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Eco-Innovation and Reverse Logistics as Drivers of Green Firm Reputation: The Mediating Role of Operational Efficiency

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Abstract. This study examines the role of eco-innovation and reverse logistics practices in determining green firm reputation, with an emphasis on operational efficiency as a mediator. Anchored in the natural resource-based view (NRBV) and resource-based view (RBV), this paper develops and tests a conceptual framework that links environmental practices to firm-level reputation outcomes in manufacturing firms within Ghana. The data for the analysis were collected through a structured survey administered to supply chain, logistics, research and development, and operations employees, which was analysed using partial least squares structural equation modelling (PLS-SEM). The paper reveals that eco-innovation is a significant influence on the adoption of reverse logistics practices among firms. Again, the findings show that implementing reverse logistics practices (RLP) has a positive impact on green firm reputation. Also, operational efficiency partially mediates the relationship between reverse logistics and green firm reputation. This research refines current understanding of the mechanisms through which environmental capabilities enhance organisational performance and offers practical implications for managers who aim to improve sustainability and competitiveness in emerging markets.

Keywords: Eco-innovation, Ghana, Green firm reputation, Natural resource-based view, Operational efficiency, Resource-based view, Reverse logistics practices,

1. INTRODUCTION

The ongoing pressure from stakeholders for companies to meet environmental standards, optimize resource use, and promote sustainability has heightened interest in reverse logistics (Zeng et al., 2022; Kalaitzi et al., 2019). In the broader context of a circular economy, reverse logistics (RL) has increasingly become a core process for companies implementing environmental responsibility as a key recovery function (Mallick et al., 2023). By facilitating reuse, remanufacturing, and recycling, RL can recover value from end-of-life products and reduce waste (Mishra et al., 2023). However, despite its growing importance, previous research on the motivations behind RL practices remains fragmented. Earlier studies identified corporate social responsibility, regulatory demands, and stakeholder pressures as primary drivers (Aryee, 2024; Tuan et al., 2024), but these mostly view reverse logistics practices (RLP) as reactive responses rather than proactive, innovation-driven capabilities.

This study fills this theoretical gap by positioning eco-innovation (EIN) as a strategic antecedent of RLP. Eco-innovation refers to the creation and introduction of new products, processes, or practices that reduce the environmental impact and increase the performance of firms (Kuo et al., 2022; Park et al., 2017). In the literature, EIN has been positioned as an environmental or market requirement. Nevertheless, there is little knowledge about how it works as a resource-based capability that facilitates downstream environmental practices. This disconnect indicates a conceptual gap between the literature on innovation, which emphasises product and process development, and the literature on logistics, which focuses on compliance with waste recovery. As a result, the processes that connect innovation capabilities with operational sustainability are poorly theorized. The response to that disconnect presented in this paper further supports the argument that EIN triggers the formation of RL routines, which form a resource base that supports operational and reputational benefits.

A second theoretical contradiction in the literature is the dual nature of RL as both a technical and symbolic ability. Although the effectiveness of the RL has been noted in the literature, such as the reduction of waste and optimisation of processes (Mihi Ramirez and Morales, 2014; Vlachos, 2016), its contribution to the development of green firm reputation (GFR) has been subjected to little empirical research (Agrawal et al., 2016; Afum et al., 2020; Asamoah et al., 2024). The literature implicitly supposes that the environmental reputation is formed as a direct result of the visible green actions, without considering the role of the firm's internal process improvements that give credibility to the latter. This paper uses RBV and NRBV to conclude that the improvement of the reputation of a firm is indirectly promoted by RLP through the reinforcement of operational efficiency (OPE). Min & Jong Joo (2006) conceptualise OPE as a firm's ability to efficiently use resources and minimise waste without sacrificing quality. The paper highlights that OPE can transform RL results into compliance results, which in turn can be converted into reputational capital, serving as the means by which substantive performance is recognised by stakeholders.

The third conceptual matter is that of context. Most of the current information regarding EIN is centered on the developed economies, where institutional frameworks and consumer activism compensate for environmental investments (Moroni et al., 2022; da Silva et al., 2025). Conversely, emerging markets like Ghana offer a more

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resource-limited context where companies implement sustainability practices not only to comply with regulations but also to improve credibility and survival in the business (Yusof et al., 2020). The analysis of EIN and RLP in these contexts provides a chance to examine the boundary conditions of RBV and NRBV assumptions, namely, whether the environmental capabilities continue to serve as sources of advantage in the case of weaker institutional incentives and more severe infrastructural bottlenecks (Cheng et al., 2023; Chofreh et al., 2020).

Three research questions drive the present study, guiding it through these analytical tensions.

The first question is the extent to which eco-innovation affects the uptake of reverse logistics practices by firms. Second, how do reverse logistics practices impact the green reputation of firms? Third, is there a mediational effect of operational efficiency between reverse logistics practices and green firm reputation? By responding to these questions, the study can go beyond the descriptive linkages to analyse how innovation-based capabilities are diffused via operational systems to produce both efficiency and legitimacy benefits.

