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Major Research Project on

Impact of Sustainable Logistics in Supply Chain

Submitted By

Rahul Singh

2K23/DMBA/095

Under the Guidance of

Dr Mohd Shuaib

Delhi School of Management

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Bawana Road

Delhi - 110042

CERTIFICATE

This is to certify that the Major Research Project titled "**Impact of Sustainable Logistics in Supply Chain**" is a bonafide record of work carried out by Rahul Singh in partial fulfillment of the requirements for the award of the degree of Master of Business Administration at Delhi School of Management, Delhi Technological University.

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DECLARATION

I hereby declare that the Major Research Project titled "**Impact of Sustainable Logistics in Supply Chain**" submitted by me is an original work and has not been submitted earlier either to this university or to any other institution for the fulfillment of the requirement for any course of study.

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ACKNOWLEDGEMENT

I take this opportunity to express my sincerest gratitude to everyone who helped and guided me in the successful completion of my Major Research Project.

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EXECUTIVE SUMMARY

In the midst of rising climate change, natural resource depletion, and global environmental issues, the function of logistics in molding sustainable development has become more crucial than ever. This research, "Impact of Sustainable Logistics in Supply Chain," delves into the revolutionary capacity of combining environmentally friendly practices across all logistics activities, and how such combination affects the efficiency, economics, and ethics of contemporary supply chains.

Green logistics, or sustainable logistics, refers to strategies to reduce the environmental footprint of logistics activities. These involve optimizing transportation methods, lowering energy usage in warehouses, reducing packaging, and facilitating circular supply chain models that allow for reuse and sustainable disposal. With increasingly globalized supply chains and complex networks, making sustainability integral to every step of the logistics process has arisen as a strategic necessity, not simply an environmental requirement.

35 The main purpose of this study is to measure the environmental, economic, and social effects of green logistics practices and also to determine the main barriers to implementation and recommend feasible measures for effective implementation. The research is informed by five main objectives:

- In order to assess how green logistics can minimize carbon emissions and maximize environmental stewardship;
- To identify economic trade-offs and long-term operating advantages;
- In order to analyze the wider social aspects, including jobs in green industries and enhanced job safety;
- To compare with industry leaders' global best practices;
- To suggest scalable recommendations that are industry-specific and region-based.

Methodologically, the research takes a cross-regional and cross-sectoral approach and identifies priority sectors like retail, manufacturing, logistics services, and e-commerce. Although the research draws on global learnings, it places particular emphasis on the Indian supply chain environment, which is marked by urbanization, infrastructural heterogeneity, and changing policy environments. The research focuses on four main areas of sustainable logistics:

- **Green Transportation: From electric cars, route routing, and alternative fueling;**
- **Eco-Friendly Packaging: Biodegradable and recyclable materials use.**
- **Energy-Efficient Warehousing: Use of renewable energy and intelligent systems;**
- **Circular Supply Chain Models: Encouraging reuse, recycling, and reverse logistics.**

Major conclusions of the research emphasize that despite the fact that advantages of sustainable logistics are widely known, some challenges prevent them from being implemented on a wide scale, such as:

- Excessive upfront capital expenditure;
- Limited availability of new technologies;
- Lack of generalized sustainability measurement;
- Regional regulatory fragmentation;
- Short-term business agendas and organizational inertia.

From a thorough literature review, analysis of the industry, and observation of case studies, the study concludes the necessity of policy intervention, democratization of technology, stakeholder awareness, and cross-functional coordination to foster the shift towards green logistics.

The research establishes that sustainable logistics is not only feasible but essential to long-term business viability. It provides quantifiable benefits in cost savings, brand equity, regulatory compliance, and risk reduction. Businesses investing in sustainable logistics today set themselves up as future-proof leaders well-positioned to succeed in a rapidly environmentally conscious global market.

Through integration of theoretical knowledge and real-world applications, this dissertation seeks to act as an extensive reference for supply chain managers, sustainability officers, business executives, and policymakers wishing to align logistics practices with the world agenda for sustainability, innovation, and shared growth.

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1. INTRODUCTION

1.1 Background

In the globalized economy of the present day, supply chains have become even more complicated, crossing continents and involving a number of stakeholders at each step. But this complexity has been acquired at a tremendous cost to the environment. The logistics industry—transportation, warehousing, packaging, and distribution—has become one of the principal culprits for environmental degradation. In reaction, the idea of sustainable logistics, also commonly known as green logistics, has become popular as a vital paradigm for revisiting and revising supply chain activity.

