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The Role of Third-Party Logistics Providers in Fostering Sustainable Logistics: Evaluating Beneficiaries and Implementation Challenges

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A B S T R A C T

This study investigates the role of third-party logistics (3PL) providers in advancing sustainable logistics practices within the Indian context, focusing on key beneficiaries and implementation challenges. Amid growing emphasis on the Sustainable Development Goals (SDGs) and evolving supply chain dynamics post-COVID-19, the research highlights the need for bottom-up insights, especially from operational-level stakeholders. A quantitative methodology was employed, using structured questionnaires to collect primary data from 204 respondents in the logistics sector. SPSS software facilitated regression and correlation analyses. Findings reveal that the regression model significantly explains 53.3% of the variance in sustainable logistics adoption ($R^2 = .533$, $p < .001$). Relative Advantage emerged as the strongest predictor ($\beta = .562$, $p < .001$), followed by Compatibility ($\beta = .233$, $p < .001$), while Implementation Challenges was statistically insignificant. Pearson and Spearman correlations supported these results, confirming strong relationships between the variables. Cronbach's Alpha value of 0.876 indicated high internal consistency. The study provides meaningful implications for both researchers and practitioners. It underscores the importance of targeted strategies that enhance sustainability performance through influential variables. Future research should further refine and contextualize key constructs to bridge strategic policies with ground-level implementation, enabling more resilient and sustainable logistics systems.

Keywords: Third party logistics, sustainable logistics, beneficiary analysis and barriers.

1. Introduction

After the introduction of Sustainable Development Goals (SDGs), the research world witnessed an upsurge in investigations related to sustainability across multiple dimensions, ranging from science to management disciplines (Bamia & Bamia, 2025; Shah et al., 2025). Since the outbreak of the COVID-19 pandemic in 2020, many research studies have focused on sustainability in management, including marketing practices (Ulmer & Rose, 2025), finance initiatives (Islam et al., 2025), human resource management initiatives (Stephen, 2025), operations management (Gideon, 2025), and supply chain management (Abbasi et al., 2025). A variety of studies have highlighted the intersection of supply chain management and sustainability, confirming that supply chains are crucial in fostering sustainability across industries (Chowdhury, 2025) and promoting resilience through the localization of global value chains (Prudnikova & Khmyz, 2025). As economic obstacles affect the seamless flow of transactions (Mendis, 2025), localization tendencies change operational strategies (Smith, 2025), and geopolitical changes have a substantial impact on global operations (Nagy et al., 2025), the corporate landscape is growing more complex. The function of third-party logistics (3PL) providers must be investigated in order to improve supply chain resilience and sustainability. These providers are crucial to the creation of sustainable supply chains (Tanchangya et al., 2025). With over 10,000 third-party logistics companies formally established in India, the importance of 3PL providers is clear (FICCI, 2024). Despite continuous difficulties with digital literacy and digitization, the logistics industry has grown quickly in India due to the rise of e-commerce platforms (Meunier, 2025). However, as per various studies (Abbasi et al., 2025; Basile et al., 2025), several challenges persist, including transport connectivity (Mookda, 2025), courier service inefficiencies (Bamia & Bamia, 2025), forward and backward linkage deficiencies (Usman, 2025), manpower shortages (Matos-Jiménez et al., 2025), technology integration hurdles (Chowdhury, 2025), business model innovation barriers (Mendis, 2025), regulatory compliance issues (Basile et al., 2025), and limited sustainability and green logistics integration (Prudnikova & Khmyz, 2025). In this context, the present study aims to investigate in detail the gravity of challenges faced by logistics providers in implementing sustainability initiatives. While studies exist on carbon footprint reduction, adoption of low-emission vehicles, and drone utilization in logistics (Neszmélyi et al., 2025; Mookda, 2025), comprehensive research focusing on bottom-of-the-pyramid logistics providers remains scarce. This study intends to fill this gap and provide valuable insights into how these challenges affect third-party logistics operations. Numerous stakeholders, including clients, environmentalists, staff members, business owners, suppliers, startups, and associated industries, are anticipated to gain from the results. It will offer crucial proof of the value of a bottom-up strategy and highlight the urgent difficulties lower-level staff members encounter when incorporating sustainable practices into day-to-day operations. Additionally, the outcomes might improve the efficacy of sustainability plans across industries by bridging the gap between grassroots implementation and high-level legislative initiatives. In light of the aforementioned, the study's goal revolves around the following objectives.