This article has three interconnected contributions to theory and practice. Theoretically, it redefines EIN as a core resource that triggers RL routines, in particular, the development of the concept of co-evolution of innovation and logistics capabilities in green supply chains. It also elucidates the sequential resource logic: the strategic combination of innovation, efficiency, and reputation, with operational efficiency being the mechanism by which technical capabilities are used to generate reputational results. The article has an empirical contribution in that it enriches the existing sustainability literature by placing the relationships of EIN-RLP-OPE-GFR in a developing economy, which has a long-standing Western bias (Tseng et al., 2019; Choi & Hwang, 2020). It disputes the prevailing perception of RL as a reactive process, and instead, it describes it as a strategic ability based on EIN, which both contributes to operational excellence and external legitimacy.

The rest of this paper is organised as follows: Section 2 is a review of the related literature and the theoretical basis of the study. Section 3 describes the research methodology, such as construct measurement, data collection, and data analysis. Section 4 includes the empirical results, statistical analysis, and discussion. Section 5 sums up the study by examining the contribution, limitations, and future research suggestions.

2. LITERATURE REVIEW

2.1. Theoretical Background

2.1.1. Natural Resource-Based View

The NRBV builds on the RBV by stressing that firms gain a sustained advantage by being able to protect and enrich the natural environment using capabilities (Hart, 1995). It assumes that environmental strategies, i.e., pollution prevention, product stewardship, and sustainable development, are the sources of competitive advantage in case they are entrenched in the routine of firms and can hardly be imitated (Hart & Dowell, 2011). In this theoretical rationale, it is possible to conceptualise EIN and RLP as complementary environmental capabilities that put the principles of NRBV into practice.

Eco-innovation fits in the dimensions of pollution prevention and product stewardship, as it allows firms to redesign products and processes that reduce environmental externalities and guarantee cleaner production (Relich, 2015). The concept of RL is sustainable development, as it encourages the reuse of materials, a decrease in waste, and the circulation of resources in a closed cycle (Yu et al., 2021). Collectively, these abilities depict an active chain whereby EIN serves as a meta-capability that triggers the emergence of RLP, which in the end boosts operational efficiency as well as the reputation of firms. This development is a demonstration of the shift of environmental strategies to technological innovation and then to systemic sustainability performance.

The NRBV further describes the generation of two types of value: internal and external. On the internal level, RLP and OPE help to increase efficiency and cost-effectiveness in the process, whereas on the external level, they help to improve legitimacy and trust in the stakeholders, which leads to an improved firm reputation. In a developing-country setting with less institutional and regulatory power, these capabilities can be sought by the firms as an adaptive response to the lack of resources and stakeholder pressure instead of a formal requirement (Agyabeng-Mensah et al., 2023). Therefore, this paper builds upon the NRBV by illustrating how the environmental capabilities can co-evolve within the institutional limitations to bring forth both efficiency-driven and legitimacy-based benefits.

2.1.2. Resource-Based View

According to the RBV (Barney, 1991), companies achieve sustained competitive advantage by creating valuable, rare, inimitable, and non-substitutable resources and capabilities. In this context, RLP and OPE are conceptualised as organisational capabilities, which transform EIN into performance and reputational results. The RLP is an indicator of an integrative ability to control returns, remanufacturing, recycling, and waste minimisation, hence creating economic and environmental value (Jack et al., 2010). OPE reflects the capacity of the firm to simplify the processes, maximise the utilisation of resources, and increase the reliability of the processes, connecting the value to the internal efficiency with the value created by the external stakeholders.

The RBV perspective views these capabilities as the mechanisms that transform sustainability-oriented innovations into a competitive advantage. The OPE mediating position between RLP and the green firm's reputation is consistent with the RBV logic that performance differentials are the result of the strategic use of

distinctive capabilities (Amit & Schoemaker, 1993; 2016). Companies that use RL to improve efficiency are capable of meeting the expectations of their stakeholders, meeting environmental regulations, and developing plausible green images (Chen, 2008).

However, the traditional RBV's static focus on resource possession limits its explanatory power in dynamic sustainability contexts (Wilden et al., 2013). This study, therefore, adopts a dynamic capabilities lens, viewing RLP and OPE as higher-order routines that allow firms to reconfigure resources in response to ecological and institutional pressures (Teece, 2007). In developing-country settings like Ghana, where institutional voids and resource constraints prevail, these capabilities often emerge through inter-organizational collaboration and institutional support (Salazar & Peláez, 2012).

The combination of the RBV and the NRBV provides a more comprehensive understanding of how eco-innovation serves as a meta-capability that facilitates the achievement of both efficiency and legitimacy, bridging internal operational excellence with external reputational benefits. Figure 1 contains the conceptual framework of the study.

