource allocation. Another objective is to assess the impact of AI on cost-effectiveness. This involves quantifying the impact of AI technologies on the cost-effectiveness ofGreen Reverse Logisticsand measuring the reduction in costs associated with the return of medical supplies, including labor, transportation, and storage, through the use of AI. This objective is crucial for demonstrating the tangible benefits of AI in improving the financial performance ofGreen Reverse Logisticsprocesses.

Literature Review

Artificial intelligence (AI) has brought about a paradigm shift, significantly altering the way supply chains are managed and optimized. AI, a branch of computer science that focuses on creating intelligent machines capable of performing tasks requiring human intelligence, has become a cornerstone in various industries, including logistics. This technological advancement encompasses sophisticated algorithms and computational models that enable machines to learn, reason, and make decisions akin to human cognition. The application of AI in logistics is particularly noteworthy due to its potential to revolutionize the field. By optimizing processes and enhancing decision-making capabilities, AI has the power to streamline operations, reduce costs, and improve the overall efficiency of supply chains. This literature review underscores the transformative impact of AI on logistics, highlighting its role in addressing the complex challenges inherent in supply chain management, from the planning and execution of deliveries to the management of returns and inventory. As AI continues to evolve, it promises to further disrupt the logistics industry, offering new opportunities for innovation and efficiency. Reverse logistics, a critical yet often overlooked component of supply chain management, plays a pivotal role in the efficient operation of businesses, particularly in industries where the return of goods is a common occurrence. This process involves the management of the return of products to the manufacturer or supplier, which can range from the return of unsold goods to the repair and refurbishment of used products. The complexity ofGreen Reverse Logisticsis compounded by the need for accurate tracking, efficient handling, and compliance with various regulations, making it a challenging area for businesses to manage effectively. The integration of artificial intelligence (AI) technologies intoGreen Reverse Logisticsprocesses has the potential to significantly enhance operational efficiency and cost-effectiveness. AI can automate the tracking and management of returned goods, predict maintenance needs, and optimize the return process by identifying the most efficient routes and schedules. Moreover, AI can provide valuable insights into consumer behavior, enabling businesses to tailor their return policies and strategies to meet customer expectations and improve customer satisfaction. However, the implementation of AI inGreen Reverse Logisticsis not without its challenges. These include the need for substantial investment in technology, the integration of AI systems with existing supply chain processes, and the management of data privacy and security concerns. Despite these challenges, the potential benefits of AI inGreen Reverse Logisticsare substantial, offering businesses the opportunity to improve their operational efficiency, reduce costs, and enhance customer satisfaction. This literature review explores the role of AI in reverse logistics, highlighting its potential to transform the way businesses manage the return of goods. It underscores the importance of strategic planning, investment in technology, and the development of robust data management practices in the successful integration of AI intoGreen Reverse Logisticsprocesses. As AI continues to evolve, it is expected to play an increasingly significant role in the management of reverse logistics, offering new opportunities for businesses to optimize their supply chains and enhance their competitive advantage.

The integration of artificial intelligence (AI) intoGreen Reverse Logisticsprocesses offers a promising avenue for enhancing cost-effectiveness and operational efficiency. AI's ability to analyze vast amounts of data, identify patterns, and make informed predictions is particularly valuable in this context. By automating the measurement process, AI can significantly reduce the time and resources required for manual data analysis, thereby increasing the speed and accuracy of cost-effective strategy development and implementation. Machine learning algorithms, a cornerstone of AI, are particularly adept at optimizing resource allocation and minimizing costs. These algorithms can be trained on historical data to recognize patterns and trends, enabling them to predict future costs and identify opportunities for cost savings. For instance, they can analyze transportation costs, inventory levels, and return rates to suggest more efficient routes, reduce overstocking, and streamline return processes. Predictive analytics, another powerful AI technique, provides real-time insights into various aspects ofGreen Reverse Logisticsprocesses. By analyzing current data and applying machine learning models, predictive analytics can forecast future costs, such as transportation expenses or inventory turnover times, allowing companies to adjust their strategies proactively. This proactive approach not only helps in reducing costs but also in improving the overall efficiency ofGreen Reverse Logisticsoperations. Moreover, AI's ability to identify inefficiencies and bottlenecks in theGreen Reverse Logisticsprocess is invaluable. By pinpointing areas where resources are not being used optimally, AI can guide companies towards more cost-effective practices. This could involve recommending changes in inventory management strategies, suggesting more efficient return policies, or optimizing the use of transportation resources.Building on the transformative power of AI in reverse logistics, a research model can be developed to analyze the specific mechanisms through which AI impacts cost-effective measurement in supply chain management. This model can explore the interplay between AI technologies, such as machine learning and predictive analytics, and key performance indicators related toGreen Reverse Logisticscosts. By examining how AI algorithms optimize transportation routes, predict returns, and manage inventory, the research model can provide valuable insights into the overall impact of AI on supply chain efficiency and cost reduction strategies. Through empirical validation and analysis, this research model can offer practical recommendations for companies looking to harness the full potential of AI inGreen Reverse Logisticsmeasurement.

