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Environmental Sustainability in Freight Forwarding: An Exploratory Study of Green Logistics Practices in Hyderabad, India

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ABSTRACT

The freight forwarding industry serves as a crucial bridge between importers, exporters, and shipping and transportation companies. By facilitating the smooth movement of goods across borders, freight forwarders play a vital role in global trade. However, this industry also significantly impacts environmental stability due to the emission of harmful gases, carbon footprints, waste generation, and improper disposal practices, such as dumping waste into the soil. These activities contribute to environmental degradation and pose serious threats to natural ecosystems. Therefore, it is essential for the freight forwarding industry to adopt green initiatives and sustainable practices to minimize its environmental impact and promote long-term ecological balance. This study attempts exploratory research on green logistics practices and the challenges of their implementation in the case of freight forwarding industry in Hyderabad, India. Using primary research with 150 employees in freight forwarding companies, the paper explores the levels of awareness and adoption, as well as challenges to green logistics management. The study tested the following five hypotheses: educational gaps, economic barriers, customer demand, industry structure, and heterogeneity. Using convenience random sampling and quantitative data analysis, the results show that employees have considerable gaps in education and awareness, as only 28.0% of employees are also very familiar with green logistics concepts. The major barriers inhibiting the widescale adoption included high upfront costs (74.7%), education and awareness challenges (65.3%), customer expectations for competitive pricing (62.7%), and extended installation time (60.0%) All five hypotheses were confirmed with chi-square statistics from 19.76 to 45.72 ($p<0.05$). We highlight that the diversity of company sizes within the freight forwarding industry results in a spectrum of behavior when it comes to adopting green practices. Micro-level enterprises are facing much more significant challenges (58.0%) than higher-level firms at these conditions, coupled with highly uneven resource distribution (60.7%) Despite these barriers, the majority of respondents acknowledge the significance of green logistics concerning his/her company for operational efficiency (93.3%) and competitive advantage (86.7%). The results highlight a vital relationship where comprehensive education programs, targeted financial support and collaborative efforts from stakeholders can help highlight the more sustainable environmental approach to this activity.

1. INTRODUCTION

As a key facilitator in global trade and the supply chain ecosystem, the freight forwarding industry acts as an intermediary between shippers and a variety of transportation services. Nevertheless, the business' activities are major drivers of environmental damage, including carbon dioxide emissions, waste production and resource consumption [1, 2]. With mounting awareness towards environmental issues globally, green logistics management has emerged as an important line of action for facilitating sustainability drive in the freight forwarding industry.

1.1 The fragmented landscape of green logistics implementation

It makes freight transport and logistics industry a heterogeneous ecosystem, where the adoption of the green practices varies across the three organizational contexts, namely, structure, size and geographical locations [3]. This data highlights the diversity of organizations involved. The industry fragmentation makes it challenging to create sustainable frameworks that can be applied across the whole sector. Moreover, not only do the number of freight forwarders differ in technological capabilities, but this also leads to differences in the application of technologies that can help enable swift progress to much more sustainable freight forwarding. One of the most notable fragmentations based on technology exists between large corporations who are well-resourced and smaller entities who are capital and knowledge limited. Moreover, the role of stakeholders critically affects the adoption pathway of green logistics. Prataviera et al. [4] explain the nuance of primary stakeholders (e.g., customers,

shareholders) vs. secondary stakeholders (e.g., regulation, local communities) associated with sustainability agendas. The need to balance these different stakeholder interests while achieving operational viability can be a significant challenge for many freight forwarding operators, particularly smaller ones. Pressure to achieve data-driven, immediate business goals often supersedes second-order environmental importance in the list of operational metrics, amounting to a significant barrier to sustainable practices.

1.2 Barriers and challenges in sustainability transition

There are several barriers to the widespread adoption of green logistics practices throughout the freight forwarder industry. Leung et al. [5] highlight that management attitudes and awareness levels are internal barriers to sustainability, and external factors can be regulatory frameworks and market demands. Management's reluctance to take sustainability initiatives seriously, typically results from insufficient payback (direct or otherwise) and fears of competitive handicap. Companies operating in jurisdictions with more lenient or poorly enforced environmental laws tend to hesitate in this regard even more. Another significant challenge is the economic dimension. This perception that initial costs of changing to a sustainable operation are so high scares many companies, especially small ones with thin margins. For example, Lin and Ho [6] pointed out in the context of developing economies such as China, logistical companies tend to regard the immediate economic benefits as more important than environmental benefits. During economic downturns, these tradeoffs between economic and environmental sustainability are further exaggerated, with short term, instability-fueled survival taking precedence over sustainability. This uncertainty is compounded in practice by the absence of standardized metrics to quantify the economic gains from investing in green logistics, also creating a disincentive to adopt them.

1.3 Bridging the gap: Moving toward inclusive sustainability

Tackling the sustainability gap will require interventions that are aware of the unique challenges faced by smaller freight forwarding companies. Kanyepe et al. [7] underline the importance of management commitment with respect to adopting green logistics, they propose that commitment from management serves as a potent moderator between sustainability initiatives and operational performance. By creating customized strategies for adoption that take into account the capacity of small companies while showing real benefits, adoption rates across the industry spectrum are likely to take off faster. Another important factor for maintaining sustainability across industries is educational initiatives. Nithishkumar and Thandayuthapani [8] highlight a large gap in knowledge about (1) the benefits of green logistics; and (2) how the average company effectively implements green logistics. Targeted education, training programs, and knowledge-sharing platforms can help fill these gaps to enable smaller companies to pursue sustainability journeys even with modest resources. These partnerships can foster cross-industry collaborations, resource access, and the flow of knowledge while building a nurturing environment for both emerging and existing industry players to succeed. Achieving environmental stability in the freight forwarding sector will not be a linear process but will require a multi-faceted approach that recognizes the sector's organizational complexity while also considering the segmentation of barriers faced across the industry. Supporting diversity within sustainability may be the key to creating an environmental strategy that allows for diverse industries and businesses in the travel sector. Reporting best practices in environmental management and demonstrating how to sustain a diverse range of businesses will ensure the Travel & Tourism industry can actually move beyond fragments of sustainable strategies.

The freight forwarding industry in Hyderabad presents a unique context for studying green logistics adoption due to several city-specific factors. As a major IT and logistics hub in South India, Hyderabad experiences distinctive challenges including rapid urbanization, traffic congestion in key industrial corridors, and local regulatory pressures from the Telangana State Pollution Control Board. The city's logistics sector is characterized by a mix of traditional operators and technology-driven startups, creating a dynamic but fragmented landscape. Additionally, Hyderabad's position as a landlocked city necessitates complex multimodal transportation networks, further complicating sustainable logistics implementation. These contextual factors distinguish Hyderabad's freight forwarding industry from other Indian cities and provide valuable insights into how regional variations influence green logistics adoption in developing economies.

1.4 Objectives of the study

The primary objectives of this research are:

1. To find out how much of awareness and adoption level of green logistics practices among freight forwarding companies in Hyderabad, India.
2. To find out and measure the main obstacles limiting the development of green logistics management in freight forwarding and to pay more attention to the lack of education and organizational difficulties.
3. To analyze the impact of freight forwarding industry's unstructured environment on its adoption of green practices, particularly at the micro-level.
4. To assess the impact of industry heterogeneity and enterprise scale on green logistics practices.

To recommend solutions for addressing the identified impediments and improving environmental sustainability in the freight forwarding industry.

1.5 Research hypotheses

Drawing on the literature review and research purposes, the present study proposed the following hypotheses:

H1: A study on the education and awareness of the freight forwarders with respect to the green logistics practices in Hyderabad.

H2: The high initial cost, financial limitations, and lengthy process of installation blockade green logistics in freight forwarding companies.

H3: The demands of customers for competitive pricing and prompt delivery of goods hinder the implementation of green logistics practices.

H4: Unorganized nature of the freight forwarding industry, especially for micro level companies, is a barrier to adopting green logistics management.

H5: Different companies of dissimilar sizes behave

differently in green logistics adoption due to industrial heterogeneity.