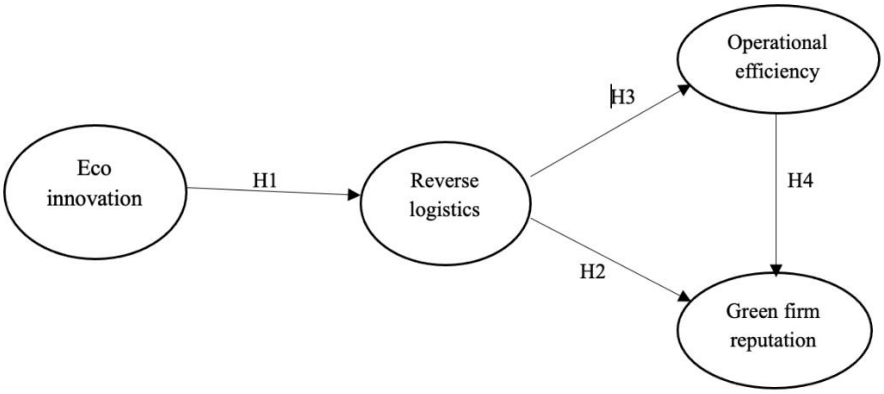

Figure 1: Conceptual framework.

2.2. Empirical Review and Hypothesis Development

2.2.1. Eco-Innovation as a Driver of Reverse Logistics Practices

Eco-innovation is the creation and introduction of products, processes, or management strategies that have a significant positive effect on the environment (Kiefer et al., 2019). It is not an environmental add-on feature but a radical approach that can facilitate circular business models and sustainable supply chain activities (Ul-Durar et al., 2023). By using cleaner production technologies, green product design, and process adjustments, companies develop the technical and strategic background for RLP (Flygansvær et al., 2019).

Previous studies have proved that EIN-inclined firms are more prone to building systemic abilities to address product returns, waste management, and closed-loop logistics (Zhang et al., 2022). Eco-innovation triggers the necessity of reversing flows of goods, materials, and information, which enhances the infrastructure and planning necessary to achieve successful RLP. It is therefore hypothesized that:

H_1: Eco-innovation is positively associated with reverse logistics practices.

2.2.2. Reverse Logistics Practices and Green Firm Reputation

A green firm reputation is the view of stakeholders regarding a firm's environmental commitment and ethical status (Abdelzaher & Newburry, 2016). As an observable and quantifiable environmental program, reverse logistics is an indicator of environmentally proactive behaviour. By reusing used products, disposing of waste, and making logistics sustainable, companies gain legitimacy among consumers who are environmentally conscious (Choudhary et al., 2023). These practices satisfy the compliance requirements and make the firm stand out in markets where green credentials play a significant role in brand equity and trust. Based on these facts, it is hypothesized that:

H_2: Reverse logistics practices are positively associated with green firm reputation.

2.2.3. Reverse Logistics Practices and Operational Efficiency

Reverse logistics activities enhance OPE through minimising disposal expenses, recovering valuable resources, and optimising inventory (Govindan et al., 2015). Through the effective management of returned products and excess inventory, firms can minimise lead times, enhance throughput, and utilise available resources more efficiently. The companies that effectively institutionalise RL are also likely to build operational resilience, which is another aspect of efficiency, by enhancing flexibility and reusing resources (Sureka et al., 2018). Having a well-developed reverse logistics system also helps coordinate with suppliers and customers more effectively and

minimise variability and waste. In view of the above discussion, it is hypothesized that:

H_5: Reverse logistics practices are positively associated with operational efficiency.

2.2.4. Operational Efficiency and Green Firm Reputation

Stakeholders tend to appreciate operational efficiency that results in consistent quality, reliability, and waste reduction, and also leads to a green image (Raut et al., 2017). Stakeholders view efficient firms as more competent in terms of incorporating environmental objectives into the core business activities. Besides, efficient firms are more likely to present better environmental and financial performance, which strengthens the idea that environmental responsibility and operational excellence could coexist (Siefan et al., 2025). Operational improvements (e.g., reduction of energy and material use, reduction of emissions, etc.) are also frequently mentioned in sustainability reports and in the media (Zhang and Chen, 2020), which also improves the image of the firm. Based on the above discussions, it is hypothesised that:

H_6: Operational efficiency has a positive relationship with green firm reputation.

2.2.5. The Intervening Effect of Operational Efficiency

The connection between RLP and GFR is not necessarily direct, but OPE can play a critical role. The internal functioning of the firm is optimised by RL as it lowers the costs and makes the supply chain more responsive to the needs, which subsequently influences the perception of the stakeholders towards the firm (Abdelzaher & Newburry, 2016). For instance, a company that implements RLP to complete the loop but fails to improve efficiency may not enjoy a significant reputational advantage. In contrast, RLP can cause visible operational excellence, which strengthens the stakeholder beliefs about competence, accountability, and sustainability (Saruchera & Asante-Darko, 2021). Empirical literature has provided evidence of the relevance of intermediate performance, such as OPE, in the transfer of green practices into reputation benefits (Famiyeh et al., 2019). It is suggested, therefore, that:

H_7: Operational efficiency mediates the connection between reverse logistics practices and the green firm reputation.