Sustainable logistics means the combination of environmental best practices throughout the entire supply chain. Its general aim is to minimize the environmental impact of logistics operations without compromising efficiency, cost savings, and service quality. This means routing transport in the most effective way possible to save fuel, using low-emission vehicles, going to renewable energy sources in warehouses, saving waste when packaging, and facilitating circular processes like reverse logistics and recycling.

One of the key drivers behind this movement is the increasing awareness of the role that the logistics industry plays in climate change. Transport alone accounts for almost 25% of global CO_2 emissions, a figure set to increase with the exponential growth of e-commerce, world freight demand, and just-in-time delivery systems. For sustainable logistics, then, not only is it an environmental imperative but also an economic and reputational one. Governments across the globe are imposing stricter regulations on carbon emission and fuel efficiency, and consumers are increasingly becoming green-conscious in their buying patterns.

At the same time, technology is taking center stage to facilitate the shift. Technologies like Artificial Intelligence (AI) and Machine Learning (ML) are driving predictive analytics and route optimization, drastically reducing delivery miles and fuel consumption. The use of Electric Vehicles (EVs), other fuels such as Compressed Natural Gas (CNG) and Hydrogen, and automated warehouses with solar power and intelligent

lighting systems are revolutionizing logistics infrastructure. In addition, the Internet of Things (IoT) is enhancing energy monitoring and real-time tracking, making transparency as well as efficiency better.

Firms that integrate sustainable logistics into their business are realizing several advantages. These are long-term cost savings, alignment with international standards of sustainability, improving stakeholder confidence, and ESG ranking competitiveness. Therefore, sustainability is no longer considered a box to be ticked as a matter of compliance but as an integral strategy for risk management, innovation, and leadership in the market.

This research attempts to determine how sustainable logistics is transforming the future of supply chains, the issues organizations encounter in adopting these practices, and the real-world effect on business performance and the environment. Through the examination of existing trends, technology, and actual practices, this study endeavors to underscore the power of transformation of sustainable logistics as an enabler of resilient and responsible supply chains.

1.2 Problem Statement

In spite of the increasing international focus on environmental sustainability and the known advantages of green logistics, the take-up of sustainable logistics practices in supply chains continues to be sluggish and patchy. Although pioneering companies in developed economies are starting to adopt sustainable innovations, many organizations—particularly in developing markets and among small and medium-sized enterprises (SMEs)—still experience major barriers.

This shift from traditional to sustainable logistics is not without hurdles. The main hurdles are:

- **Financial Constraints**

  High upfront costs associated with:

  - Electric Vehicles (EVs)

- Renewable energy systems
- Smart warehousing technologies

These deter especially smaller firms that struggle to justify long-term returns on investment.

- **Technological Gaps**
  - Limited access to tools such as AI, IoT, and blockchain
  - Inadequate technical know-how to integrate these into logistics workflows
- **Lack of Standardization**
  - Absence of universally accepted sustainability benchmarks or KPIs
  - Increased risk of **greenwashing**, which damages stakeholder trust
- **Regulatory Complexity**
  - Varying environmental regulations across geographies
  - Difficulty in implementing a consistent and compliant sustainability strategy across borders
- **Behavioral Resistance**
  - Short-term financial priorities overshadowing long-term sustainability goals
  - Organizational inertia and reluctance to change traditional workflows

These obstacles not only hinder the widespread adoption of sustainable logistics but also undermine the overall efficacy and validity of green supply chain efforts.

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The purpose of this research is:

- To explore the most significant barriers to implementing sustainable logistics practices

- To examine their effect on operational performance and supply chain sustainability
- To provide actionable, scalable solutions that align environmental with business objectives

With an understanding of these issues in detail, the research aims to facilitate the creation of actionable frameworks for establishing resilient and environmentally sustainable supply chains.

1.3 Objectives of the Study

The central aim of this study is to explore the role, importance, and real effect of sustainable logistics on the development of contemporary supply chain structures. By examining the environmental, economic, and societal aspects, this study seeks to offer a holistic picture of how sustainable logistics activities contribute to organizational performance as well as global sustainability objectives.