It includes the activities that minimize the negative environmental effects of, and improve the ecological performance of, logistics activities through the entire supply chain, including the forward and reverse flows of goods, information and services [9]. This thus contributes to sustainable development through balancing economic, environmental, and social objectives. In fact, greening operations of freight forwarding industry is not only an environmental need but also a way to gain competitive advantage and operational efficiency [10, 11]. Though the significance of green logistics is established, the usage of green logistics on behalf of the freight forwarding industry, especially in developing countries such as India is limited. Sustainable design: The pioneering design direction in the industry, including sustainable materials selection, presents significant challenges in terms of economic, organizational limitations, and market demands [12, 13]. Identifying these obstacles is necessary to create techniques for improving environmental sustainability in freight forwarding activities. The purpose of this study is to examine the present scenario of the green logistics phenomenon in the freight forwarding sectors of Hyderabad, India, and pinpoint the issues that pose as impediments towards implementing the green logistics process, especially the issue of lack of education and awareness, heterogeneity of the industry and the barriers created by smaller organizations. Insights into the Practical Challenges and Opportunities in Green Logistics Management: By conducting a study on employees' perceptions and experiences on green logistics management, the research on green logistics management highlights the practical challenges and opportunities in this area. The results add to the body of knowledge on sustainable logistics and provide practical implications for industry practitioners and policymakers interested in fostering environmental sustainability in the freight forwarding industry.

1.6 Literature review

The freight forwarding industry is under increasing pressure to minimize its environmental impact while ensuring operational efficiency. In this literature review, we critically evaluate the latest academic contributions related to sustainability issues in logistics operations. While studies generally expose a complex interplay of technological, organizational, and regulatory elements influencing green practices adoption, there are notable inconsistencies in the literature. For instance, studies by studies [6] present contradictory findings regarding the influence of governmental support, with Centobell et al. [3] emphasizing its critical importance in developed economies while Lin and Ho [6] question its effectiveness in emerging markets like China. Similarly, the relationship between company size and adoption capability shows mixed results across studies, with Evangelista [14] suggesting resource constraints as universal barriers regardless of company size, while Nithishkumar and Thandayuthapani identify significant variations based on organizational scale. These inconsistencies highlight potential contextual differences that our research in Hyderabad aims to clarify. Although economic factors dominate the literature, the evidence supporting competitive benefits from environmentally-friendly logistics varies considerably in strength and applicability across different market contexts. Here we summarize key findings across multiple in Table 1.

Table 1 Summary of literature survey

References	Methodology	Key Findings
[1]	Systematic literature review analyzing 46 peer-reviewed papers published between 2000-2016 using content analysis and descriptive statistics	Mapped the evolution of environmental sustainability research in third-party logistics from 2000-2016; identified predominance of survey-based methodologies; highlighted research gaps including limited focus on performance measurement and technology adoption.
[2]	Comprehensive literature review and content analysis of 72 peer-reviewed articles with taxonomic classification of research approaches	Mapped research streams in environmental sustainability for logistics; identified methodological limitations in existing research; proposed comprehensive research agenda focusing on performance measurement, technology adoption, and collaboration.
[3]	Quantitative cross-country analysis using structured surveys of 141 Logistics Service Providers (LSPs) across multiple countries with statistical hypothesis testing	Found significant variations in green practices adoption across countries; identified enabling technologies that support sustainability goals; demonstrated correlation between technology adoption and achievement of sustainable development goals in supply chains.
[4]	Mixed-methods stakeholder analysis combining interviews with 32 stakeholders and quantitative influence-interest matrix mapping	Mapped stakeholder influence and interests in green logistics implementation; demonstrated importance of multi-stakeholder engagement; identified misalignment between stakeholder priorities as implementation barrier.
[5]	Empirical research using survey data from 203 logistics service providers with hierarchical regression analysis and mediation testing	Explored relationship between environmental sustainability and green management practices in logistics; found positive impacts on operational efficiency and market positioning; identified organizational characteristics that predict adoption success.
[6]	Quantitative study using hierarchical regression analysis of survey data collected from 322 logistics companies in China	Determined key factors affecting green practice adoption for logistics companies in China; highlighted technological, organizational, and environmental determinants; found regulatory pressure and governmental support were particularly influential.
[7]	Quantitative survey-based research using structural equation modeling with data from 218 road freight companies to test hypothesized relationships	Demonstrated positive relationship between green logistics adoption and operational performance in road freight sector; established management commitment as a critical moderating factor; recommended leadership development to support sustainability transitions.
[8]	Quantitative analysis of logistics performance index data from 42 freight forwarding companies in	Evaluated logistics performance indicators at freight forwarding companies in Chennai; correlated sustainability practices with business

	Chennai using correlation and regression analysis	performance; recommended balanced performance measurement systems integrating economic and environmental metrics.
[9]	Comprehensive literature review with taxonomic classification of operational research methods in green freight transportation	Highlighted the critical role of operational research in green freight transportation; emphasized optimization models for reducing environmental impacts; identified research opportunities in modeling emissions, integrating multiple objectives, and considering uncertain parameters.
[10]	Development and validation of a composite index through expert panel consultation, analytic hierarchy process (AHP), and confirmatory factor analysis	Developed comprehensive assessment framework for environmental and social sustainability in freight transportation; validated metrics through industry feedback; enabled benchmarking of sustainability performance across operators.
[11]	Multi-criteria decision-making approach using interval-valued intuitionistic fuzzy digraph matrix with data from 18 domain experts and sensitivity analysis	Evaluated implementation roadblocks for green freight systems; developed quantitative assessment of barrier relationships; identified leverage points for system improvement through targeted interventions.
[12]	Mixed-methods approach combining Interpretive Structural Modeling (ISM) and graph-based Decision Making Trial and Evaluation Laboratory (gDEMATEL) technique with expert input	Identified and prioritized barriers to green freight transportation in Indian logistics; found infrastructure limitations, financial constraints, and lack of awareness as critical barriers; proposed systemic intervention strategies.
[13]	Theoretical analysis using systematic literature review and conceptual framework development with thematic analysis	Provided comprehensive overview of barriers to green transformation in logistics organizations; categorized barriers into technological, organizational, economic, and regulatory dimensions; proposed integrated framework for transformation management.
[14]	Exploratory multiple case study involving semi-structured interviews with managers from seven Italian transport and logistics companies	Revealed varying levels of environmental commitment among transport and logistics companies; identified resource constraints as major barriers; found that customer pressure was a significant driver for sustainability initiatives.
[15]	Mixed-methods case study of Saudi Arabian logistics sector combining in-depth interviews with 18 logistics managers and document analysis of policy frameworks	Identified country-specific challenges to green logistics implementation; highlighted regulatory gaps, knowledge limitations, and infrastructure constraints; proposed framework for addressing implementation barriers in developing economies.
[16]	Exploratory case study of biomethane adoption in Swedish freight transport sector using 24 semi-structured interviews with stakeholders across the value chain	Explored biomethane use as a green logistics practice in freight transport; identified infrastructure development as critical success factor; demonstrated environmental and economic benefits of alternative fuel adoption.
[17]	Systematic literature review with bibliometric analysis of academic publications on urban freight logistics and land use planning education	Identified gaps in urban freight logistics education; found limited integration of land use planning with logistics in educational curricula; recommended comprehensive educational frameworks to address sustainability challenges.
[18]	Qualitative research using semi-structured interviews with 22 experts from logistics companies, complemented by focus group discussions	Identified barriers and enablers for electrification in road freight transport; highlighted infrastructure limitations, vehicle capability concerns, and cost barriers; suggested policy interventions and collaborative approaches to accelerate transition.
[19]	Conceptual study using scenario analysis and strategic roadmapping based on industry reports and secondary data	Analyzed trucking industry's potential leadership role in green logistics transition; proposed roadmap for industry transformation; highlighted technological innovations, policy support, and business model adaptation as key success factors.
[20]	Cross-sectional survey of 362 logistics service customers in South Africa using structured questionnaires with statistical analysis	Investigated customer perspectives on green logistics in South Africa; found growing awareness but limited willingness to pay premium for green services; highlighted gap between customer expectations and industry practices.
[21]	Quantitative research using partial least squares structural equation modeling with data from 97 logistics service providers in Thailand	Investigated antecedent factors for green initiatives among logistics service providers; demonstrated contributions to corporate goals; found regulatory compliance, competitive advantage, and customer requirements as primary motivators.
[22]	Empirical study using structural equation modeling with data collected from 217 logistics companies through standardized questionnaires	Identified key antecedents of green logistics practices implementation; demonstrated positive effects on supply chain management performance; highlighted the importance of organizational culture and stakeholder pressure as drivers.
[23]	Systematic review of 54 peer-reviewed articles on green vehicle adoption in last-mile logistics using PRISMA methodology and content analysis	Analyzed adoption patterns of green vehicles in last-mile logistics; identified technological, economic, and regulatory barriers; highlighted electric vehicles and cargo bikes as promising solutions with context-specific implementation challenges.
[24]	Empirical study using structural equation modeling with data from 267 manufacturing firms to test hypothesized relationships	Investigated relationships between green logistics, circular practices, and Industry 4.0 technologies; found that institutional pressure and supply chain flexibility moderate adoption; demonstrated synergistic benefits of integrated approaches.