3. RESEARCH METHODS

3.1. Measurement Items

A questionnaire was designed based on the validated scales of previous studies. The seven items of Ye et al. (2013) were used to measure the reverse logistics practices, which included collection, recycling, reuse, and remanufacturing practices. The green firm's reputation was measured using three of the items of Zhao et al. (2020) that focused on the environmental responsibility, trustworthiness, and recognition of the stakeholders. Eco-innovation was measured based on five items of Saturnino Neto et al. (2014) and Park et al. (2017), which indicate eco-designed products, green processes, and resource-efficient innovations. Operational efficiency was measured using five items by Min and Jong Joo (2006), which assessed productivity, reduction in costs, lead time, and flexibility in the firm's process. The content validity of the instrument was established by reviewing it with four academic experts and four industry practitioners; pilot testing was conducted to further refine the clarity and relevance of the context.

3.2. Data Collection

A structured questionnaire was used to collect data from key personnel in the selected manufacturing firms in Ghana. To ensure representation from various industries, the researchers employed a stratified random sampling approach. The survey items were refined through a pilot study that was carried out before full deployment on 10 organisations. The final survey was administered both physically and electronically within 10 weeks between April and June 2025. Out of 151 questionnaires that were administered, 101 valid responses were received and considered for analysis, which constituted a response rate of 67. This rate is acceptable when it comes to field-based studies in Sub-Saharan Africa, where organisational bureaucracy, internet unavailability, and logistical issues tend to impede higher rates of responses (Azungah, 2019; Ali et al., 2021). The statistical power analysis of Cohen (1992) was used to determine the adequacy of the sample because it suggests that a minimum of 88 subjects is needed to detect medium effect sizes ($f^2 = 0.15$) at a statistical power of 0.80 and a 5 percent significance level. In addition, the selected method of analysis, the Partial Least Squares Structural Equation Modelling (PLS-SEM), is not as restrictive regarding sample size as the covariance-based SEM (CB-SEM), and is particularly appropriate in explanatory studies (Hair et al., 2017).

4. RESULTS AND DISCUSSION

4.1. Demographics of Respondents

The study surveyed 101 respondents, predominantly male (71.3%), with most aged between 31 and 45 years (38.6%). A significant proportion held a bachelor's degree (37.6%) or HND (29.7%), and respondents were mainly operations (28.7%), logistics (24.8%), procurement (23.8%), and R&D managers (20.8%). Over half of the firms had operated for more than 10 years (52.5%), with most employing 100–150 workers (27.7%). The sample represented diverse industries, particularly metal/building products (17.8%), apparel and accessories (16.8%), and

printing/packaging (14.9%). (See Table 1).

Table 1: Respondents' Characteristics.

Variable	Frequency (n)	Percentage (%)
Gender		
Male	72	71.3
Female	29	28.7
Age		
19–30	27	26.7
31–45	39	38.6
46–60	16	15.8
>61	2	2.0
Education		
HND	30	29.7
Bachelor's Degree	38	37.6
Master's Degree	27	26.7
Postgraduate Diploma	6	5.9
Others	2	2.0
Position		
Logistics Manager	25	24.8
R&D Manager	21	20.8
Operations Manager	29	28.7
Procurement Manager	24	23.8
Others	2	2.0
Age of firm		
1–2 years	6	5.9
3–5 years	15	14.9
6–10 years	27	26.7
More than 10 years	53	52.5
Firm size		
100–150	28	27.7
151–200	11	10.9
201–250	15	14.9
>251	16	15.8
Industry		
Apparel & Accessories	17	16.8
Printing/Packaging	15	14.9
Metal/Building Products	18	17.8
Electrical/Electronics	13	12.9
Rubber & Plastic	12	11.9
Health & Beauty Aids	7	6.9

4.2. Measurement Model Results

The reliability of individual indicators was evaluated using standardized outer loadings, as shown in Table 2. For eco-innovation, loadings ranged from 0.678 to 0.806 (Ein1 = 0.802, Ein2 = 0.678, Ein3 = 0.751, Ein4 = 0.698, Ein5 = 0.806), indicating acceptable convergence despite a few marginally lower values. Green firm reputation demonstrated strong reliability, with loadings between 0.871 and 0.920 (Gfr1 = 0.871, Gfr2 = 0.920, Gfr3 = 0.881). Operational efficiency also showed high reliability, with loadings from 0.835 to 0.883 (Ope1 = 0.835, Ope2 = 0.855, Ope3 = 0.883). Reverse logistics practices exhibited loadings between 0.734 and 0.802 (Rlp1 = 0.802, Rlp2 = 0.734, Rlp3 = 0.758, Rlp4 = 0.781, Rlp5 = 0.801). Overall, these results confirm that all indicators significantly contribute to their respective constructs, supporting the measurement model's reliability and unidimensionality.