4. Research Methodology

4.1. Questionnaire and Pre-Testing

Supply chain visibility was measured with eight adapted items from prior studies and AI-based Decision Support Systems (DSS) was assessed by using 8 measurement items mainly based on. Reverse Logistics were measured by 12 items incorporated from existing literature and Sustainable Performance was examined however fewer items have been used for this purpose. To maintain content validity, expert academicians and practitioners with rich experience from the construction industry were invited to supply chain management. Before the data collection, a pre-test was performed with 3 academic experts and two construction industry engineers who were strategically selected based on their expertise in AI applications, reverse logistics, and sustainability practices. The pre-test aimed to assess for clarity, relevance and applicability of questionnaire items. The feedback showed that the measures were suitable and did not require the internationalization of response options, validating questionnaire readiness for wider data collection.

4.2 Sample Design and Data Collection:

The target population are managers and key decision-makers in the construction industry, particularly those that deal with supply chain management and reverse logistics. It was selected to impact the field of sustainability as well as due to a rise in applications of AI technologies for the construction industry (in particular, setting up operational efficiencies). Results 150 usable responses were received from construction project managers, supply chain employees and logistics coordinators who have extensive function-level experience in using AI applications for reverse logistics sustainability performance within their firms. Data collection took place using a structured survey that caters to the mentioned professionals which in return provides the most appropriate insights for identifying the mediating role of sustainability performance in AI influencing reverse logistics effectiveness within the construction industry.

4.3. Data Analysis

The target population are engineering and key decision-makers in the construction industry, particularly those that deal with supply chain management and reverse logistics. It was selected to impact the field of sustainability as well as due to a rise in applications of AI technologies for the construction industry (in particular, setting up operational efficiencies). Results 150 usable responses were received from construction project managers, supply chain employees and logistics coordinators who have extensive function-level experience in using AI applications for reverse logistics sustainability performance within their firms. Data collection will take place using a structured survey that caters to the mentioned professionals which in return provides the most appropriate insights for identifying the mediating role of sustainability performance in AI influencing reverse logistics effectiveness within the construction industry.

4.4 Common Method Bias

Common method bias may occur when data are collected from a single source, potentially inflating or deflating the observed relationships between variables. This study by highlighted the importance of addressing common method variance when using PLS-SEM and recommended employing the full collinearity test to assess this bias. In the present study, variance inflation factors (VIF) were calculated as part of the full collinearity test to identify any potential common method bias. VIF values above 3.3 would indicate a common method bias; however, all VIF values in this study were found to be less than 3.3. Thus, common method bias was not a concern in this investigation of the mediating role of sustainability performance in the impact of AI on enhancing reverse logistics within the construction industry.

4.5 Assessment of the Measurement Model

Table 1. Measurement items and reliability.

Constructs	**Items**	**Factor loadings**	**Cronbach's Alpha**	**C.R.**	**(AVE)**
CRM	CRM1	0.803	**0.880**	**0.909**	**0.626**
	CRM2	0.715			
	CRM3	0.768			
	CRM4	0.842			
	CRM5	0.789			
	CRM6	0.826			
DSS	DSS1	0.754	**0.890**	**0.916**	**0.645**
	DSS2	0.800			
	DSS3	0.793			
	DSS4	0.823			
	DSS5	0.821			
	DSS6	0.824			
Reverse logistics	RL1	0.849	**0.898**	**0.921**	**0.662**
	RL2	0.837			
	RL3	0.853			
	RL4	0.786			
	RL5	0.804			
	RL6	0.748			
Supply Chain Visibility	SCV1	0.806	**0.875**	**0.909**	**0.667**
	SCV2	0.823			
	SCV3	0.755			
	SCV4	0.810			
	SCV5	0.883			
Sustainable Performance	SP1	0.720	**0.848**	**0.892**	**0.623**
	SP2	0.783			
	SP3	0.804			
	SP4	0.807			
	SP5	0.829			