The objectives of the study are as follows:

- **To assess the environmental impact of sustainable logistics practices** Evaluate how the adoption of green logistics measures—such as cleaner transportation, energy-efficient warehousing, and waste reduction—contributes to the reduction of carbon emissions, resource consumption, and overall ecological footprint.
- **To analyze the economic implications and trade-offs involved** Examine the cost-benefit dynamics of implementing sustainable logistics solutions, including their effect on operational efficiency, long-term cost savings, risk mitigation, and competitiveness in the global marketplace.
- **To explore the social benefits of sustainable logistics adoption** Investigate how sustainable logistics initiatives can promote job creation in green sectors, enhance occupational health and safety, and strengthen community engagement through ethical and transparent supply chain practices.

- **To benchmark global best practices and successful case studies** Identify and evaluate industry-leading examples of companies that have effectively integrated sustainable logistics into their operations, drawing key lessons and transferable insights from their strategies and outcomes.
- **To formulate practical, actionable strategies for implementation** Develop a set of realistic and scalable recommendations tailored to organizations across different sectors and regions, accounting for their specific resource limitations, infrastructure readiness, and regulatory contexts.

1.4 Scope of the Study

This research takes a cross-regional and cross-sectoral perspective to study the adoption and effects of sustainable logistics in new supply chains. The focus is on several industries like retail, manufacturing, logistics services, and e-commerce to ensure that different strategies, issues, and results related to environmentally friendly logistics are met across various operating conditions.

While the study harnesses world best practices and trends in order to create a general overview, it has a strong focus on the Indian context, where the interactions of accelerating industrialization, urban growth, and changing regulatory environments create a distinctive canvas for sustainable change.

The research concentrates on the following major areas of sustainable logistics:

- **Green Transportation**
  - Use of electric and hybrid vehicles
  - Route optimization using digital tools
  - Adoption of low-emission or alternative fuels
- **Eco-Friendly Packaging**

- Implementation of recyclable, compostable, or biodegradable packaging materials
- Reduction of single-use plastics and excess packaging

- **Energy-Efficient Warehousing**
  - Integration of smart systems (lighting, HVAC, automation)
  - Utilization of renewable energy sources such as solar or wind power
- **Circular Supply Chain Models**
  - Practices that support product reuse, recycling, remanufacturing, and responsible end-of-life disposal
  - Reverse logistics systems that enable material recovery and waste minimization

Through the exploration of these domains, the study aims to:

- Appreciate how sustainable logistics supports the three pillars of sustainability: environmental conservation, social stewardship, and economic success—the triple bottom line (People, Planet, Profit)
- Provide practical insights and frameworks to practitioners, policymakers, and supply chain leaders to implement or improve sustainability in logistics operations
- Close the gap between practice and theory by pointing out both the operational realities and the strategic potential of sustainable logistics projects

This research is **exploratory and applied in nature**, focusing on identifying scalable solutions that can be adapted across industries and regions with varying levels of infrastructure and resource availability.

2. LITERATURE REVIEW

Sustainable logistics has become a key area of emphasis among supply chain management activities, with the goal of balancing the historically conflicting goals of economic performance and environmental protection. While climate change pressures have mounted globally, logistics systems are being called upon more and more to cut their ecological impact while meeting or exceeding performance expectations. Rodrigue (2021) cites that sustainable logistics operational practices extend beyond environmental value in addressing resource efficiency and improving social and economic resilience. This literature review integrates such crucial academic and industry observations on the adoption, influence, and issues of sustainable logistics in various operational areas.

2.1 Green Transportation and Logistics Technologies

Transportation is one of the major contributors to supply chain CO_2 emissions, reporting close to 25% of global CO_2 emissions (IEA, 2022). Green transport has thus emerged as a dominant topic in the field of sustainable logistics. These cover:

- Usage of electric and hybrid fleets of vehicles
- Usage of alternative fuels like biodiesel, LNG, and hydrogen
- AI-based route optimization to save mileage and fuel usage

Research indicates that organizations employing AI and IoT-based solutions are able to reduce fuel consumption and delivery time by as much as 20% (FarEye, 2023). For instance, DHL has introduced electric delivery vans and predictive routing engines to reduce emissions substantially, establishing best practices for logistics service providers.

These practices not only reduce the environmental footprint but also increase fleet efficiency and reliability of delivery, proving that ecological and operational aspirations can converge through technological intervention

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2.2 Reverse Logistics and Circular Economy Practices

The rise of the **circular economy** has placed **reverse logistics** at the forefront of sustainable supply chain design. This involves:

- Return and reuse of products or packaging
- Recycling and remanufacturing of components
- Recovery of value from end-of-life goods

Reverse logistics is claimed to reduce dependency on virgin materials as well as curtail landfill disposal by Sarkis (2012). It presents economic benefits as well, for example, minimized cost of production and new profits through the rehabilitation of products.