- To examine how adoption of sustainable logistics practices is impacted by awareness and compatibility in sustainable logistics.
- To assess the role of third-party logistics in enhancing sustainable logistics practices in Indian context.
- To analyze how relative advantage in integrating sustainable logistics serves as a catalyst in promoting sustainable logistics practices.

2 Literature Review

Hofmann and Osterwalder (2017) analyze the impact of digitalization on third-party logistics (3PL) providers, emphasizing both the threats and opportunities emerging in the industry. Their study integrates Porter's five forces framework with digital innovation research to assess how disruptive technologies, such as autonomous vehicles, 3D printing, and platform-based logistics solutions, are transforming 3PL business models. The authors identify three key threats to traditional 3PL providers. Firstly, those focusing on standardized services are experiencing a decline in market share due to emerging transport technologies and customized service solutions. Secondly, digital platforms and online logistics services are increasingly taking over management-related functions, reducing 3PLs to mere freight forwarders. Lastly, the risk of forward and backward integration is growing, as major e-commerce firms like Amazon and platform providers such as Uber Freight develop their own logistics capabilities, thereby bypassing traditional 3PL services. Despite these challenges, strategic opportunities exist for 3PLs that embrace digital transformation, including the adoption of platform-based logistics, cloud computing, and real-time analytics to enhance operational efficiency and create new value-added services.

The selection of third-party logistics providers is influenced by several factors, as explored by Anderson et al. (2010). Their study reveals three distinct customer decision models based on service differentiation, proven solutions, and cost sensitivity. Using discrete choice modeling, they find that reliable performance, pricing, and customer service recovery are the most critical attributes in the selection process. The research highlights that while reliable delivery performance is universally prioritized, firms differ in their weighting of cost versus service quality. Some prioritize lower costs, whereas others seek high levels of customer interaction, innovation, and supply chain flexibility. This segmentation underscores the necessity for 3PL providers to tailor their offerings to specific customer needs rather than adopting a uniform approach.

The integration of 3PL providers into supply chains is further examined by Jayaram and Tan (2010), who investigate its impact on firm performance. They identify four key enablers that contribute to effective 3PL integration: information integration, selection criteria, performance evaluation, and relationship building. Their findings suggest that firms that integrate 3PLs tend to emphasize these enablers more than those managing logistics internally. Information integration involves seamless data sharing between firms and logistics providers, improving coordination, while relationship building fosters trust and cooperation, which are crucial for long-term partnerships. Additionally, selecting the right 3PL based on industry knowledge, financial stability, and commitment to quality enhances logistics efficiency. Performance evaluation ensures continuous improvement by assessing 3PLs based on service level, on-time delivery, and responsiveness. However, despite these theoretical advantages, the study finds no significant performance differences between firms that integrate 3PLs and those that do not, suggesting that the effectiveness of integration depends on strategic alignment and execution rather than merely outsourcing logistics functions.

Social sustainability in the evaluation of third-party logistics providers is explored by Jung (2017), who emphasizes the importance of incorporating employee welfare, occupational health, human rights, and philanthropy into 3PL evaluation criteria. The study employs the fuzzy analytic hierarchy process (AHP) to develop an evaluation framework that balances economic and social factors. Findings indicate that while cost remains a dominant selection criterion, firms are increasingly recognizing the strategic importance of social sustainability in logistics partnerships. This shift suggests that businesses are beginning to integrate corporate social responsibility into their logistics decision-making processes, enhancing their brand reputation and stakeholder relationships.