Table 1: Before testing the relationships between variables in this study, a confirmatory factor analysis (CFA) was conducted to evaluate the measurement model. The analysis focused on three key parameters: factor loadings, Average Variance Extracted (AVE), and Composite Reliability (CR). All factor loadings exceeded the recommended threshold of 0.708, ranging from 0.715 to 0.883, indicating that each item strongly represents its respective construct Customer Relationship Management (CRM), Decision Support

Systems (DSS), Reverse Logistics (RL), Supply Chain Visibility (SCV), and Sustainable Performance (SP). The AVE values, which ranged from 0.623 to 0.667, were all above the 0.50 threshold, confirming that the constructs capture sufficient variance. Additionally, the CR values for all constructs, which ranged from 0.892 to 0.921, exceeded the recommended 0.70 threshold, indicating strong internal consistency. Cronbach's Alpha values, all above 0.848, further supported the reliability of the constructs. These results confirm that the measurement model has good convergent validity and reliability, providing a solid foundation for the subsequent structural analysis.

Table 2. HTMT

	CRM	**DSS**	**Reverse logistics**	**Supply Chain Visibility**	**Sustainable Performance**
CRM					
DSS	**0.839**				
Reverse logistics	**0.651**	**0.677**			
Supply Chain Visibility	**0.706**	**0.836**	**0.772**		
Sustainable Performance	**0.819**	**0.817**	**0.639**	**0.725**	

Table 2 Then comes the discriminant validity which is also been evaluated in this study the discriminant validity of the model was analyzed by using a ratio associating different traits to homogeneouTrait-Monotrait (HTMT) metric tests. It is the same as the Fornell–Larcker criterion, but this HTMT ratio would be more accurate for discriminant validity in comparison with old methods. The literature review suggests a 0.90 cut-off value for HTMT analysis to establish that constructs are separate from each other, the trait was used to elucidate this construct clarity. As shown in Table 2, the values of all HTMT were smaller than the threshold value of 0.90, with a maximum reported figure of 0.839 for CRM and DSS (Table 2). It implies that the model has discriminant validity because it is established, and says that the constructs of customer Relationship Management (CRM), Decision Support Systems (DSS), Reverse Logistics, Supply Chain visibility and Sustainable Performance are distinct enough from each other to be measured on different things.

Table 3: Fornell-Larcker

	CRM	**DSS**	**Reverse logistics**	**Supply Chain Visibility**	**Sustainable Performance**
CRM	0.791				
DSS	0.750	0.803			

Reverse logistics	0.587	0.611	0.814		
Supply Chain Visibility	0.629	0.741	0.688	0.817	
Sustainable Performance	0.711	0.712	0.566	0.631	0.789

Table 3: The discriminant validity of the constructs in the study was evaluated using the Fornell-Larcker criterion. According to this method, discriminant validity is confirmed when the square root of the Average Variance Extracted (AVE) for each construct is greater than the correlations with other constructs. As shown in Table 3, the diagonal values (square roots of the AVE) for CRM (0.791), DSS (0.803), Reverse Logistics (0.814), Supply Chain Visibility (0.817), and Sustainable Performance (0.789) all exceed their respective inter-construct correlations, indicating that each construct is sufficiently distinct from the others. This confirms that the model possesses adequate discriminant validity, ensuring that the constructs are measuring different aspects of the investigated phenomena within the context of AI's impact on reverse logistics in the construction industry.

Table 4: **R2 Adjusted**

Variable	**R-square**	**R-square adjusted**
Reverse logistics	0.321	0.316
Sustainable Performance	0.591	0.583

Table 4 The explanatory power of the Model in the study was evaluated using R-square and respective adjusted value as per Table 4. Reverse Logistics R-square is 0.321 which shows that about the same amount of variance must be explained by an independent variable, thus an adjusted R-square value = 0.316 considering slight correction for large number predictors. The R-square for For Sustainable Performance is 0.591 (Adjusted = 0.583). The highest value in the model represents a good fit and a major predictive capacity as they prove an intermediate impact of AI and sustainability on Reverse Logistics & Sustainable Performance outcomes within the construction sector.