HP and Apple, among other companies, have shown effective reverse logistics models by recovering used products and reintroducing components into the production cycle, improving cost efficiency as well as leadership in brand sustainability.

2.3 Sustainable Warehousing and Infrastructure Optimization

Warehousing operations—traditionally energy-intensive—offer substantial potential for environmental optimization. Literature highlights several key interventions:

- **Installation of solar panels** to power facilities
- **Energy-efficient HVAC and lighting systems**
- **Use of recyclable or biodegradable packaging materials**
- **Automation technologies** to reduce energy waste

Mahindra Logistics, for instance, has pioneered solar-powered warehouses and green buildings in India, reporting a 40% decrease in energy costs. Research indicates that sustainable warehousing not only reduces emissions but also improves **operational agility**, **worker safety**, and **regulatory compliance**.

2.4 Role of Government Policies and Regulatory Frameworks

Governmental support and policy alignment are critical enablers of sustainable logistics. National frameworks—such as India's **National Logistics Policy (2022)**—emphasize:

- Integration of multimodal transportation systems
- Incentives for EV adoption in logistics
- Development of green logistics parks
- Standardized carbon accounting frameworks

Such strategies are designed to create a logistics environment that encourages green innovation and makes sustainable behavior more affordable. Tax breaks, public-private collaboration, and infrastructure investment are crucial in alleviating the financial pressure on private firms, particularly SMEs.

Yet, as McKinnon et al. (2015) point out, the fragmentation of rules by regions is an issue that still exists, tending to lead to compliance uncertainty for multinational activities.

2.5 Technological Innovation as a Catalyst

Technology is a recurring enabler across all domains of sustainable logistics. Key technological interventions include:

- AI-based predictive analytics for fleet and inventory management
- IoT-enabled sensors for real-time fuel and emissions monitoring
- Blockchain for supply chain transparency and sustainability verification

According to Accenture (2021), firms that deploy smart logistics technologies see a **15–25% improvement** in energy efficiency and resource utilization. Blockchain, in particular, has been highlighted as a trust-building tool in the supply chain, ensuring end-

to-end traceability and preventing **greenwashing**—where companies falsely claim sustainability efforts.

2.6 Economic and Operational Trade-offs

While the long-term gains of sustainable logistics are substantial, literature acknowledges the **short-term economic trade-offs**:

- High capital investment in green vehicles and infrastructure
- Potential disruption to existing logistics models
- Challenges in measuring ROI from sustainability efforts

Sarkis (2012) emphasizes that companies tend to find sustainability an expense focus instead of a value generation. Longitudinal investigations indicate, however, that companies with investment in green logistics register increased brand loyalty, supply chain resilience, and cost savings due to improvement of efficiency in the long run.

2.7 Empirical Gaps and the Need for Industry-Specific Case Studies

Despite robust theoretical foundations, the literature lacks **empirical validation across diverse sectors and geographies**. There is a scarcity of:

- Quantitative assessments linking sustainable logistics to financial performance
- Comparative data across industries like e-commerce, automotive, and retail
- Region-specific insights, especially from developing economies like India

This gap reinforces the need for **real-world case studies** to ground theory in practice. Examples such as:

- **Nokia**: Achieved a 68% emissions reduction through multimodal freight strategies
- **Mahindra Logistics**: Deployed EV fleets and solar infrastructure to cut carbon and operating costs

These examples are a good beginning, but more extensive and profound study is necessary to provide scalable insights.

The literature confirms that supply chain sustainability is both an operational imperative and a strategic opportunity. It is more than environmental compliance, and it includes economic efficiency, technical innovation, and social responsibility. Practical realization is hindered by the issue of costs, technological preparedness, and regulatory disparity.

This research seeks to add to this body of knowledge by closing the theory-to-practice gap—namely, in the context of India and cross-sectoral—thus offering organizations evidence-based strategies to infuse sustainability into their logistics and supply chain activities.

3. RESEARCH METHODOLOGY

This research employs a mixed-method research design, blending qualitative and quantitative data to investigate the effect of sustainable logistics on supply chain performance. The research methodology blends empirical insights from industry experts with secondary findings from published materials to provide a balanced and contextualized analysis.