Table 2: Outer loadings of constructs.

	Ein	Gfr	Ope	Rlp
Ein1	0.802			
Ein2	0.678			
Ein3	0.751			
Ein4	0.698			
Ein5	0.806			
Gfr1		0.871		
Gfr2		0.92		
Gfr3		0.881		
Ope1			0.835	
Ope2			0.855	
Ope3			0.883	
Rlp1				0.802
Rlp2				0.734
Rlp3				0.758
Rlp4				0.781
Rlp5				0.801

Construct reliability and convergent validity were evaluated using Cronbach's alpha (α), composite reliability (CR), and average variance extracted (AVE), as presented in Table 3. All constructs confirmed acceptable internal consistency. Specifically, Cronbach's alpha values ranged from 0.768 (EIN) to 0.869 (GFR), exceeding the recommended minimum threshold of 0.70 (Nunnally & Bernstein, 1994). Similarly, CR values ranged from 0.866 (EIN) to 0.920 (GFR), all of which exceeded the 0.70 benchmark (Hair et al., 2019), confirming the internal reliability of the constructs. In terms of convergent validity, the AVE for each construct exceeded the 0.50 threshold, ranging from 0.601 (RLP) to 0.793 (GFR). These results confirm that a substantial proportion of variance is captured by the constructs relative to measurement error, thereby demonstrating satisfactory convergent validity (Fornell & Larcker, 1981).

Table 3: Psychometric properties of constructs.

	Cronbach's alpha	Composite reliability (rho_a)	Average variance extracted (AVE)
Ein	0.803	0.812	0.560
Gfr	0.869	0.870	0.793
Ope	0.822	0.828	0.736
Rlp	0.836	0.843	0.602

To ensure that the constructs in the structural model are empirically distinct, two commonly applied methods were used to assess discriminant validity: the Fornell & Larcker criterion (1981) and the Heterotrait–Monotrait (HTMT) ratio of correlations (Henseler et al., 2015). In Table 4, the square root of AVE for each construct was greater than its correlations with other constructs. The AVE values for (EIN = 0.826), (GFR = 0.891), (OPE = 0.858), and (RLP = 0.775) all exceeded the corresponding inter-construct correlations. This suggests that each construct shares more variance with its associated indicators than with any other latent variable, thereby confirming discriminant validity (Fornell & Larcker, 1981).

Table 4: Fornell–Larcker Criterion.

	Ein	Gfr	Ope	Rlp
Ein	0.749			
Gfr	0.596	0.891		
Ope	0.663	0.653	0.858	
Rlp	0.620	0.698	0.690	0.776

The HTMT ratio values (see Table 5) were below the conservative threshold of 0.85 (Henseler et al., 2015). The highest HTMT value observed was 0.843 (between EIN and OPE), while the lowest was 0.734 (between EIN and GFR). These results provide additional support that the constructs are conceptually distinct.

Table 5: HTMT Ratio.

	Ein	Gfr	Ope	Rlp
Ein				
Gfr	0.703			
Ope	0.796	0.765		
Rlp	0.749	0.809	0.799	

4.3. Structural Model Results

The bootstrapping was employed to test the significance and strength of hypothesized relationships using path coefficients, *t*-values, and *p*-values. A hypothesized relationship is considered significant when the *p*-value is less than 0.05 (Hair et al., 2019). As shown in Table 6, the results revealed that eco-innovation has a strong and significant positive effect on reverse logistics practices ($\beta = 0.620$, $t = 9.321$, $p < 0.001$), thereby supporting H1. This indicates that EIN initiatives play a crucial role in fostering the adoption and implementation of reverse logistics within manufacturing firms. A significant and positive relationship was also found between RLP and green firm reputation ($\beta = 0.472$, $t = 3.683$, $p < 0.001$), supporting H2. This finding implies that firms that effectively implement reverse logistics initiatives, such as product recovery, recycling, and waste minimization, tend to enhance their environmental reputation and strengthen their green corporate image. Additionally, RLP significantly influences operational efficiency ($\beta = 0.690$, $t = 10.452$, $p < 0.001$), confirming H3. This demonstrates that reverse logistics not only contributes to environmental sustainability but also streamlines internal operations and reduces waste-related costs. Moreover, OPE significantly affects GFR ($\beta = 0.328$, $t = 2.417$, $p = 0.016$), supporting H4. This suggests that improvements in operational efficiency can result from reverse logistics initiatives, positively shape how external stakeholders perceive the firm's environmental responsibility and reputation. Taken together, these findings provide clear answers to the study's research questions.

First, the results confirm that EIN significantly enhances the implementation of RL initiatives, underscoring the role of innovative environmental strategies in driving sustainable operational practices.

Second, the analysis shows that RL has a strong positive effect on green firm reputation, indicating that environmentally responsible recovery and recycling activities enhance stakeholder perceptions of the firm.