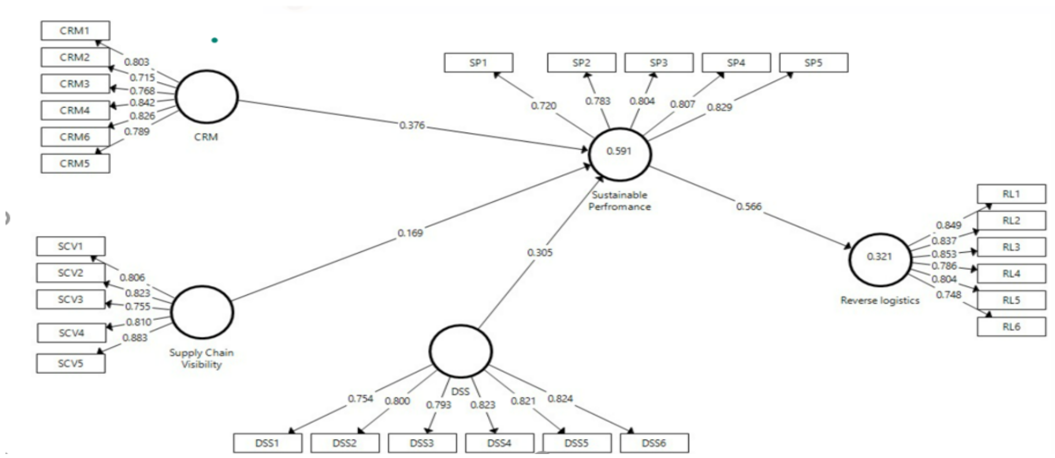


Figure 2. Measurement model

4.6 Assessment of the Measurement Model

This study measured the measurement model in order to examine the constructs concerning influence of AI on reverse logistics enhancement, which was mediated by sustainability performance considering construction industry. To further enhance the robustness and reliability of measures, we drafted our constructs by using a verified measurement scale based on previous AI applications in reverse logistics , sustainability performance , logics principles originating from resource-based view (RBV) literature, pilot tested with industrial experts. The measurement model of the study was validated through advanced statistical techniques, such as confirmatory factor analysis (CFA) based on survey data obtained from Engineering and decision-makers in construction companies. These results presented in CFA and confirm that all constructs had both discriminant validity as well reliability: The measures were respectably adequate for subsequent analysis. Such a robust validation process is to ensure that the ensuing structural equation modeling (SEM) result truly depicts AI, sustainability performance and reverse logistics interactions within construction context accurately in order to offer deep-rooted useful strategic guidelines for implementing AI technologies with key sustainable goals.