While extensive research exists on green logistics adoption globally, studies specific to the Hyderabad context remain limited. The city's unique positioning as both a traditional freight hub and an emerging technology center creates

distinctive implementation challenges. Local regulatory frameworks, including Telangana's industrial waste management policies and the Greater Hyderabad Municipal Corporation's transportation regulations, significantly impact how freight forwarders approach sustainability. Furthermore, cultural factors such as the traditional business practices of local freight operators, many of whom operate as family businesses with established methods resistant to change, create additional barriers not frequently encountered in Western contexts. Figure 1 illustrates ten major environmental impacts of the freight forwarding industry, including GHG emissions, fuel consumption, air and marine pollution, packaging waste, deforestation, noise, e-waste, over-consumption, and improper waste management.

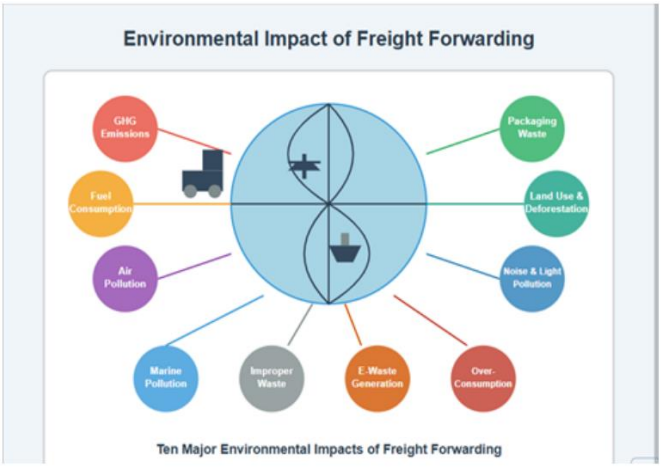

Figure 1. Environmental impact of freight forwarding industry

2. MATERIAL AND METHODS

2.1 Research design

This study employed an exploratory research design to investigate the adoption of green logistics practices and barriers to implementation in the freight forwarding industry. The research combined a comprehensive literature review with primary data collection to gain insights into employee perceptions and experiences regarding green initiatives in the freight forwarding sector in Hyderabad, India. The research approach was primarily quantitative, using structured questionnaires to collect data that could be analyzed statistically to test the proposed hypotheses, with particular focus on educational gaps, industry heterogeneity, and challenges faced by micro-level companies.

2.2 Sampling and data collection

A stratified random sampling method was utilized to select participants for the study. Determining the exact number of freights forwarding companies operating in Hyderabad is challenging due to the dynamic nature of the logistics industry and the continuous emergence of new enterprises. Based on recent data, as of January 23, 2025, there are approximately 257 freight forwarding agencies operating in Hyderabad [15]. To ensure representative sampling across the industry's heterogeneous landscape, we first categorized companies into three strata based on size: micro-level enterprises (fewer than 10 employees), medium-sized companies (10-50 employees), and large organizations (more than 50 employees). Using business directories and industry association listings, we identified approximately 140 micro-level enterprises, 85 medium-sized companies, and 32 large organizations operating in Hyderabad. We then selected companies from each stratum using proportional allocation, ensuring that the number of companies sampled from each stratum was proportional to the stratum's size in the overall population. Within selected companies, participants were chosen based on their roles and involvement in logistics operations, with efforts to include representation across organizational hierarchies.

This approach helped mitigate potential selection bias and improved the generalizability of findings across Hyderabad's freight forwarding sector. While perfect representativeness remains challenging due to industry fragmentation and limited accessibility of some micro-level operators, our sampling approach provides valuable insights into the diverse perspectives within the industry. The sample consisted of 150 employees distributed across 43 freight forwarding companies (25 micro-level, 13 medium-sized, and 5 large organizations), reflecting the approximate proportional distribution in the Hyderabad market. The demographic profile showed a predominance of male employees (64.7%) with most respondents in middle management positions (54.7%) and in the 31-40 years age bracket (42.0%). A majority of participants had undergraduate education (52.0%) and were distributed across various experience levels, with 30.0% having 3-5 years of experience in the industry. Figure 2 shows the geographical location of Hyderabad in India, highlighted in orange. Situated in south-central India, Hyderabad serves as the research area for the study, bordered by the Arabian Sea and Bay of Bengal.

Figure 2. Map of research area

This flowchart illustrates the research methodology for a study on green logistics in the freight forwarding industry. It depicts a sequential process beginning with exploratory research design, followed by literature review and questionnaire development. The methodology includes convenience random sampling of 150 employees, data collection through structured questionnaires, statistical analysis using SPSS, and hypothesis testing of five key propositions. The diagram also highlights sample demographics, questionnaire design, and research methodology, providing a comprehensive overview of the study's systematic approach.

2.3 Questionnaire development

The questionnaire was developed based on a thorough review of existing literature on green logistics management in the freight forwarding industry. Key references used in formulating the questions included studies by these authors [16, 17] among others. The questionnaire was structured into three main sections:

1. Green Logistics Management: This section assessed respondents' familiarity with green logistics practices, their company's prioritization of green initiatives, management commitment, and the use of green vehicles in logistics operations.

2. Obstacles to Green Logistics Adoption: This section examined the main barriers to adopting green logistics practices, including economic (high initial costs, limited financial resources, long installation process), organizational (lack of education and awareness, insufficient management commitment), technological, and market-related challenges (customer demands for competitive pricing and fast delivery).

3. Customer Expectations and Green Initiatives: This section explored the relationship between customer demands and the implementation of green logistics practices, focusing on issues such as pricing, delivery speed, and environmental awareness.

Special attention was given to questions that addressed the educational gaps in the industry, the challenges faced by micro-level companies, and the impact of industry heterogeneity on green logistics adoption, as these were identified as critical factors in the literature review. Figure 3 presents a flowchart of the research methodology, detailing steps from exploratory design, literature review, questionnaire development, and sampling to data collection, statistical analysis, hypothesis testing, and conclusions based on employee perceptions in freight forwarding.