3.1 Research Design

The study adopts an exploratory and descriptive approach. The study aims at examining existing practices, determining challenges, and revealing trends in the adoption of sustainable logistics. The design is based on a dual stream of evidence:

- Secondary sources: such as academic journals, industry white papers, sustainability reports, and company case studies.
- Primary findings: derived through systematic surveys and interviews with supply chain and logistics experts.

3.2 Data Collection Methods

- Secondary Data: Drawn from global and regional logistics leaders such as DHL, Maersk, Flipkart, and Amazon, as well as policy documents and government publications related to India's logistics and sustainability initiatives.
- Primary Data: Obtained through:
    - An online survey distributed to logistics professionals, capturing quantitative data on awareness, adoption, challenges, and performance metrics.
    - Qualitative interviews conducted with supply chain managers and environmental consultants to gain deeper insights into strategic implementation and barriers.

3.3 Data Analysis

The analysis was conducted using both thematic and comparative methods:

- Qualitative data (from interviews and open-ended survey responses) were analyzed thematically to identify recurring patterns and strategic approaches.
- Quantitative data (from the survey) were evaluated to uncover trends, performance indicators, and correlation between sustainability practices and operational efficiency.

Cross-company comparative analysis was conducted to analyze best practices, industry standards, and context-based challenges across different organizations. Ensuring reliability, depth, and relevance of findings across various sectors of the Indian logistics landscape required this blend of methodologies.

4. CASE STUDY / ANALYSIS / DISCUSSIONS AND RECOMMENDATIONS

4.1 Introduction to Case

Sustainable logistics is picking up pace as a strategic pillar of supply chain transformation in India, where urbanization, e-commerce growth, and environmental interests intersect. With transport and warehousing contributing to some of the largest levels of greenhouse gas emissions, the logistics industry is facing increasing pressure to embrace

environmentally friendly practices that are aligned with regulatory standards as well as consumer expectations.

This case study delves into the green logistics efforts of two prominent companies—**Flipkart** and **DHL Express India**. Both companies have undertaken progressive, large-scale programs to reduce their ecological footprint, enhance operational effectiveness, and meet international standards. The case combines organizational information with findings from a survey of logistics professionals, highlighting challenges of integrating adoption, employee involvement, technology integration, and major sustainability indicators.

4.1.1. Flipkart's Sustainable Logistics Initiatives

Flipkart, India's online retail behemoth, has gone a long way in integrating sustainability into its logistics network. Its efforts demonstrate a mix of curbing waste, sustainable transportation, and sensitizing employees.

- **Single-Use Plastic Packaging Removal:** As of July 2022, Flipkart removed 100% single-use plastic packaging from its entire value chain. Flipkart now employs biodegradable packaging materials, recyclable mailers, and, in most instances, doesn't use secondary packaging at all. Close to 15% of its items are delivered without additional packaging, straightforwardly decreasing packaging waste and resource consumption.
- **LNG-Powered Truck Deployment:** Partnering with GreenLine Mobility Solutions, Flipkart deployed 25 LNG-powered trucks in December 2024. LNG is a cleaner fuel compared to diesel, reducing CO_2 emissions and enhancing fuel efficiency. It is a hybrid model that supplements Flipkart's electric vehicle (EV) plan.
- **EV Fleet Expansion:** Flipkart is expanding its last-mile delivery fleet with electric vehicles, focusing on metro cities that have high pollution rates. The move is consistent with consumer pressure for clean deliveries and urban air quality issues.
- **Employee Awareness and Training:** Flipkart has begun conducting in-house sustainability training for its logistics staff. Delivery staff and warehouse staff are trained in waste segregation, smart driving practices, and energy-saving measures in warehouses.

- **Key Challenges:** In our survey, Flipkart has challenges in expanding EV infrastructure to Tier-2 and Tier-3 cities, upfront investment hurdles for LNG trucks, and compliance with sustainability packaging guidelines among third-party sellers.
- **KPIs and Monitoring:** CO_2 savings from EV usage, percentage reduction in packaging materials, and energy usage by the fleet are monitored by Flipkart. It reports these KPIs on a quarterly basis to its ESG governance committee.

4.1.2. DHL Express India's GoGreen Strategy

DHL Express India has used its worldwide sustainability mandate to localize effective initiatives within the Indian logistics industry. Under the Deutsche Post DHL GoGreen strategy, DHL has instituted technologies and partnerships to drive environmental accountability.