5. Path Result

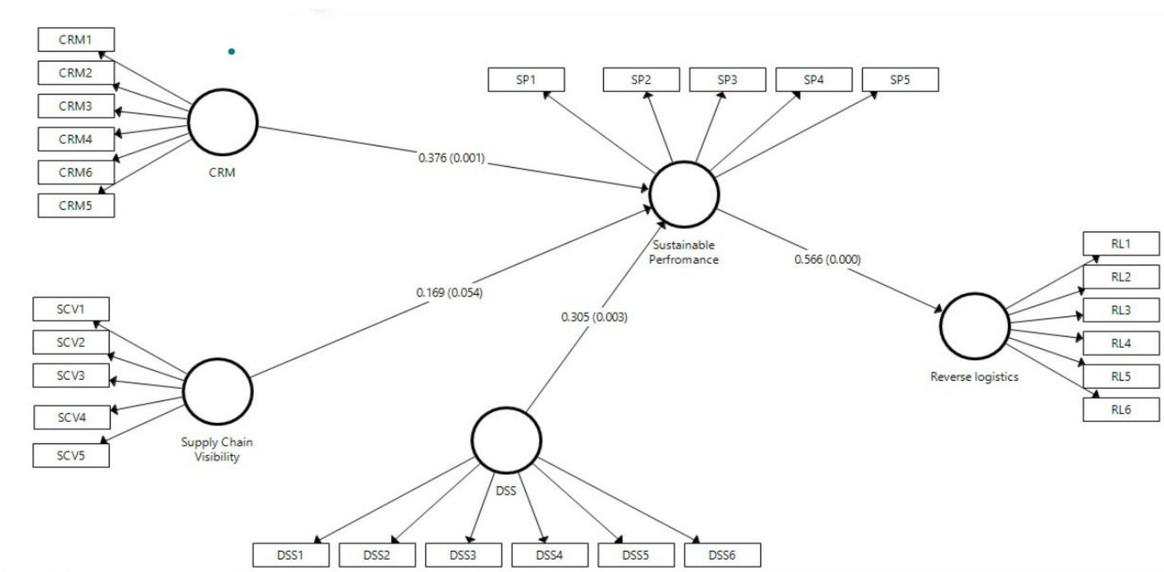
5.1 Specific Indirect Effects

Table 6. Hypotheses testing estimates

	Original sample	**Sample mean**	**Standard deviation**	**T statistics**	**P values**	**Result**
CRM -> Sustainable Performance	0.376	0.375	0.113	3.323	0.001	Supported
DSS -> Sustainable Performance	0.305	0.308	0.103	2.961	0.003	Supported
Supply Chain Visibility -> Sustainable Performance	0.169	0.173	0.085	1.985	0.048	Supported

Sustainable Performance -> Reverse logistics	0.566	0.577	0.077	7.307	0.000	Supported
CRM -> Reverse logistics	0.213	0.214	0.062	3.421	0.001	Supported
DSS -> Reverse logistics	0.173	0.179	0.070	2.482	0.013	Supported
Supply Chain Visibility -> Reverse logistics	0.095	0.103	0.056	1.701	**0.090**	**Unsupported**

Table 6 Explanation of the Direct Relationships between Variables Focusing on AI Impacts for Improving Reverse Logistics in Constructing Industry by Mediating Effects Due to Sustainability Performance AI-based customer relationship management (CRM) has a significant and positive impact on sustainable performance β =0.376, p-value 0.001, for AI-base decision support systems(DSS) : β= 0305 and P-value=.003 as well in supply chain visibility: β=.169, P- value.=048 Moreover, sustainable performance is strongly and positively related to reverse logistics β = 0.566, p < 0.001, signifying that a high level of sustainability leads to better RE outcomes Finally, in reverse logistics CRM is significantly associated with DSS β = 0.213, p-value = 0.001 and they both have a direct positive effect on the performance of planning stage as shown for DSS too β = 0.173, p-value=.013. However, the relationship between supply chain visibility and reverse logistics is shown to be not significant β = 0.095 ., p-value = 0.090, which means that although on the whole it positively enhances sustainability, its direct effect in terms of improving reverse logistics performance seems lower than for other drivers These findings contribute to an understanding of how AI-driven systems and sustainability practices are integrated in reverse logistics operations for optimal use in the construction sector.



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DSS -> Sustainable Performance -> Reverse logistics	0.173	0.179	0.070	2.482	**0.013**	Supported
Supply Chain Visibility -> Sustainable Performance -> Reverse logistics	0.095	0.103	0.056	1.701	**0.090**	Unsupported

The results presented in Table 6 outline the individual indirect effects in terms of the relationship between the variables within the construction industry, with an emphasis on whether sustainability performance mediates the impact of AI innovation on reverse logistics improvement. First, as per the table, the results reveal that AI-based CRM has a significant and positive indirect impact on reverse logistics through sustainable performance by the p-value of 0.001, it is not supported. Second, the AI-based DSS has a significant and positive indirect impact on reverse logistics and is supported through sustainable performance, with a p-value of 0.013. Third, its indirect effect of supply chain visibility on reverse logistics through sustainable performance was insignificant, itu2019s a p-value of 0.090. In the results, it is shown that even though supply chain visibility contributes to the performance of sustainability, the use of intermediaries to reverse logistics can still somehow reduce the impacts of supply chain visibility.

6. Finding

6.1 Discussion and Conclusions

The research also makes several important conclusions, suggesting that most of the hypotheses tested were confirmed and providing insights for the construction industry regarding AI utilization to improve reverse logistics with sustainability performance. We operationalized AI-driven systems namely, an AI-based customer relationship management CRM and an AI-based decision support system DSS to evaluate their effect on sustainability performance in the first step of our study. Results showed that there is a positive and significant correlation and AI-driven tools are indeed necessary for more sustainable effects in reverse logistics outcomes. This is in line with the shift towards leveraging technology to facilitate smoother operations and eco-friendly practices within construction. In addition to this, the study also examined how these AI-powered systems have a sustainable effect on reverse logistics. These results gave statistical confirmation that reverse logistics were improved by CRM as well as DSS, demonstrating the importance of these tools to increase optimization in returning materials for reusing or disposal actions and hence help design more sustainable supply chains. On the other hand, although SCV had a positive effect on sustainability performance, this did not have statistical meaning in reverse logistics. Put differently, it seems as though visibility may be less influential on reverse logistics than strong sustainability practices; however, its benefits are potentially more effectively realized when mediated through the latter. In addition, the study confirms that sustainability performance has a significant mediating role while positively influencing reverse logistics. The findings further revealed that sustainability performance significantly mediates the relationship between AI-driven systems and reverse logistics indicating a need for incorporating sustainable aspects in technological developments to attain superior operational results.