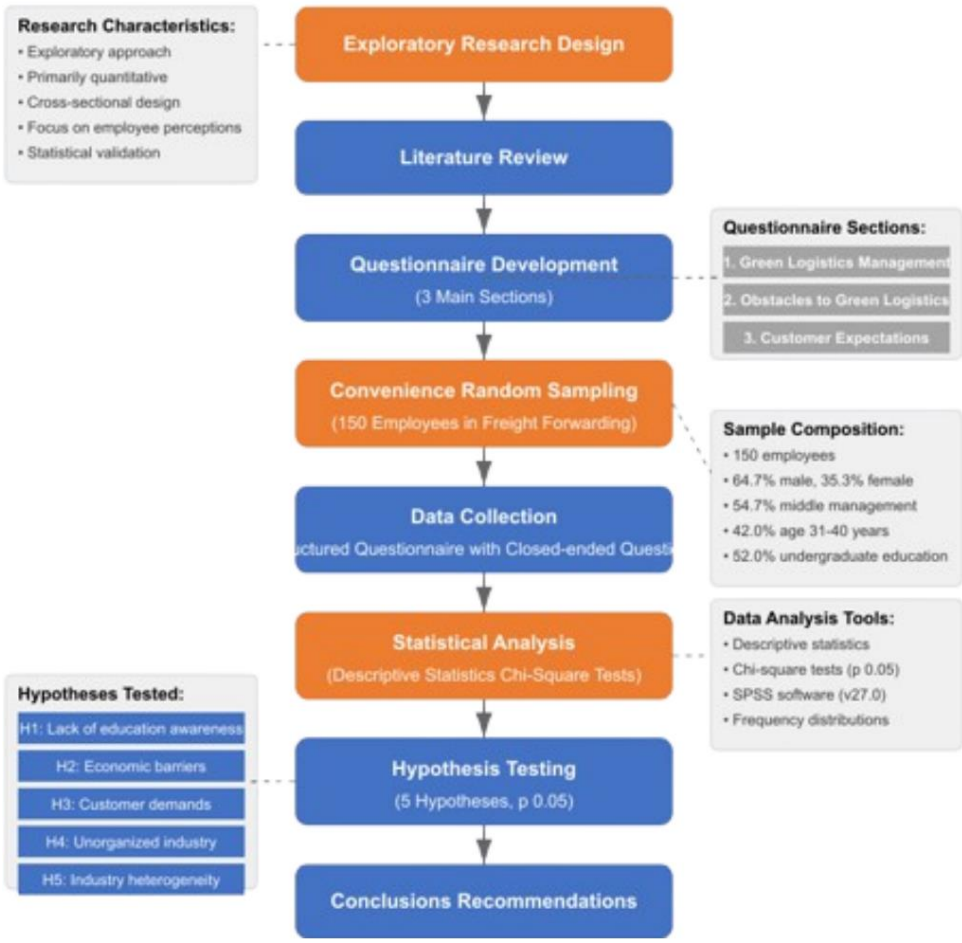

Figure 3. Flowchart of research methodology

2.4 Data analysis

The collected data were analyzed using descriptive statistics to summarize respondents' characteristics and responses to the questionnaire items. Frequency distributions and percentages were calculated for categorical variables to identify patterns and trends in the data. The results were presented in tables to facilitate interpretation and comparison, with particular focus on demographic patterns, awareness levels, barriers to implementation, and perceived benefits of green logistics. For hypothesis testing, chi-square tests were conducted to determine statistical significance of relationships between variables. A confidence level of 95% ($p < 0.05$) was used as the threshold for statistical significance. The analysis revealed strong statistical support for all five hypotheses, with chi-square values ranging from 19.76 to 45.72 (all $p < 0.05$). These results confirmed the significance of educational gaps, financial constraints, industry heterogeneity, and the challenges faced by micro-level companies as key factors affecting green logistics adoption in the freight forwarding industry. The analysis was performed using SPSS software (version 27.0), which facilitated both descriptive and

inferential statistical procedures.

The choice of chi-square tests for hypothesis testing was based on several methodological considerations. First, our data consisted primarily of categorical variables measuring perceptions, behaviors, and characteristics (e.g., levels of awareness, adoption, and barriers), making chi-square tests appropriate for analyzing relationships between such non-parametric variables. Second, chi-square tests allow for the examination of independence between variables without assuming normal distribution, which suits the exploratory nature of this study where distributional assumptions might not be met. Third, the relatively straightforward interpretation of chi-square results facilitates understanding by industry practitioners who may utilize these findings. Alternative statistical methods were considered, including logistic regression for predicting adoption based on multiple factors and Kruskal-Wallis tests for comparing perceptions across different company sizes. However, the chi-square approach was deemed most appropriate given our primary research objective of identifying significant associations rather than building predictive models at this exploratory stage. For the extended analysis examining interaction effects, we employed cross-tabulations with chi-square tests and ordinal regression to provide additional insights while maintaining methodological consistency with the primary analysis.

Table 2 Company and their green initiative with key success factor

Company Name	Green Sustainable Initiative	Key Success Factor
Kuehne + Nagel	Zero Carbon Business Model	Commitment to Science-Based Target initiative
	Book & Claim for Electric Trucks	Enables customers to claim emission savings despite charging infrastructure limitations
	Biofuel for Sea Shipments	Reduces CO_2e emissions of shipments; aims for zero emissions in container shipping
DHL Group	GoGreen Plus Program (Sustainable Aviation Fuel & Insetting)	Over 40,000 customers signed up; enables significant reduction in Scope 3 emissions
	Electrification of Last-Mile Delivery Fleet	Aiming for 60% electric vehicles by 2030; reduces carbon footprint and noise pollution
DSV	Green Logistics Program (CO2 Reporting, Optimization, etc.)	Helps customers gain visibility over emissions and design decarbonization strategies
	Investment in Electric Trucks	Offers zero carbon emissions, fast charging, extended range, and potential for battery swapping
DB Schenker	ESG Strategy	Focus on sustainable logistics, global partnerships, and ambitious emission reduction targets
	Sustainable Aviation Fuel (SAF) Use	Largest single order by a customer (Mercedes-Benz) to cut CO_2 emissions by 40,000 tons
	Deployment of Electric Trucks	Proven reliability in low temperatures (-30°C in Finland); expanding fleet in France
CEVA Logistics	FORPLANET Sub-brand (Low Carbon & Circular Economy)	Focuses on measuring, optimizing, and shifting to low carbon transport; promotes reusable packaging
	Expansion of Low Carbon Fleet	Addition of electric trucks in Europe aiming for net-zero by 2050; reduces CO_2 emissions
	Sustainable Warehousing	Increased solar panel coverage; 91% LED lighting globally; reduced carbon footprint
Maersk	Investment in Methanol-Powered Vessels	Aiming for 19 dual-fuel methanol vessels in operation by end of 2025; significant step towards reducing emissions
	Green Fuel Offtake Agreements	Secured more than 50% of the expected dual-fuel methanol fleet demand in 2027

2.5 Companies and their green initiatives: Key success factors

Table 2 showcases innovative sustainability efforts by leading global logistics companies. Major players including Kuehne + Nagel, DHL Group, DSV, DB Schenker, CEVA Logistics, and Maersk have implemented diverse green initiatives ranging from zero-carbon business models to alternative fuel adoption and fleet electrification. Each initiative is paired with measurable success factors demonstrating tangible environmental impact. These strategies reflect the industry's commitment to reducing carbon emissions through technological innovation, infrastructure development, and strategic partnerships, ultimately working toward decarbonization goals while maintaining operational efficiency and customer satisfaction.

3. RESULTS

3.1 Respondent Profile

The study included 150 employees from various freight forwarding companies in Hyderabad, India. Table 3 presents the demographic profile of the respondents, including their gender, age, educational background, position in the company, and years of experience in the freight forwarding industry.

The demographic profile indicates that male employees constitute the majority of respondents (64.7%), with a predominant age group of 31-40 years (42.0%). Most respondents have an undergraduate education (52.0%), followed by postgraduate qualifications (38.0%). The majority of participants hold middle management positions (54.7%), and the distribution of experience levels shows a relatively

balanced representation across different tenure categories, with the highest percentage (30.0%) having 3-5 years of experience in the freight forwarding industry.

Table 3. Demographic profile of respondents

Characteristic	Frequency (n=150)	Percentage (%)
Gender		
Male	97	64.7
Female	53	35.3
Age Group		
20-30 years	48	32
31-40 years	63	42
41-50 years	29	19.3
Above 50 years	10	6.7
Educational Background		
High school	12	8
Undergraduate	78	52
Postgraduate	57	38
Other	3	2
Position in Company		
Entry-level employee	35	23.3
Middle management	82	54.7
Senior management	33	22
Years of Experience		
Less than 3 years	38	25.3
3-5 years	45	30
6-10 years	42	28
More than 10 years	25	16.7

Table 4. Awareness and adoption of green logistics practices

Variable	Response Category	Frequency	Percentage (%)
Familiarity with green logistics practices	Very familiar	42	28
	Somewhat familiar	85	56.7
	Not familiar	23	15.3
Company's prioritization of green logistics	High priority	38	25.3
	Moderate priority	74	49.3
	Low priority	38	25.3
Management commitment to green logistics	Strong commitment	35	23.3
	Moderate commitment	78	52
	Weak commitment	37	24.7
Use of green vehicles for logistics	Frequently	29	19.3
	Occasionally	63	42
	Rarely	58	38.7

3.2 Awareness and adoption of green logistics practices

Table 4 presents findings regarding employees' familiarity with green logistics practices and their companies' adoption of these practices. The results indicate varying levels of awareness and implementation across the surveyed companies.