- **GoGreen Plus and Sustainable Aviation Fuel (SAF):** In February 2024, DHL launched its GoGreen Plus service in partnership with Aragen Life Sciences. This service uses SAF for international air freight, significantly reducing emissions by up to 80% compared to traditional jet fuel.
- **Carbon-Neutral Logistics:** DHL provides carbon-offset shipping options through investment in renewable energy and afforestation projects. These offsets are certified and audited, giving customers transparency and control over their carbon footprint.
- **Green Fleet Deployment:** DHL has introduced electric vans for intra-city last-mile delivery in major Indian cities. These vehicles reduce noise and air pollution and are supported by in-house EV maintenance training for drivers.
- **Employee Sustainability Training:** DHL offers online modules and workshops for employees across logistics operations, with KPIs linked to fuel savings, route efficiency, and emissions compliance.
- **Key Challenges:** The survey and case data reveal that DHL faces high costs in SAF procurement, infrastructure constraints for EVs in non-metro zones, and limited customer uptake of carbon-neutral shipping without incentives.

- **Monitoring and KPIs:** DHL's India GoGreen dashboard tracks carbon offsets per shipment, SAF fuel consumption, and electric fleet mileage.

4.1.3. Analysis of Sustainable Logistics Factors

Using industry responses and case data, the following framework categorizes the key factors affecting sustainable logistics implementation:

Table 4.1 Analysis of Logical Factors

Factor Type	Key Factors	Description	Reference Link
Operational	**Process Optimization**	Streamlining supply chain processes reduces waste and boosts sustainability.	Anderson, G. (2023). Smart, sustainable supply chains are finally becoming real. Wired.
	Route Optimization	AI-powered routing reduces emissions and improves delivery efficiency.	Peakermap. (2023). Green supply chains: Tech's role in sustainable logistics.
	Waste Reduction	Waste-to-energy practices and circular logistics cut down landfill dependency.	The Guardian. (2014). Urban mining: The search for rare earths in Europe's waste.
Social	**Labor Rights & Equity**	Promoting fair wages and workplace safety in green logistics chains.	Zhang, Y., & Lin, R. (2019). Environmental and social sustainability in logistics. Journal of Cleaner Production, 232, 123-134.
	Gender Inclusion	Empowering women in logistics, especially in agrarian supply chains.	Bhat, S. (2024, March 8). HEAT is ensuring women in supply chains are climate resilient. Reuters.

Factor Type	Key Factors	Description	Reference Link
	Transparency & Ethics	Ethical sourcing and transparency to reduce corruption and build trust.	Kumar, P. (2023). Digital ethics and supply chain sustainability. MDPI Proceedings, 76(1), 103.
Technical	**Automation & Robotics**	Automation reduces resource use and increases warehouse energy efficiency.	Toxigon. (2023). The role of technology in sustainable logistics.
	Data Analytics	Real-time analytics improve demand forecasting and inventory decisions.	Toxigon
	Green Technologies	Adoption of EVs, hydrogen fuels, and solar-powered fleets for clean logistics.	Peakermap

The research established that green logistics projects have made tangible reductions in operational effectiveness. Flipkart and DHL both said that delivery expenses and emissions decreased, demonstrating that green logistics can perform better while reducing long-term costs. One of the factors in their success was collaborative relationships—e.g., Flipkart's partnership with GreenLine and DHL's collaboration with Aragen—which allowed access to cleaner technologies and shared knowledge. In addition, increased consumer preference for green delivery choices, especially among city-based customers, is accelerating. This change in consumer preference supports the commercial case for sustainability as a source of competitive advantage.

Another valuable finding is the significance of transparency metrics. Companies that establish and measure key performance indicators (KPIs)—e.g., carbon intensity per shipment or waste through packaging—are well placed to expand green programs and disclose progress openly. Internal culture is also crucial. It was found that employee

engagement and sustainability education are as important as technological preparedness. Firms that invest in training and recognition schemes for warehouse employees, delivery personnel, and fleet operators promote the culture of responsibility and sustained change of behavior.