Table 6: Hypothesis Path Results.

	Relationship	β	Standard deviation	t- statistics	P-values	Decision
Hi	Ein -> Rlp	0.620	0.066	9.321	0.000	Supported
H2	Rlp -> Gfr	0.472	0.128	3.683	0.000	Supported
H3	Rlp -> Ope	0.690	0.066	10.452	0.000	Supported
H4	Ope -> Gfr	0.328	0.136	2.417	0.016	Supported
H5	Rlp -> Ope -> Gfr	0.226	0.104	2.168	0.030	Partial mediation

To test the mediating role of OPE in the relationship between reverse logistics practices and green firm reputation, the indirect path from RLP through OPE to GFR was examined. The indirect effect was statistically significant (β = 0.226, t = 2.168, p = 0.030), while the direct effect of RLP on GFR also remained significant (β = 0.472, p < 0.001). According to Zhao et al. (2010) and Hair et al. (2019), this indicates complementary partial mediation, implying that RLP influences GFR both directly and indirectly through improvements in operational efficiency. The Variance Accounted For (VAF) was computed as VAF = (Indirect Effect ÷ Total Effect) = 0.226 ÷ (0.226 + 0.472) = 32%, which falls within the 20–80% range, confirming the presence of partial mediation (Hair et al., 2019). Thus, H5 is supported.

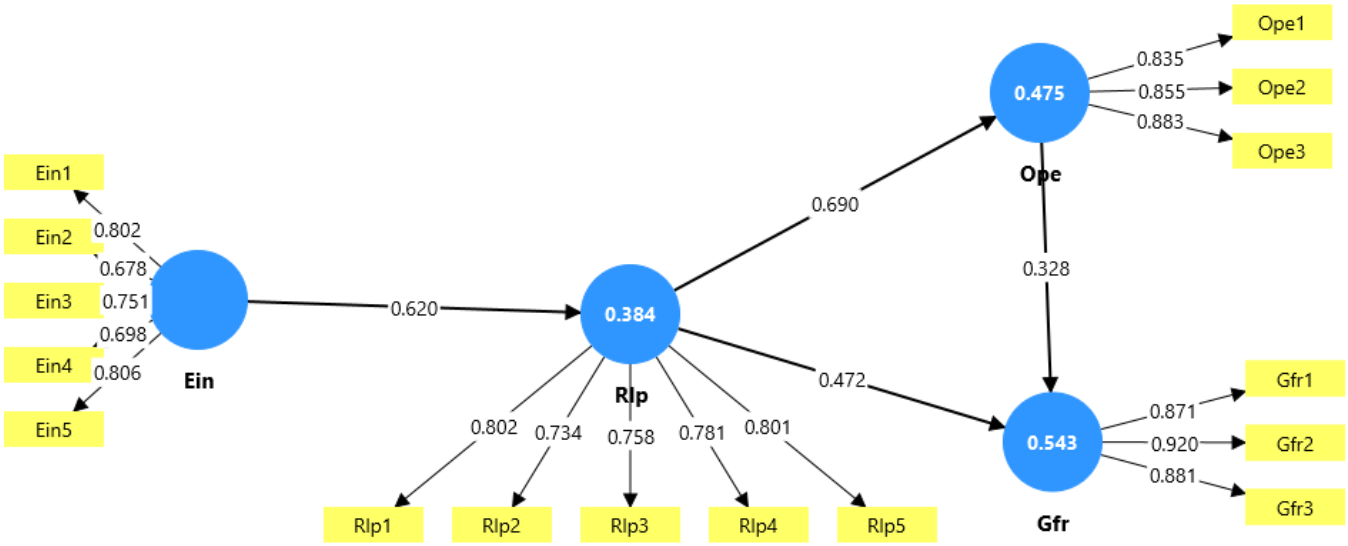

Figure 2: Structural model.

4.4. Explanatory Power and Predictive Relevance

The model's explanatory power was evaluated using the coefficient of determination (R^2) and effect size (f^2), as recommended by Hair et al. (2022) and Sarstedt et al. (2017). These indicators assess the extent to which the exogenous constructs explain the variance in the endogenous variables. As seen in Table 7, the R^2 results show that green GFR had an R^2 value of 0.543, indicating that 54.3% of its variance is explained by its predictors. OPE recorded an R^2 of 0.475, while RLP had an R^2 of 0.384, demonstrating moderate explanatory power consistent with Hair et al. (2019).

The f^2 results further highlight the contribution of each exogenous construct to the endogenous variables. EIN exerted a large effect on RLP (f^2 = 0.623) and a small-to-medium effect on OPE (f^2 = 0.123). The effect of GFR on RLP was moderate (f^2 = 0.256), whereas OPE had a very large effect on RLP (f^2 = 0.906). Cohen's (2013) guidelines indicate that where f^2 values of 0.02, 0.15, and 0.35 correspond to small, medium, and large effects, respectively, these results suggest that the model demonstrates strong explanatory power, with RLP being the most strongly predicted construct.