Beyond service providers, third-party logistics providers have evolved into supply chain orchestrators, as proposed by Zacharia et al. (2011). Their study integrates transaction cost economics (TCE), resource-based theory (RBT), and network theory (NT) to establish a framework explaining how 3PLs add value beyond traditional logistics functions. They identify four primary components that define a 3PL orchestrator: standardization, visibility, neutral arbitration, and collaboration. Standardization ensures seamless logistics operations across multiple supply chain partners, facilitating efficiency, while visibility enables 3PLs to monitor and optimize logistics networks, reducing uncertainties. Neutral arbitration positions 3PLs as unbiased facilitators, capable of influencing supply chain improvements without organizational bias. Lastly, collaboration enhances supply chain integration by encouraging resource sharing and strategic partnerships among stakeholders. The study underscores that by assuming this expanded role, 3PLs enable firms to focus on core competencies while leveraging specialized logistics expertise to drive innovation and operational efficiency.

The impact of 3PL capabilities on exporters' performance is further examined by Yeung et al. (2012) through the lens of the resource-based view (RBV). Their study investigates how outsourcing logistics services influences competitive advantage and business performance, particularly for export firms operating in dynamic and competitive environments. They categorize 3PL capabilities into basic capabilities, such as transportation and warehousing, and augmented capabilities, including IT support, supply chain integration, and strategic partnerships. Findings indicate that augmented capabilities significantly enhance exporters' competitive advantage, ultimately improving their export performance. However, the research also acknowledges potential challenges in 3PL relationships, such as misalignment of expectations, inadequate service levels, and failure to achieve cost reductions. Notably, 55% of 3PL relationships are terminated within three to five years due to poor communication, lack of strategic alignment, and unrealistic expectations. The study underscores that while outsourcing logistics functions can create competitive advantages, its success depends on selecting 3PL providers with strong augmented capabilities and fostering collaborative relationships. It contributes to supply chain management literature by providing empirical evidence on the strategic role of 3PLs in enhancing exporters' performance.

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Sustainable logistics has gained prominence in recent years, with decision support systems (DSS) playing a crucial role in optimizing sustainability-related decisions. Qaiser et al. (2017) conduct a bibliometric analysis of DSS in sustainable logistics, identifying key research trends, gaps, and emerging themes. Their findings highlight the necessity of integrating multi-criteria decision analysis (MCDA) to enhance sustainability decision-making. Jayarathna et al. (2022) further explore sustainable logistics in the transition to a circular economy, categorizing 47 key practices into environmental preservation, dynamic capabilities, and social well-being. Findings suggest that economic value creation is the primary driver of circular economy adoption, followed by environmental and social value creation. Björklund and Forslund (2018) identify a five-phase sustainable logistics innovation process, which includes idea generation, idea selection, concept development, business case development, and implementation with learning. They emphasize the role of logistics service providers in sustainability innovation, while also noting challenges such as lack of customer involvement and slow decision-making. Ren et al. (2020) conduct a systematic review of green and sustainable logistics, classifying research into five thematic areas: economic, planning, application, technology, and operations research. Their study underscores the importance of integrating artificial intelligence, blockchain, and the Internet of Things into sustainable logistics solutions.

The logistics industry in India, analyzed by Viswanadham and Puvaneswari (2004), faces significant infrastructure challenges, digital transformation trends, and policy reforms such as the Goods and Services Tax. Key industry segments include automotive, pharmaceuticals, FMCG, and electronics, with improvements in infrastructure and regulation streamlining deemed essential for India's logistics sector to meet global standards. Singh et al. (2011) examine logistics' role in green supply chain management within India's courier service industry, highlighting road transport as the highest contributor to carbon emissions. E-commerce adoption has reduced emissions by minimizing direct transportation needs, with green logistics strategies such as optimized routing and eco-friendly transportation playing a crucial role in sustainability. Lastly, Twenhöven and Petersen (2019) explore blockchain's impact on logistics, identifying its potential to enhance transparency, efficiency, and cost reduction, while also noting challenges such as digitalization gaps, regulatory hurdles, and data security concerns.

The reviewed literature highlights the evolving role of third-party logistics in digitalization, sustainability, and supply chain orchestration. Strategic integration, social sustainability, and technological innovations like blockchain are essential for modern logistics. Additionally, sustainable logistics research emphasizes the transition to circular economy models, green logistics strategies, and decision support systems. The Indian logistics sector faces unique challenges, including infrastructure inefficiencies, regulatory bottlenecks, and high costs. Addressing these issues through policy reforms and digital transformation is crucial for enhancing competitiveness and sustainability in logistics operations.