Drawing on these findings, the research identifies a number of strategic proposals. Firstly, firms should invest in dual-fuel fleets of EVs supplemented with liquefied natural gas (LNG) vehicles in markets where EV support infrastructure is weak. Secondly, widening training programs emphasizing sustainability can guarantee frontline personnel are equipped and encouraged to adopt green processes. Third, there is a robust argument for universalization of KPIs across the logistics sector—parameters such as clean miles transported and packaging recycling rates can induce uniformity and benchmarking. Businesses should also leverage government programs under the National Logistics Policy to recover capital outlay on green technology. On the consumer side, providing opt-in carbon-neutral delivery, sustainability badges, and other customer-visible green attributes can increase loyalty and brand image. Lastly, imposition of compliance among suppliers through contractual conditions linked to sustainability guarantees consistency in environmental standards down the supply chain.

Though valuable insights are provided by the findings, the research also identifies a number of limitations. One fundamental limitation was not being able to access proprietary information, particularly regarding detailed cost structures and emissions performance. This restricted the quantitative analysis to a limited depth. Moreover, as the research has only taken into consideration India, its extension to other nations with varied infrastructure or policy environments might be limited. The industry coverage was also limited, with a concentration primarily on e-commerce and express logistics, without venturing into sectors such as agriculture, pharma, or cold-chain logistics. Finally, as the technology landscape in logistics is changing so fast—especially in EVs, SAF, and AI—some of the conclusions will become obsolete, justifying continuous research and occasional re-estimated studies.

Despite these constraints, the study offers actionable, workable strategies for businesses looking to integrate sustainability into their logistics chain. Flipkart and DHL's experiences illustrate how innovation, partnership, and intra-organizational alignment can assist organizations in meeting both environmental and economic goals. As India leads the way in greener supply chains, this case is a useful guidebook for logistics players making the shift toward sustainable operations.

4.2 Data Collection (Sources and Approach)

To ensure a comprehensive and evidence-based analysis, this study employed a mixed-method approach to data collection, incorporating both primary and secondary sources.

Primary Data:

- A structured questionnaire was prepared and sent out through Google Forms to logistics professionals throughout India. The survey sought to obtain views on sustainable logistics adoption, technological integration, employee training, perceived challenges, and key performance indicators.
- Respondents were managers and operation staff employed in industries like e-commerce, logistics services, retail, and warehousing. 45 valid responses were received and examined.

Secondary Data:

- Public reports and press releases from Flipkart and DHL Express India were used to extract information on sustainability milestones, strategic initiatives, and technology deployments.
- Government documents, such as India's National Logistics Policy (2022), provided context on regulatory frameworks and incentive programs.
- Peer-reviewed academic journals and white papers on sustainable supply chain practices supported the literature review and comparative analysis.

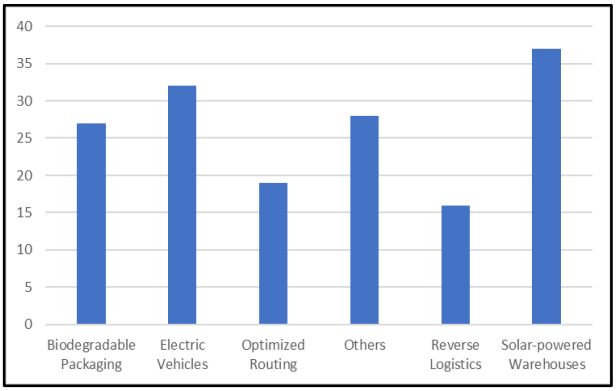
Approach:

- Quantitative data from the survey were compared to determine trends and common issues.
- Qualitative data from case study reports and sustainability reports were employed in the interpretation of organizational outcomes and strategies.
- Triangulation was employed to confirm findings, juxtaposing survey feedback with organizational case information and available literature.

This multi-source methodology enabled a nuanced and balanced exploration of sustainable logistics practices, with both general industry trends and company-specific implementations being assessed in detail.