These results offer new insights to the construction industry on how it could benefit from using AI and sustainability in reverse logistics, which can lead to enhanced organizational performance and competitive advantage. Consequently, the type of issue is thoroughly identified to clarify how AI-based systems affect reverse logistics through sustainability performance. There is a predominant critical perspective on the importance of construction companies in implementing holistic techniques that incorporate advanced practices and green standards for enhanced optimization of reverse logistical operations. These findings are important for informing practitioners and policy-makers in their attempts to improve the efficiency of construction industry supply chains from both an operational as well as environmental perspective.

6.2 Theoretical Implications

The research provides several theoretical contributions to the extant literature, primarily about AI integration as well as reverse logistics and sustainability within construction. Theoretically, this study benefits the literature in contributing towards understanding how AI-driven systems, Customer Relationship Management systems and Decision Support Systems influence reverse logistics with sustainability performance as a mediator variable. The results contribute to the extant literature on sustainable supply chains and provide a new outlook regarding how advanced technologies are part of sustainability's role in improving reverse logistics. Hence, several avenues for future research on the intersections of AI with sustainability including reverse logistics across various sectors will be built based on this literature review.

6.3 Managerial Implications

This study provides useful insights into construction engineering, especially the ones leading SMEs. Managers looking to utilize AI for better reverse logistics along with greater sustainability performance can use the insights as a guideline. Practical implications Managers are exhorted to priorities sustainability as both an intermediate and a central linkage driver that can contribute towards perfecting reverse logistics efficiency within the organization. engineering can foster more positive operational results while increasing long-term resilience by forming strategies that integrate AI-driven innovations and sustainability. Furthermore, the study reveals that there needs to be a balance struck between all AI capabilities and the way you run your business today to ensure efficient as well as consistent reverse logistic implementations. Empowering construction SMEs to leverage this AI-driven reverse logistics capability will improve their performance, enhance market competitiveness and aid in the advancement of the economy.

6.4 Limitations of Study

However, due to the limitations of data and resources related to AI integration for reverse logistics and sustainability context in the development sector, the construction industry is under focus. Structurally and operationally the construction industry is different from most other industries; thus any conclusions drawn based on these two key premises may not be fully generalizable to all sectors. Moreover, even though the study dealt with sustainability performance as a mediator only for two main AI-driven systems CRM and DSS, further technologies which might facilitate or hinder this process remained unexplored. Funding and time constraints may have limited the sample size, which could compromise data saturation. Moreover, the sample relies more on middle-level and first-line managers but does not necessarily reflect senior executives' viewpoints as they relate to AI or sustainability concerning reverse logistics. Lastly, it would have been interesting to further explore the different social and educational backgrounds of the managers without treating management as a unified profession since there are great differences between their perceptions. These three limitations indicate that while the study provides useful perspectives, additional research is necessary to investigate further generalizability of findings and different stakes.

6.5 **Conclusions**

This study approaches as new and contributes to the literature by exploring whether sustainability performance mediates in between AI impacts on reverse logistics concerning construction industry. We perform research that investigates the effective integration of AI-driven systems, specifically in customer relationship management (CRM) and decision support systems (DSS), into reverse logistics processes when it is synergizing with sustainability practices implemented. In examining this association, we showed that the positive relationship between AI and reverse logistics is significantly strengthened by sustainability performance thus enhancing operating efficiency while mitigating environmental harm. The findings of the study highlight guiding principles that could be a tipping point in ensuring AI technologies are aligned with sustainable goals to lead to better results in reverse logistics and offer construction firms a roadmap for sustainability, or perhaps improving organizational performance. Results thus justify the argument that AI needs to be embedded in sustainability as a sound managerial practice for improving reverse logistics and overall supply chain performance among construction firms.

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