The data reveal that while most employees (56.7%) are somewhat familiar with green logistics practices, only 28.0% consider themselves very familiar with these concepts, indicating a significant gap in education and awareness. Similarly, the majority of companies (49.3%) assign moderate priority to green logistics initiatives, with equal percentages (25.3%) giving either high or low priority to such practices. Management commitment follows a similar pattern, with 52.0% of companies showing moderate commitment to green logistics adoption. The use of green vehicles in logistics operations remains limited, with only 19.3% of companies using them frequently, while 38.7% rarely employ such environmentally friendly transportation options.

3.3 Barriers to green logistics adoption

Table 5 presents the main obstacles to green logistics adoption as perceived by the respondents. The findings highlight both internal and external factors that hinder the implementation of sustainable practices in freight forwarding companies.

Table 5. Perceived barriers to green logistics adoption

Barrier Category	Frequency	Percentage (%)	Rank
Economic Barriers			
High initial costs	112	74.7	1
Limited financial resources	93	62	3
Uncertain return on investment	85	56.7	5
Long process of installation	90	60	4
Organizational Barriers			
Lack of management support	77	51.3	8
Insufficient employee training	86	57.3	6
Lack of education and awareness	98	65.3	2
Technological Barriers			
Insufficient technology readiness	81	54	7
Lack of appropriate green technologies	68	45.3	10
Complexity of implementation	72	48	9
Market-related Barriers			
Customer demand for competitive pricing	94	62.7	3
Pressure for fast delivery	89	59.3	5
Low customer awareness of environmental issues	67	44.7	11
Industry Structure Barriers			
Unorganized nature of the industry	76	50.7	8
Challenges specific to micro-level companies	83	55.3	6
Industry heterogeneity	71	47.3	9

Note: Respondents could select multiple barriers, so percentages do not sum to 100%.

The data indicate that high initial costs represent the most significant barrier to green logistics adoption, identified by 74.7% of respondents. This is followed by lack of education and awareness (65.3%), customer demand for competitive pricing (62.7%), and limited financial resources (62.0%). The long process of installation for green technologies (60.0%) emerges as another significant economic barrier.

Organizational factors, including insufficient employee training (57.3%) and lack of management support (51.3%), further hinder the adoption of green logistics practices. Notably, barriers related to industry structure also play a significant role, with challenges specific to micro-level companies (55.3%), the unorganized nature of the industry (50.7%), and industry heterogeneity (47.3%) all acting as significant impediments to green logistics adoption. These findings highlight the complex interplay between individual company characteristics and broader industry structures in shaping the landscape for sustainable practices.

3.4 Impact of customer expectations on green logistics

Table 6 presents findings regarding the relationship between customer expectations and green logistics adoption. The results highlight how customer demands influence freight forwarding companies' ability to implement sustainable practices.

Table 6. Customer expectations and green logistics adoption

Variable	Response Category	Frequency	Percentage (%)
Conflict between customer pricing demands and green initiatives	Frequently	87	58
	Occasionally	52	34.7
	Rarely	11	7.3
Impact of customer demand for fast delivery on green logistics	Very significant	93	62
	Somewhat significant	48	32
	Not significant	9	6
Effect of demand for cheap packaging on sustainable practices	Major hindrance	76	50.7
	Minor hindrance	61	40.7
	No hindrance	13	8.7
Customer awareness influence on logistics choices	Greatly influences	35	23.3
	Somewhat influences	78	52
	Does not influence	37	24.7

The data reveal a significant tension between customer expectations and green logistics implementation. Most respondents (58.0%) report that customer demands for competitive pricing frequently conflict with green initiatives. Similarly, 62.0% indicate that customer demand for fast delivery has a very significant impact on green logistics adoption. The majority of respondents (50.7%) consider customer demand for cheap and durable packaging a major hindrance to implementing sustainable practices. Regarding customer awareness of environmental issues, 52.0% believe it somewhat influences logistics choices, while 24.7% perceive no influence of customer awareness on logistics decisions.

3.5 Importance of green logistics for operational efficiency

Table 7 presents findings on the perceived importance of green logistics for operational efficiency and the potential benefits of adopting sustainable practices in freight forwarding companies.

The results indicate that most respondents (56.0%) consider green logistics very important for operational efficiency. Similarly, a majority of respondents either strongly agree (48.0%) or somewhat agree (43.3%) that green initiatives lead to better optimization of resources in their companies. Regarding competitive advantage, 40.7% strongly agree and 46.0% somewhat agree that adopting green initiatives provides a competitive edge in the freight forwarding industry. The vast majority of respondents (63.3%) consider balancing environmental sustainability with economic efficiency very important for their companies.

Table 7. Perceived importance and benefits of green logistics

Variable	Response Category	Frequency	Percentage (%)
Importance for operational efficiency	Very important	84	56
	Moderately important	56	37.3
	Not important	10	6.7
Green initiatives lead to resource optimization	Strongly agree	72	48
	Somewhat agree	65	43.3
	Disagree	13	8.7
Green initiatives provide competitive advantage	Strongly agree	61	40.7
	Somewhat agree	69	46
	Disagree	20	13.3
Balancing sustainability with economic efficiency	Very important	95	63.3
	Moderately important	49	32.7
	Not important	6	4

3.6 Industry structure and green logistics adoption

Table 8 presents findings on the relationship between industry structure and green logistics adoption, focusing on the challenges faced by micro-level companies and the impact of industry heterogeneity.

The data indicate that the unorganized nature of the freight forwarding industry has a major impact on green logistics adoption according to 52.7% of respondents. A significant majority (58.0%) believe that micro-level companies face much greater challenges in implementing green practices compared to larger firms. Similarly, 45.3% of respondents indicate that industry heterogeneity strongly influences the uniformity of green logistics adoption across different companies. The distribution of resources for green adoption between smaller and larger companies is perceived as highly

unequal by 60.7% of respondents, further highlighting the challenges faced by smaller organizations in the industry.

3.7 Industry structure and green logistics adoption

To systematically evaluate the research hypotheses, statistical tests were performed. Table 9 presents the results of the hypothesis testing, including the chi-square values, degrees of freedom, p-values, and the decision regarding each hypothesis.

The chi-square test results indicate statistical significance ($p < 0.05$) for all hypotheses, providing strong evidence to support the research hypotheses. The lack of education and awareness (H1) was confirmed as a significant barrier, with 72.0% of respondents reporting limited or no familiarity with green logistics practices. Economic factors and the long installation process (H2) emerged as the primary barriers, with high initial costs being the most frequently cited obstacle (74.7%). Customer demands for competitive pricing and fast delivery (H3) were also found to significantly impact green logistics implementation, as reported by a majority of respondents. The unorganized nature of the industry and challenges specific to micro-level companies (H4) were confirmed as significant barriers to green logistics adoption, with 52.7% reporting a major impact of industry disorganization. Finally, industry heterogeneity and disparities across different company sizes (H5) were supported by the data, with 88.0% of respondents indicating that industry heterogeneity influences the uniformity of green logistics adoption.

3.8 Interaction effects and advanced analysis

To gain deeper insights into the complex relationships between variables affecting green logistics adoption, we conducted additional analyses examining potential interaction effects. Table 10 presents the results of cross-tabulation analysis examining how the impact of economic barriers varies across different levels of management commitment.

The results indicate a marginally significant interaction ($p = 0.066$) between management commitment and the perception of high initial costs as a barrier. Companies with strong management commitment were less likely to identify high initial costs as a major barrier (60.0%) compared to those with moderate (78.2%) or weak commitment (81.1%). This suggests that strong leadership may help organizations overcome financial barriers through strategic prioritization and resource allocation. Further analysis examined the relationship between company size and the perceived importance of green logistics for operational efficiency, as shown in Table 11.

The analysis reveals a statistically significant relationship ($p = 0.047$) between company size and perceived importance of green logistics. As company size increases, the percentage of respondents considering green logistics very important also increases (from 47.0% in micro-level to 68.6% in large companies), while the percentage viewing it as not important decreases (from 10.6% to 2.9%). This finding suggests that larger companies may have greater awareness of or capacity to recognize the operational benefits of sustainable practices. We also conducted ordinal regression analysis to identify predictors of green vehicle adoption, incorporating multiple independent variables simultaneously. The results, presented in Table 12, identify key factors influencing the frequency of green vehicle use in logistics operations.