3. Research Methodology

3.1 Research design

Analyzing the contribution of third-party logistics (3PL) providers to sustainable logistics is best done using quantitative research technique since it can measure factors like cost effectiveness, carbon emissions, and service quality objectively across large samples. It makes it possible to identify important beneficiaries and do statistical analysis of implementation difficulties.

3.2 Sample size

A sample size of 204 is sufficient for quantitative research as it provides enough statistical power to detect meaningful relationships and generalize findings within an acceptable margin of error. According to Krejcie and Morgan (1970), for a population size of over 20,000, a sample of around 384 is ideal for a 95% confidence level; however, when constraints exist, a sample above 200 is still considered adequate for reliable analysis, especially in exploratory or applied research (Sekaran & Bougie, 2019). Thus, a sample of 204 ensures credible insights while balancing feasibility and statistical accuracy.

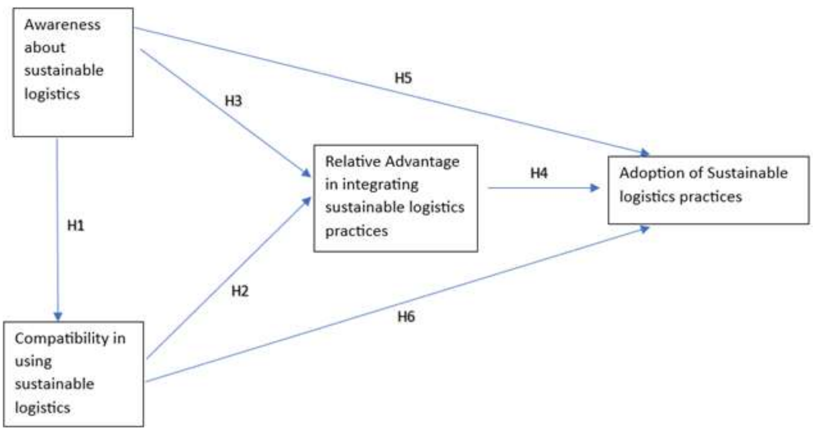

Figure 1 - Conceptual Model

Hypotheses

H1: Awareness about sustainable logistics influences Compatibility in using sustainable logistics.

H2: Compatibility in using sustainable logistics, has a direct positive impact on Relative Advantage in integrating sustainable logistics practices.

H3: Awareness about sustainable logistics, positively impact relative advantage in integrating SLPs.

H4: Relative Advantage in integrating sustainable logistics practices mediates the relationship between Awareness and compatibility in adoption of SLPs.

H5: Awareness about sustainable logistics directly influences adoption of Sustainable logistics practices.

H6: Compatibility in using sustainable logistics positively impacts adoption of Sustainable logistics practices.

3.3 Data collection

Primary data collection is best suited for this topic as it allows researchers to gather first-hand, specific, and current insights directly from stakeholders involved in third-party logistics, such as logistics managers, service providers, and clients. This approach ensures data relevance and contextual accuracy, especially when assessing sustainability practices, beneficiary perceptions, and real-time implementation challenges. Using a structured questionnaire facilitates standardized data collection, enabling easy quantification and comparison of responses (Saunders, Lewis, & Thornhill, 2019). It also supports the use of statistical tools like SPSS for deeper analysis, enhancing the validity and reliability of the findings.

Table 1 - Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.730a	0.533	0.526	0.56436	0.533	75.691	3	199	0

The predictive ability of the independent factors (Compatibility, Implementation, and Relative Advantage) on the dependent variable was investigated using a multiple linear regression analysis. The model was statistically significant, according to the results (F(3,199)=75.691, p<.001), indicating that the predictors together accounted for a sizable amount of the variance in the outcome variable. The model's multiple correlation coefficient, R=.730, showed that the observed and predicted values were strongly positively correlated. According to the coefficient of determination, R2=.533, the model accounts for roughly 53.3% of the variance in the dependent variable. After adjusting for the number of predictors, the corrected R2 was.526. The standard error of the estimate was .56436, indicating the average distance between the observed and predicted values. These findings suggest that the combination of the predictors provides a robust model for predicting the dependent variable.