Table 7: Model Evaluation – R^2, f^2, and Q^2 Values.

Endogenous Construct	R^2	Adjusted R^2	F^2 Effect Sizes
GFR	0.543	0.537	–
OPE	0.475	0.472	EIN- OPE = 0.123
RLP	0.384	0.380	EIN- RLP = 0.623
			GFR- RLP = 0.256
			OPE -RLP = 0.906

The paper evaluates the model's out-of-sample predictive power, using the *PLSpredict* procedure (Shmueli et al., 2019; Hair et al., 2022). This approach compares the prediction errors of the PLS-SEM model with those from a linear benchmark model (LM). A PLS model demonstrates superior predictive ability when its RMSE values are

lower than those of the LM model. As reported in Table 8, most indicators of GFR and RLP exhibited lower RMSE values under the PLS-SEM model than the LM benchmark, indicating strong predictive relevance. However, OPE produced slightly higher RMSE values for some indicators, suggesting moderate predictive accuracy. Overall, the results provide evidence of satisfactory predictive performance, confirming that the model's explanatory relationships extend beyond the estimation sample and offer practical predictive validity in humanitarian logistics contexts.

Table 8: PLSpredict Results: Indicator- and Construct-Level Predictive Assessment.

Construct	Indicator	PLS-SEM RMSE	LM RMSE	Q^2predict	MAE	Predictive Power
GFR	Gfr1	1.407	1.435	0.311	0.624	Moderate
	Gfr2	1.347	1.373			
	Gfr3	1.372	1.398			
OPE	Ope1	1.350	1.316	0.371	0.618	Strong
	Ope2	1.377	1.291			
	Ope3	1.257	1.226			
RLP	Rlp1	1.533	1.617	0.352	0.602	Strong
	Rlp2	1.460	1.490			
	Rlp3	1.345	1.412			
	Rlp4	1.468	1.488			
	Rlp5	1.373	1.378			

Overall, the explanatory and predictive assessments confirm that the model is both theoretically robust and practically relevant. The R^2 and f^2 results indicate that the exogenous constructs explain a meaningful proportion of variance in the endogenous variables, demonstrating strong in-sample explanatory power. Complementarily, the *PLSpredict* results show that all Q^2predict values are positive and the PLS-SEM RMSE values outperform the linear benchmark model, evidencing solid out-of-sample predictive accuracy. Together, these findings affirm that the model captures theoretically significant relationships while maintaining predictive validity, underscoring its reliability and applicability for research and managerial decision-making in sustainability-oriented supply chain contexts.

5. DISCUSSION

The research paper estimates and analyses the relationship between eco-innovation, reverse logistics practices, operational efficiency, and green farm reputation, and determines whether operational performance mediates the relationship between reverse logistics practices and green farm reputation. We discuss these findings in light of the principles and assumptions of the RBV and NRBV theories, as well as the existing literature.

The first research question of the paper aims to determine the extent to which eco-innovation influences reverse logistics practices. The findings show that eco-innovation is a strong factor that drives the RLP of manufacturing firms in Ghana. This finding validates our hypothesis 1, asserting a positive relationship between EIN and reverse logistics practices. The NRBV theory argues that environmental innovation is a proactive capability that motivates firms not only to implement an operationalised process that may reduce ecological harm but also to align and transform the operations of the firm towards the circular economy (Makhloufi et al. 2022). According to Sumrin et al. (2021), firms that integrate EIN programmes in their manufacturing processes and production activities tend to establish effective production recovery systems, which are equivalent to reverse logistics activities. RL includes environmentally friendly innovations such as product take-back schemes, recycling, packaging, adherence to sustainability goals, reduction in the use of inputs, and reuse, among others. In addition, the high effect size of EIN-RLP also highlights EIN's substantive contribution to RLP. The finding could also mean that companies' EIN brings operational and environmental returns despite the absence of formal recycling infrastructure. Also, although EIN drives RLP, this effect can change across industries based on the adoption of technology and regulatory pressure, creating a possible boundary condition that will be explored in future research.

With regard to the second research question, the results show that RLP strongly and positively affects the green firm's reputation. This result validates H2, which confirms the RBV idea that the reputation of a firm is a good, immovable, intangible asset that may be used to maintain its competitive edge (Chikán et al., 2022). Prior studies stress that RLP can be used as a visible sign of environmental commitment of a firm by means of responsible waste management and product take-back programmes (Younis et al., 2020). Other researchers (e.g., Hazen et al., 2012; Cheng et al., 2018) have established positive correlations between circular supply chain practices and enhanced corporate image. Additionally, the medium size of the effect of RLP suggests that although RLP has a substantial positive effect on GFR, the process of its occurrence may involve stakeholder involvement or environmental certification.

The last research question was to examine whether operational efficiency mediates the link between the reverse logistics practices and green firm reputation. To achieve this, the paper needed to identify the correlation between reverse logistics practices and operational performance, as well as the outcomes of operational

performance. These were formulated as hypotheses, specifically hypothesis 4.