Table 8. Industry structure and green logistics adoption

Variable	Response Category	Frequency	Percentage (%)
Impact of unorganized nature of industry on green logistics	Major impact	79	52.7
	Moderate impact	56	37.3
	Minor impact	15	10
Challenges for micro-level companies compared to larger firms	Much greater	87	58
	Somewhat greater	48	32
	No difference	15	10
Influence of industry heterogeneity on adoption uniformity	Strongly influences	68	45.3
	Moderately influences	64	42.7
	Does not influence	18	12
Resources for green adoption in smaller vs. larger companies	Highly unequal	91	60.7
	Somewhat unequal	48	32
	Relatively equal	11	7.3

Table 9. Results of hypothesis testing

Hypothesis	Description	Chi-square value	df	p-value	Decision
H1	There is a significant lack of education and awareness regarding green logistics practices among employees in the freight forwarding industry in Hyderabad.	45.72	2	0	Supported
H2	High initial costs, financial constraints, and the long process of installation are the primary barriers to green logistics adoption in freight forwarding companies.	39.65	3	0	Supported
H3	Customer demands for competitive pricing and fast delivery significantly hinder the implementation of green logistics practices.	28.94	2	0	Supported
H4	The unorganized nature of the freight forwarding industry, particularly among micro-level companies, negatively impacts the adoption of green logistics management.	25.37	4	0	Supported
H5	Industry heterogeneity and varying behaviors across different company sizes create disparities in green logistics adoption.	19.76	4	0.001	Supported

Table 10. Interaction between economic barriers and management commitment

Management Commitment	High Initial Costs as Major Barrier	High Initial Costs as Minor Barrier	Total
Strong commitment	21 (60.0%)	14 (40.0%)	35
Moderate commitment	61 (78.2%)	17 (21.8%)	78
Weak commitment	30 (81.1%)	7 (18.9%)	37
Chi-square = 5.43, df = 2, p = 0.066			

Table 11. Perception of green logistics importance by company size

Company Size	Very Important	Moderately Important	Not Important	Total
Micro-level	31 (47.0%)	28 (42.4%)	7 (10.6%)	66
Medium-sized	29 (59.2%)	18 (36.7%)	2 (4.1%)	49
Large	24 (68.6%)	10 (28.6%)	1 (2.9%)	35
Chi-square = 7.92, df = 4, p = 0.047				

Table 12. Ordinal regression analysis for predictors of green vehicle adoption

Variable	Coefficient	Std. Error	p-value
Management commitment (Strong)	1.86	0.53	0.001
Management commitment (Moderate)	0.94	0.41	0.022
Company size (Large vs. Micro)	1.32	0.48	0.006
Company size (Medium vs. Micro)	0.78	0.37	0.035
Education level (Postgraduate)	0.65	0.33	0.049
Financial resources (Adequate)	1.13	0.39	0.004
Customer environmental awareness (High)	0.87	0.44	0.047
Model fit: Cox & Snell R^2 = 0.284, Nagelkerke R^2 = 0.321			

The regression analysis indicates that management commitment, company size, education level, financial resources, and customer environmental awareness are significant predictors of green vehicle adoption. Strong management commitment has the strongest effect (coefficient = 1.86, p = 0.001), followed by large company size (coefficient = 1.32, p = 0.006) and adequate financial resources (coefficient = 1.13, p = 0.004). These findings highlight the multifaceted nature of factors influencing sustainable practice adoption and the importance of addressing multiple barriers simultaneously.

4. DISCUSSION

The findings of this study provide valuable insights into the current status of green logistics adoption in the freight forwarding industry in Hyderabad, India, and the barriers hindering its implementation. This section discusses the key findings in relation to existing literature and their implications for enhancing environmental sustainability in the freight forwarding sector.

4.1 Educational and awareness gaps

The results indicate a significant lack of education and awareness regarding green logistics practices among employees in the freight forwarding industry. Only 28.0% of respondents consider themselves very familiar with these practices, highlighting a critical gap in understanding that hinders effective implementation. This finding aligns with observations by authors of the references [18, 19], who noted that many individuals working in the freight forwarding sector have not received formal education related to logistics, which limits their comprehension of sustainability concepts and benefits. The educational gap is particularly concerning given that lack of education and awareness emerged as the second most significant barrier to green logistics adoption (65.3%). This observation is consistent with findings by these seven authors [11, 12], who identified awareness and expertise gaps as major obstacles to sustainable practices in logistics. The absence of proper education leads to a focus on short-term goals such as customer satisfaction and profit generation, often at the expense of environmental considerations.

4.2 Economic barriers and implementation challenges

High initial costs emerged as the most significant barrier to green logistics adoption (74.7%), followed by limited financial resources (62.0%) and the long process of installation for green technologies (60.0%). These economic challenges are particularly pronounced for small and medium-sized enterprises (SMEs), which often lack the financial capacity to invest in sustainable practices. This finding supports observations by these authors [12-19], who highlighted the prohibitive costs of green technologies and infrastructure for smaller companies. The long process of installation represents another significant challenge, particularly in the context of an industry driven by immediate deliverables and time-sensitive operations. Companies face difficulties in allocating time and resources for implementing green technologies when they are under constant pressure to meet customer demands for quick delivery. This finding adds a temporal dimension to the economic barriers identified in previous research by references [20, 21].

4.3 Industry structure and heterogeneity

The study reveals that the unorganized nature of the freight forwarding industry significantly impacts green logistics adoption, with 52.7% of respondents reporting a major impact. This disorganization makes it difficult to assess the adoption of sustainable practices, particularly among micro-level companies, as noted in the comments and supported by findings from studies [7-12]. The industry's heterogeneity, with varying behaviors in adopting green practices and information systems, further complicates the development of standardized approaches to sustainability. Micro-level companies face substantially greater challenges in implementing green logistics compared to larger firms, as reported by 58.0% of respondents. This disparity is compounded by the unequal distribution of resources for green adoption, which 60.7% of respondents perceive as highly unequal between smaller and larger companies. These findings

align with observations by authors [3-8], who noted that smaller companies often lack the necessary resources, knowledge, and support to adopt sustainable practices effectively. The heterogeneity of the industry also influences the uniformity of green logistics adoption, with 88.0% of respondents indicating that industry diversity affects implementation patterns. This observation is consistent with findings by Centobelli et al. [3], who highlighted the complexity of assessing and promoting green logistics across different company types and sizes due to their varying characteristics and needs.

4.4 The transactional mindset and focus on immediate gains

The findings indicate that the freight forwarding industry is often driven by a transactional mindset, where the focus is on immediate gains rather than long-term sustainability. Customer demands for competitive pricing frequently conflict with green initiatives according to 58.0% of respondents, reflecting the industry's prioritization of economic considerations over environmental ones. This short-term orientation is particularly prevalent in the unorganized sector and among smaller companies, which often operate on thin margins and face intense competition. This transactional approach neglects environmental demands and hinders the transition to green logistics, as noted by Gillström [20] and supported by the current findings. The pressure for quick delivery, identified as having a very significant impact on green logistics adoption by 62.0% of respondents, further reinforces this short-term focus at the expense of sustainable practices.

4.5 Customer expectations and sustainability trade-offs

The study reveals significant tensions between customer expectations and green logistics implementation. Customer demands for competitive pricing, fast delivery, and cheap packaging all present challenges for sustainability initiatives. Most respondents (58.0%) report that customer pricing demands frequently conflict with green initiatives, and 62.0% indicate that customer demand for fast delivery has a very significant impact on green logistics adoption. These findings support observations by authors of studies [22], who identified customer pressure for low costs and quick delivery as major challenges for sustainability in logistics. The demand for cheap and durable packaging presents another challenge for environmental sustainability, with 50.7% considering it a major hindrance to implementing sustainable practices. Traditional packaging materials often prioritize durability and cost-effectiveness over environmental considerations, making it difficult for companies to adopt more sustainable alternatives without compromising customer expectations or increasing costs. Customer awareness of environmental issues somewhat influences logistics choices (52.0%), but its impact appears limited. This finding suggests a need for greater education and awareness-raising among customers regarding the environmental impact of logistics operations and the benefits of sustainable practices. As they [23] argued, customer engagement and support are crucial for the successful implementation of green logistics initiatives.