Table 2: Descriptive Statistics (for AD, IM, CO, RA)

	Mean	Std. Deviation	N
AD	3.2946	0.81964	203
IM	3.6741	0.90657	203
CO	3.4069	0.81578	203
RA	3.6049	0.92328	203

Descriptive statistics were computed for all variables involved in the regression analysis to understand their central tendency and dispersion. The dependent variable, Adoption (AD), had a mean score of 3.29 (SD = 0.82), indicating a moderately high average response. Among the independent variables, Implementation (IM) recorded the highest mean value of 3.67 (SD = 0.91), suggesting that respondents generally rated this variable the highest. Relative Advantage (RA) followed closely with a mean of 3.60 (SD = 0.92), while Compatibility (CO) had a mean of 3.41 (SD = 0.82). All variables were measured on the same scale and had relatively similar standard deviations, indicating a comparable level of variability in responses. The sample size for each variable was consistent at N = 203, ensuring uniformity in the dataset used for analysis.

Pearson correlation coefficients were computed to examine the strength and direction of relationships between the dependent variable (Adoption) and the independent variables (Implementation, Compatibility, and Relative Advantage). The analysis revealed that Adoption was significantly and positively correlated with all three independent variables: Relative Advantage showed the strongest correlation with Adoption (r = .708), suggesting a strong positive relationship.

Table 3: Pearson Correlations

Column 1	Adoption	Implementation	Compatibility	Relative Advantage
Pearson Correlation				
Adoption	1			
Implementation	0.408	1		
Compatibility	0.589	0.446	1	

Relative Advantage	0.708	0.551	0.637	1
N				
Adoption	203	203	203	203
Implementation	203	203	203	203
Compatibility	203	203	203	203
Relative Advantage	203	203	203	203

Compatibility (CO) was also positively correlated with Adoption (AD) ($r = .589$), indicating a moderate-to-strong association. Implementation (IM) had a moderate positive correlation with Adoption (AD) ($r = .408$). Additionally, intercorrelations among the independent variables were also notable: Relative Advantage (RA) correlated strongly with Compatibility (CO) ($r = .637$) and moderately with Implementation (IM) ($r = .551$). Compatibility (CO) and Implementation (IM) were moderately correlated ($r = .446$). All correlations were based on a consistent sample size of $N = 203$, ensuring reliability and comparability across variables. These findings indicate that all three predictors share a positive association with the dependent variable, supporting their inclusion in the regression analysis.

Table 4: ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	72.323	3	24.108	75.691	.000b
Residual	63.381	199	0.318		
Total	135.704	202			

a. Dependent Variable: Adoption

b. Predictors: (Constant), Relative Advantage, Implementation, Compatibility

To evaluate the regression model's overall significance, an analysis of variance (ANOVA) was conducted. $F(3,199)=75.691$, $p<.001$, showed that the model was statistically significant. This demonstrates that a substantial amount of volatility in the dependent variable (adoption) can be explained by the collection of independent factors (relative advantage, implementation, and compatibility). While the residual, or unexplained variance, was 63.381, the regression model explained a Sum of Squares of 72.323. The dependent variable's overall variance was 135.704. The model's explanatory power was further demonstrated by the regression's mean square, which was 24.108, which was much greater than the residual mean square of 0.318. These findings support the notion that the model's predictors have a major impact on the dependent variable's prediction.