The third hypothesis was on whether the logistics practices of reverse logistics led to operational efficiency in manufacturing companies in the global South. The results indicated that there is a strong and significant relationship between the two variables. We calculated the effect size of the variables, which showed a very large effect. This emphasises the fact that RL, as operationalised in most manufacturing companies, is not only a sustainable operation but also a major factor in determining the optimisation of manufacturing processes. This observation is consistent with the resource-based viewpoint, which states that reverse logistics contributes to internal capabilities, which in turn contribute to better inventory control. This eventually leads to less resource usage at each stage as well as better agility of the supply chain among the trading partners (Yu et al., 2021). The findings also support the theory of the natural resource-based view, which considers environmentally driven practices as a means to enhance efficiency (Hart & Dowell, 2011).

Hypothesis 4 results indicate that operational efficiency has a positive and significant impact on green firm reputation. Since companies are found to be eco-friendly and identify efficient operations as a factor in determining their place in the competitive market, they are also seen to be environmentally responsible. This assertion is in line with recent studies that found that lean and green operational excellence correlates with positive stakeholder perceptions (Dubey et al., 2022). These results align with the relational-based view theory, that efficiency serves as a gauge for cost-effective resource utilisation. Moreover, the results corroborate NRBV's assertion that legitimacy and trust are influenced by environmental efficiency (Kim & Kraft, 2017).

Although the research established that OPE partially mediates the RLP-GFR relationships, the logistical inefficiencies, skills mismatches, and waste segregation systems in Ghanaian companies might restrict the potential of these benefits. Such contextual facts imply that, even though RLP is an efficiency driver, its performance impact can be contingent on the presence of other supporting infrastructure and managerial skills.

The predictive abilities of the model based on PLSpredict were tested in this paper. The research model shows positive predictive relevance and also has out-of-sample predictive power, which is a significant validation of social science research. The results demonstrate that eco-innovation is a key driver of reverse logistics capability. Moreover, the model affirmed that reverse logistics practices increase operational efficiency and green firm reputation.

These conclusions demonstrate that the research paper is not only empirical but also provides confidence in the results.

6. CONCLUSION AND THEORETICAL IMPLICATIONS

6.1. Conclusion

The research offers substantial empirical support for the idea that eco-innovation is a key driving factor in reverse logistics practices. These practices subsequently influence operational efficiency and the company's green reputation. Their results also indicate that reverse logistics practices directly and positively affect green firm reputation and indirectly affect its true operational efficiency, which supports a partial mediation model. These findings align with the RBV and NRBV theories. These findings suggest that eco-innovation acts as a strategic capability. That capability encourages the development of reverse logistics routines such as closed-loop product design, material recovery, reuse, and recycling, which become valuable and difficult for competitors to replicate.

Reverse logistics leads to both operational benefits, such as reducing waste, better inventory management, and more efficient return processes, as well as noticeable environmental initiatives that improve how stakeholders view credibility and responsibility. Therefore, operational efficiency acts as a means through which the enhancement in internal performance translates into external reputational value. This reasoning is consistent with the NRV perspective, which suggests that when environmental capabilities are effectively integrated into primary operations, they can yield both significant performance results and symbolic legitimacy advantages.

6.2. Theoretical Implications

As this paper has demonstrated, environmental capabilities can develop into both efficient and symbolic performance outcomes. The paper, therefore, builds on the resource-based and natural resource-based perspectives to explore how a pathway of sequential capabilities develops through eco-innovation and reverse logistics practices, all of which contribute to performance in a highly competitive manufacturing environment in the global South. The research presents evidence that operational performance is an important ingredient in competitiveness in the manufacturing industry, which partially mediates internal processes through which innovation-focused environmental practices give rise to external legitimacy. This supports the opinion that in cases where the firms invest in rare and valuable capabilities that cannot be replicated, in addition to having environmentally friendly policies and programmes, a competitive edge can be achieved where the firms are aiming to compete amongst themselves both within and outside of their geographical locations. Thus, the current work improves RBV and NB RV theories, showing that organisations should constantly invest in the inimitable capabilities, and they should focus on the environmentally friendly innovations, as this would lead to the conversion of the return on investment and a positive corporate image among the consuming population.

6.3. Managerial Implications

At the managerial level, the results position eco-innovation and reverse logistics not as compliance measures but as tools for competitive advantage. Firms should entrench such practices as part of their holistic sustainability programs that can also aim to maximise resources, reduce waste, and earn the confidence of stakeholders. Particularly, reverse logistics must be redefined as an ability that can lead to both operational and reputational payoffs, which provides a solid financial justification for environmental efforts. For policymakers and regulatory authorities, the findings indicate that institutionalising eco-innovation incentives and reverse logistics standards in terms of public procurement, industrial policy, and circular economy models is necessary to improve the sustainability performance of a nation.

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