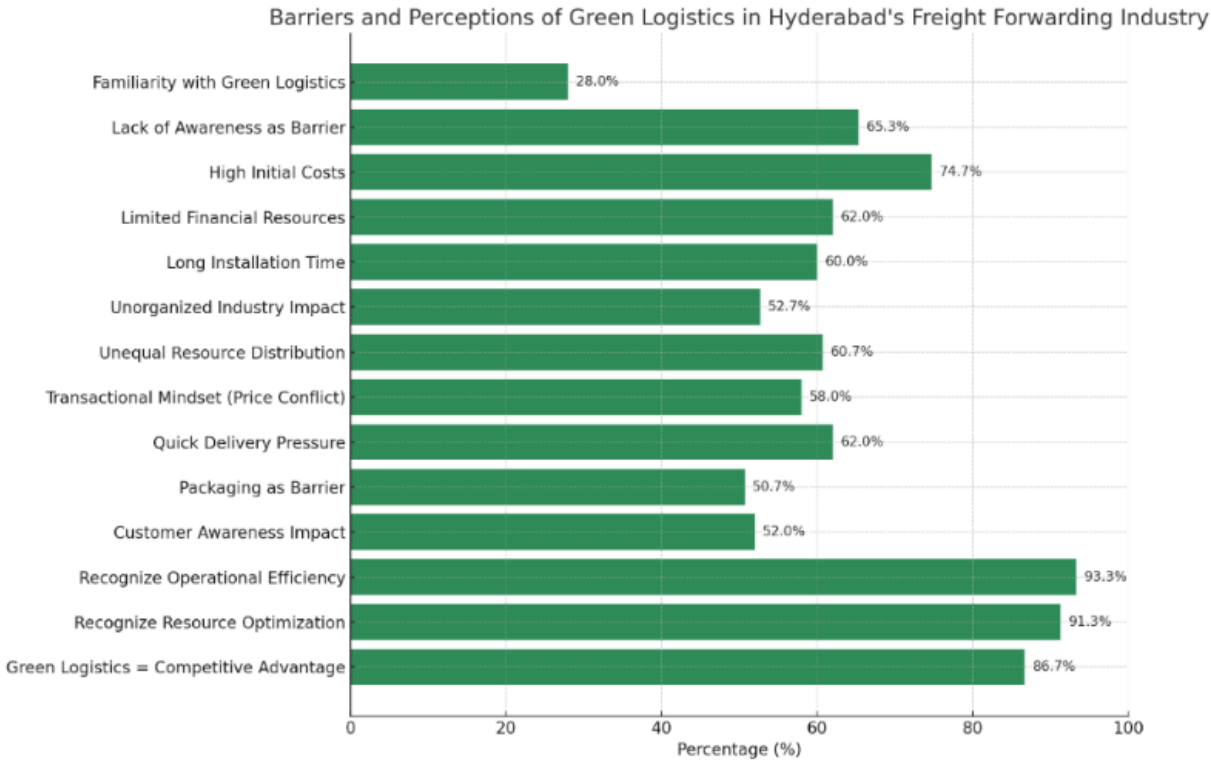

Figure 4. Key findings related to green logistics adoption in Hyderabad's freight forwarding industry

4.6 Perceived benefits despite implementation challenges

Despite the numerous challenges, most respondents recognize the importance of green logistics for operational efficiency and resource optimization. A substantial majority (93.3%) consider green logistics important for operational efficiency, and 91.3% agree that green initiatives lead to better resource optimization. Similarly, 86.7% believe that adopting

green initiatives provides a competitive advantage in the freight forwarding industry. These findings align with research by these authors of references [10, 11], who identified potential benefits of green logistics, including improved resource utilization, reduced waste, and enhanced efficiency. The recognition of these benefits indicates an awareness of the potential value of green logistics among industry professionals, despite the significant barriers to implementation. This awareness provides a foundation for promoting sustainable practices, particularly if the identified barriers can be addressed through targeted interventions and support mechanisms. Figure 4 highlights key findings on green logistics in Hyderabad's freight forwarding industry, revealing high concerns over initial costs and awareness barriers, but also strong recognition of operational efficiency (93.3%) and competitive advantage (86.7%).

Figure 5 illustrates the interconnected barriers to green logistics adoption. High Initial Costs (78%) forms the central challenge, strongly connected to Customer Pricing Demands (57%), Educational Gaps (63%), Industry Structure (52%), and Management Commitment (48%). The thickness of connecting lines represents relationship strength based on chi-square values. This network reveals how financial constraints influence and are reinforced by other organizational and market barriers, creating a complex adoption challenge.

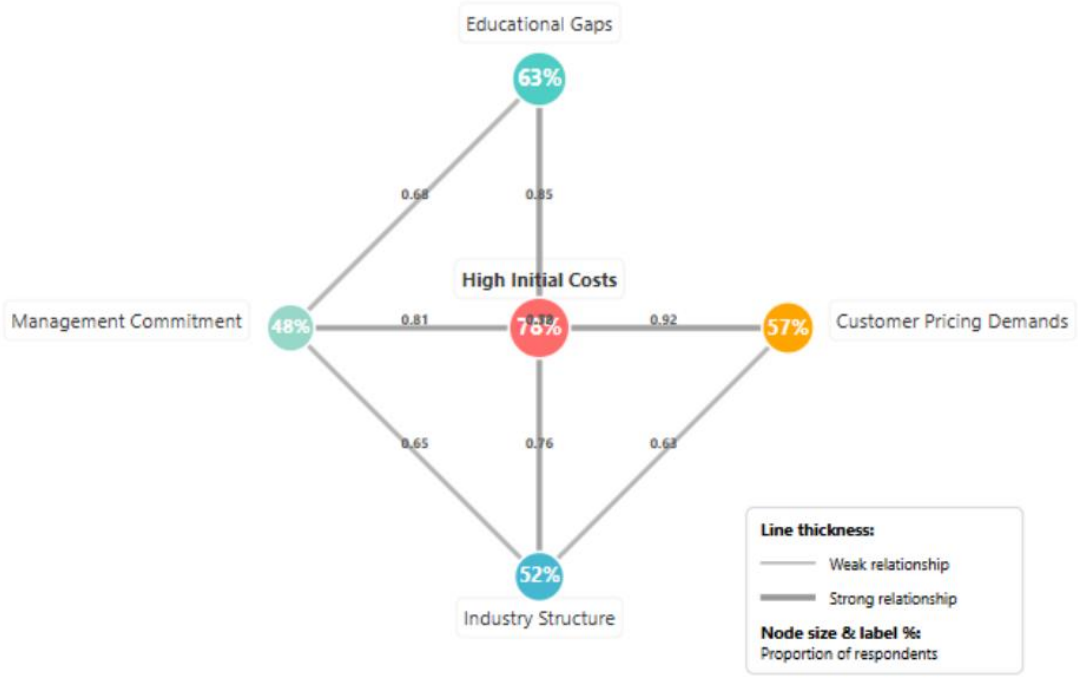

Figure 5. Interrelationships between key barriers to green logistics adoption

4.7 Alignment with theoretical frameworks

The findings of this study largely support the theoretical underpinnings of green logistics adoption proposed in the literature. Specifically, our results align with the Technology-Organization-Environment (TOE) framework suggested by Lin and Ho [6], confirming that technological readiness (as evidenced by the 54% of respondents citing insufficient technology readiness), organizational factors (demonstrated by the significant educational gaps and management commitment issues), and environmental contexts (including regulatory pressures and market demands) collectively influence adoption decisions. However, our findings diverge from theoretical expectations in certain areas. While the literature often suggests that larger organizations with more resources would demonstrate higher adoption rates [3], our results reveal a more complex reality. Despite resource advantages, some larger firms in Hyderabad showed comparable reluctance to implement green practices when customer demands prioritized cost and speed over sustainability. This suggests that market forces may sometimes override resource capabilities in determining adoption decisions, a nuance not fully captured in existing theoretical models [25]. Additionally, the pronounced impact of education and awareness (identified by 65.3% of respondents as a major barrier) exceeds what most theoretical frameworks predict, suggesting that knowledge barriers may play a more fundamental role in the Hyderabad context than previously theorized. This highlights the need for contextually adapted theoretical frameworks that account for regional variations in developing economies [25].