Table 5: Coefficients

Model	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1 (Constant)	0.717	0.198		3.613	0
Implementation	-0.006	0.053	-0.006	-0.105	0.917
Compatibility	0.234	0.064	0.233	3.67	0
Relative Advantage	0.499	0.061	0.562	8.25	0

a. Dependent Variable: Adoption

To determine the relative contributions of the independent factors (implementation, compatibility, and relative advantage) to the prediction of the dependent variable (adoption), a multiple regression analysis was performed. Above are the standardized and unstandardized coefficients and their statistical significance. The strongest and most significant predictor of adoption was found to be Relative Advantage ($B = 0.499$, $\beta = 0.562$, $t = 8.250$, $p <.001$). This means that, when all other factors are held constant, an increase of one unit in Relative Advantage results in an increase of 0.499 units in Adoption. A positive and substantial link with the dependent variable was suggested by compatibility, which also made a significant contribution to the model ($B = 0.234$, $\beta = 0.233$, $t = 3.670$, $p <.001$). Implementation, however, was not a statistically significant predictor ($p = .917$), with a negligible coefficient (B = -0.006, β = -0.006), indicating it had little to no effect on Adoption in this model. The constant (intercept) was also significant ($p < .001$), with a value of 0.717.

Table 6: Descriptive Statistics (for Awareness, Adoption, Relative Advantage, Compatibility)

	N	Minimum	Maximum	Mean	Std. Deviation
Awareness	203	1	5	3.5606	1.00396
Adoption	203	1	5	3.2946	0.81964
Relative Advantage	203	1	5	3.6049	0.92328
Compatibility	203	1	5	3.4069	0.81578

The study's four main variables—adoption, relative advantage, compatibility, and awareness—were subjected to descriptive statistics. The responses ranged from 1.00 to 5.00 on a five-point Likert scale, which was used to measure all variables (see Table 6). The following were the standard deviations and mean scores: Responses to the awareness survey showed moderate variability, with a mean of 3.5606 and a standard deviation of 1.00396. A mean of 3.2946 and a standard deviation of 0.81964 were reported by Adoption, indicating comparatively smaller dispersion around the mean. The greatest mean score was 3.6049 for Relative Advantage, with a standard deviation of 0.92328. Compatibility recorded a mean of 3.4069 and a standard deviation of 0.81578. The sample size for all variables was consistent at N = 203, with no missing data, confirming the robustness and completeness of the dataset.

Table 7: Pearson Correlations

	Awareness	Compatibility	Relative Advantage	Adoption
Awareness				
Pearson Correlation	1	.828**	.625**	.475**
Compatibility				
Pearson Correlation	.828**	1	.637**	.589**
Relative Advantage				
Pearson Correlation	.625**	.637**	1	.708**
Adoption				
Pearson Correlation	.475**	.589**	.708**	1
. Correlation is significant at the 0.01 level (2-tailed).				

To examine the relationships among the study variables, a Pearson correlation analysis was conducted. The results, presented in Table 7, indicate several statistically significant relationships. Awareness showed a strong positive correlation with Compatibility ($r = .828$, $p < .01$), a moderate positive correlation with Relative Advantage ($r = .625$, $p < .01$), and a weak to moderate correlation with Adoption ($r = .475$, $p < .01$). Compatibility was positively and significantly correlated with both Relative Advantage ($r = .637$, $p < .01$) and Adoption ($r = .589$, $p < .01$), suggesting considerable overlap among these variables. A strong positive correlation was also found between Relative Advantage and Adoption ($r = .708$, $p < .01$). Strong relationships between the variables were indicated by all correlations being statistically significant at the 0.01 level (2-tailed). These results point to perhaps common underlying constructs or influences, suggesting that as scores on one variable rise, the scores on the others likely to rise as well. A Spearman's rank-order correlation was performed to investigate the direction and strength of the monotonic correlations between the variables.

Table 8: Spearman's Correlations

	Awareness	Compatibility	Relative Advantage	Adoption
Spearman's rho				
Awareness				

Correlation Coefficient	1	.822**	.628**	.480**
Compatibility				
Correlation Coefficient	.822**	1	.657**	.594**
Relative Advantage				
Correlation Coefficient	.628**	.657**	1	.673**
Adoption				
Correlation Coefficient	.480**	.594**	.673**	1
. Correlation is significant at the 0.01 level (2-tailed).				

To explore the strength and direction of the monotonic relationships between the variables, a Spearman's rank-order correlation was conducted. Awareness demonstrated a strong positive correlation with Compatibility (ρ = .822, $p < .01$) and Relative Advantage (ρ = .628, $p < .01$), and a moderate positive correlation with Adoption (ρ = .480, $p < .01$). Compatibility was strongly correlated with Relative Advantage (ρ = .657, $p < .01$) and Adoption (ρ = .594, $p < .01$). A strong positive correlation was also observed between Relative Advantage and Adoption (ρ = .673, $p < .01$). At the two-tailed 0.01 level, all correlations were statistically significant, indicating regular and substantial links between the variables. These findings support the possibility of additional multivariate analysis by showing that increases in one variable are typically linked to increases in other variables.

Table 9: Case Processing Summary

	N	%
Cases		
Valid	203	100
Excluded	0	0
Total	203	100

A total of 203 responses were included in the analysis, all of which were deemed valid and complete, representing 100% of the dataset. No cases were excluded from the analysis, as there were no missing values among the variables used. The data was processed using listwise deletion, ensuring that only complete cases across all variables involved in the analysis were considered. This supports the robustness of the findings, as the results are based on a consistent sample without imputation or data exclusion.

Table 10: Reliability Statistics

Cronbach's Alpha	N of Items
0.876	4

To assess the internal consistency of the scale used in the study, Cronbach's Alpha was calculated for the four items included. The analysis yielded a Cronbach’s Alpha value of 0.876, indicating a high level of internal consistency among the items. This suggests that the scale is reliable and the items consistently measure the underlying construct intended for investigation

4 Discussion

The findings of this study provide valuable insights into the relationships between the independent variables (Implementation, Compatibility, Relative Advantage) and the dependent variable (Adoption). The regression analysis revealed that the overall model was statistically significant, explaining approximately 53.3% of the variance in the dependent variable ($R^2 = .533$, $p < .001$). This indicates a substantial predictive power of the model and suggests that the selected independent variables play a critical role in influencing the outcome variable. Among the predictors, Relative Advantage emerged as the most influential factor, showing the highest standardized beta coefficient (β = .562, $p < .001$). This highlights the strong predictive strength of Relative Advantage in shaping responses to Adoption. Compatibility also showed a significant positive relationship with Adoption (β = .233, $p < .001$), confirming its relevance as a contributing factor. Interestingly, Implementation was found to be statistically insignificant ($p = .917$), indicating that this variable does not have a meaningful individual impact on the dependent variable in the presence of the other predictors.

The correlation analyses further reinforce these findings, with Relative Advantage showing the strongest association with the dependent variable (r = .708), followed by Compatibility (r = .589). Both Pearson and Spearman correlation coefficients were consistent, indicating strong and statistically significant associations among the variables. Additionally, the high internal consistency of the measurement scale (Cronbach's Alpha = .876) suggests that the items used were reliable for evaluating the constructs under study. The absence of missing data and the use of listwise deletion ensured the robustness of the dataset. Overall, the study confirms that Relative Advantage and Compatibility are significant contributors to predicting Adoption, while Implementation may require further investigation or refinement to enhance its predictive value.

5 Conclusion

The findings of this study carry significant implications for both academic research and logistics practice. From a research perspective, the strong predictive relationship between Relative Advantage and Adoption emphasizes the need to explore this variable further in future studies on sustainable logistics and third-party logistics (3PL) efficiency. Researchers should consider developing refined scales or models to capture the nuances of Relative Advantage and its underlying constructs. The insignificance of Implementation suggests that this variable may be context-dependent or inadequately measured, warranting further refinement or re-evaluation in future investigations.

In terms of practical implications, the results underscore the importance of Relative Advantage and Compatibility as key drivers influencing outcomes related to 3PL sustainability initiatives. Practitioners in logistics and supply chain management should prioritize strategies aligned with these predictors—particularly those represented by Relative Advantage, given its strong impact. This could involve enhancing operational practices, stakeholder engagement, or technology integration that align with the identified variables. Moreover, the high reliability of the measurement tool supports its continued use for organizational assessments. Overall, the findings provide a data-driven basis for decision-makers to enhance sustainability performance in logistics by focusing on the most impactful factors, thereby improving strategic alignment and operational effectiveness in 3PL environments.

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