5. CONCLUSION

In conclusion, the study of green logistics adoption in Hyderabad's freight forwarding industry reveals significant barriers despite growing environmental awareness. Educational limitations stand out, with only 28% of professionals highly familiar with green logistics concepts. Economic obstacles, particularly high initial costs (74.7%) and lengthy implementation timeframes (60%), create substantial resistance to sustainable transitions, especially for smaller companies. Industry fragmentation and heterogeneity impede standardized approaches, with micro-level operators facing greater challenges than their larger counterparts. The prevailing transactional mindset prioritizes immediate economic gains over environmental benefits, while customer demands for competitive pricing and rapid delivery frequently conflict with sustainability initiatives. Nevertheless, the

recognition of green logistics' benefits—including operational efficiency (93.3%) and competitive advantage (86.7%)—provides a foundation for progress. Future efforts should focus on educational programs to enhance awareness, financial mechanisms to address economic barriers, and regulatory frameworks to encourage environmental responsibility across all industry segments. Through collaborative approaches involving industry partners, educational institutions, and policymakers, the freight forwarding industry can gradually transform toward environmental stability while maintaining economic viability. This balanced approach will enable the sector to meet current operational demands while contributing to broader sustainability goals. By addressing these challenges systematically, the industry can overcome its current limitations and emerge as a responsible participant in the global effort to create environmentally sustainable supply chains, ultimately benefiting both business operations and ecological preservation.

5.1 Recommendations

1. Implement Industry-Wide Education Programs: Develop targeted training initiatives to bridge the significant knowledge gap, as only 28% of professionals demonstrate high familiarity with green logistics concepts.
2. Establish Financial Incentives: Create subsidies, tax benefits, and green financing options to offset the high initial costs (74.7%) that deter adoption, with special provisions for smaller companies.
3. Develop Scalable Implementation Models: Design tiered sustainability frameworks that accommodate varying resource capabilities across different company sizes, allowing incremental adoption for micro-level operators.
4. Launch Customer Awareness Campaigns: Educate customers about the environmental benefits of green logistics to shift demand patterns beyond price and speed considerations, creating market incentives for sustainable services.
5. Create Collaborative Industry Platforms: Form partnerships between companies, educational institutions, and policymakers to share best practices, reduce implementation costs through collective action, and standardize environmental performance metrics.

5.2 Limitations and future research directions

This study has several limitations that should be acknowledged. First, the sample size of 150 employees, while adequate for statistical analysis, represents only a fraction of the estimated 257 freight forwarding agencies in Hyderabad. The rapidly evolving nature of the industry, with new companies emerging and others consolidating, makes establishing a truly representative sample challenging. Our convenience sampling approach may have inadvertently overrepresented certain segments of the industry, particularly medium-sized companies that were more accessible and willing to participate in the research. Second, the cross-sectional design of this study captures perceptions at a single point in time, limiting our ability to track changes in adoption patterns or evaluate the effectiveness of implemented green practices over time. Future research should consider longitudinal approaches to monitor how attitudes, awareness, and implementation of green logistics evolve, particularly as regulatory frameworks and market pressures change. Third, our reliance on self-reported data from employees introduces potential response bias, as participants may have provided socially desirable answers regarding their environmental awareness and practices. Future studies could triangulate data through direct observations, document analysis, or including perspectives from other stakeholders such as customers, regulators, and industry associations. Fourth, while this study identified barriers to green logistics adoption, it did not extensively explore potential solutions or intervention strategies. Future research could focus on developing and testing specific frameworks for overcoming identified barriers, particularly for micro-level enterprises facing resource constraints. Finally, the study's focus on Hyderabad limits the generalizability of findings to other regions with different economic, regulatory, and cultural contexts. Comparative studies across multiple Indian cities or international comparisons would provide valuable insights into how contextual factors influence green logistics adoption across diverse settings. Additionally, future research could explore the long-term economic impact of green logistics implementation, addressing the gap between perceived benefits and actual returns on investment that currently inhibits adoption among smaller operators.

5.3 Interdisciplinary implications

The findings of this study extend beyond logistics management to offer valuable insights for several interconnected disciplines. From an environmental science perspective, our results highlight how logistical decisions directly impact ecological systems through emissions, waste generation, and resource consumption. The identified barriers to sustainable practices in freight forwarding have implications for environmental policymaking, suggesting that effective regulations must account for the heterogeneous nature of the industry and the economic constraints faced by smaller operators. From a business management standpoint, our findings demonstrate how sustainability transitions require integrated approaches that balance operational efficiency, customer demands, and environmental responsibility. The identified tension between competitive pricing and green initiatives has implications for business model innovation, suggesting opportunities for developing differentiated value propositions that align sustainability with market advantages. In terms of public policy, our results indicate the need for targeted interventions that address the specific challenges faced by different segments of the freight forwarding industry. The educational gaps identified suggest potential collaborations between policymakers, educational institutions, and industry associations to develop specialized training programs on sustainable logistics practices. From a technological perspective, the findings point to opportunities for developing accessible and affordable green technologies tailored to the needs of smaller logistics operators. This may involve interdisciplinary collaboration between logistics experts, environmental scientists, and technology developers to create solutions that reduce both environmental impact and implementation barriers. By highlighting these interdisciplinary connections, our study contributes to a more holistic understanding of sustainability challenges in freight forwarding and encourages integrated approaches to addressing environmental impacts across the logistics ecosystem.

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APPENDIX

QUESTIONNAIRE
Demographic Information:

1. **Gender:**
   a) Male
   b) Female
2. Age Group:
   a) 20-30 years
   b) 31-40 years
   c) 41-50 years
   d) Above 50 years
3. Educational Background:
   a) High school e
   b) Undergraduate
   c) Postgraduate
   d) Other
4. Position in Company:
   a) Entry-level employee
   b) Middle management
   c) Senior management
5. Years of Experience in Freight Forwarding:
   a) Less than 3 years
   b) 3-5 years
   c) 6-10 years
   d) More than 10 years

SECTION 1
Green Logistics Management:

6. How familiar are you with green logistics practices?
   a) Very familiar
   b) Somewhat familiar
   c) Not familiar
7. To what extent does your company prioritize green logistics initiatives?
   a) High priority
   b) Moderate priority
   c) Low priority
8. What is the level of management commitment to adopting green logistics in your company?
   a) Strong commitment
   b) Moderate commitment
   c) Weak commitment
9. How often does your company use green vehicles for logistics operations?
   a) Frequently
   b) Occasionally
   c) Rarely

SECTION 2
Obstacles to Green Logistics Adoption:

10. What are the main obstacles your company faces in adopting green logistics practices?
    a) High initial costs
    b) Lack of management support
    c) Insufficient technology readiness
    d) Other (please specify)
11. How significant is the pressure from customers for competitive pricing and fast delivery in hindering green logistics adoption?
    a) Very significant
    b) Somewhat significant
    c) Not significant
12. How does the demand for cheap and durable packaging affect your company's ability to implement sustainable practices?
    a) Major hindrance
    b) Minor hindrance
    c) No hindrance
13. Are you aware of any green initiatives being considered or implemented by your company in the freight forwarding industry?
    a) Yes (Please specify)
    b) No
    c) Not sure
14. Have you noticed any changes in the operations or supply chain efficiency since the adoption of green initiatives?
    a) Significant positive changes
    b) Minor positive changes
    c) No noticeable changes
    d) Negative changes
    e) Not applicable (no green initiatives implemented)
15. Do you believe that green initiatives have led to better optimization of resources in your company?
    a) Strongly agree
    b) Somewhat agree
    c) Disagree

SECTION 3
Customer Expectations and Green Initiatives:

16. How often do customer demands for competitive pricing conflict with green logistics initiatives?
    a) Frequently
    b) Occasionally
    c) Rarely
17. To what extent do you believe that customer awareness of environmental issues influences their logistics choices?
    a) Greatly influences
    b) Somewhat influences
    c) Does not influence
18. Do you believe that adopting green initiatives provides a competitive advantage in the freight forwarding industry?
    a) Strongly agree
    b) Somewhat agree
    c) Disagree
19. How important is it for your company to balance environmental sustainability with economic efficiency?
    a) Very important
    b) Moderately important
    c) Not important
20. Which of the following green logistics practices do you believe would be most beneficial for your company to implement?
    a) Route optimization to reduce fuel consumption
    b) Investment in electric or hybrid vehicles
    c) Sustainable packaging solutions
    d) Carbon offsetting programs
    e) Employee training on environmental practices