4.3 Data Analysis

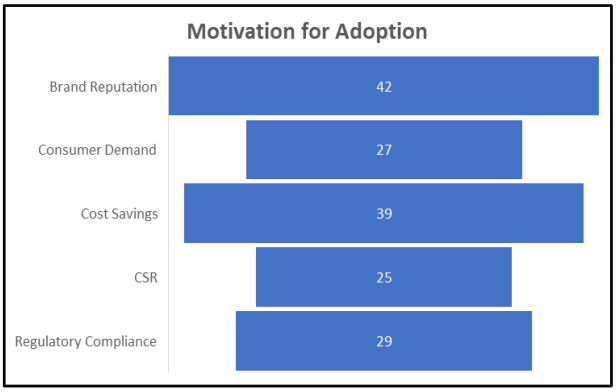
Image 4.1 Green Practice Followed



From the chart, it can be inferred that solar-powered warehouses and electric vehicles are the most widely adopted green logistics practices among surveyed organizations, indicating a strong focus on infrastructure-based sustainability solutions. In contrast, lower adoption rates for practices like optimized routing and reverse logistics suggest that digital and circular economy strategies are still underutilized. This reflects a trend where companies may prioritize visible, long-term investments over operational changes that require process overhauls or advanced technical integration. The relatively high selection

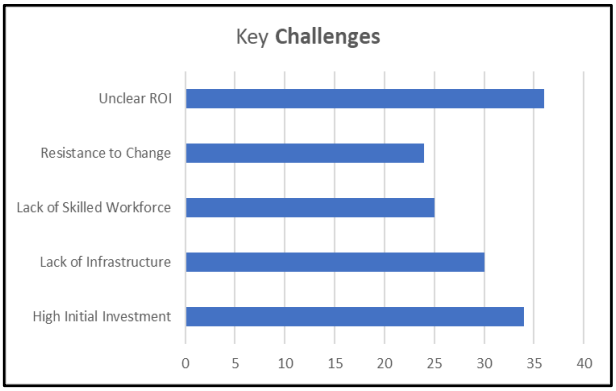
of "Other" practices also points to the presence of diverse, context-specific sustainability initiatives that go beyond mainstream approaches.

Image 4.2 Motivation for Adoption



The chart indicates that the primary motivations for adopting sustainable logistics practices among respondents are brand reputation (42) and cost savings (39), suggesting that companies view sustainability as both a strategic branding tool and a path to long-term operational efficiency. Regulatory compliance (29) and consumer demand (27) also play notable roles, reflecting external pressures and shifting market expectations. Interestingly, Corporate Social Responsibility (CSR) ranks lowest (25), implying that while ethical responsibility matters, tangible business benefits and external perceptions are stronger drivers of sustainability adoption.

Image 4.3 Key Challenges

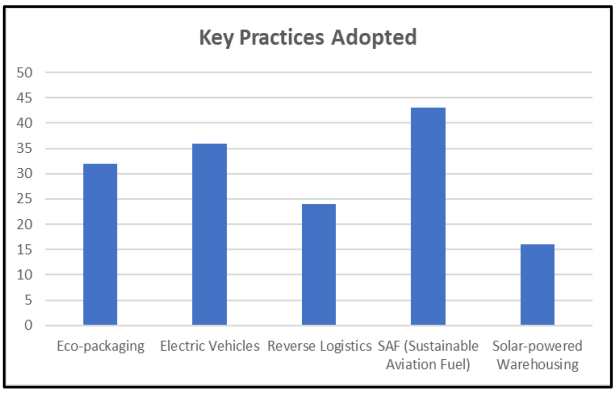


The chart reveals that the most significant challenge faced by organizations in adopting sustainable logistics is unclear return on investment (ROI), cited by the highest number of respondents. This suggests uncertainty about measurable financial benefits continues to

deter deeper commitment to green practices. High initial investment also emerges as a major barrier, highlighting cost sensitivity, especially among small to mid-sized firms. Other challenges—lack of infrastructure, skilled workforce, and resistance to change—are relatively evenly distributed, indicating that both technical and cultural factors hinder the transition to sustainable logistics in many organizations.

The chart illustrates that Sustainable Aviation Fuel (SAF) is the most widely adopted green logistics practice among respondents, indicating growing attention toward decarbonizing long-haul and air-based logistics. Electric vehicles and eco-packaging also show strong adoption, reflecting efforts to reduce emissions and minimize environmental impact in last-mile delivery and packaging waste. Reverse logistics is moderately adopted, suggesting gradual movement toward circular supply chains. Interestingly, solar-powered warehousing has the lowest uptake, possibly due to higher upfront infrastructure costs or longer ROI timelines, signaling an area with potential for future investment and policy support.

Image 4.4 Key Practices Adopted



1. Experience vs. Cost Reduction Effectiveness

- **H_0: Years of experience have no impact on perceived effectiveness in cost reduction.**
- **H_1: Years of experience impact perceived effectiveness in cost reduction.**

Image 4.5

Kruskal-Wallis Test

Ranks

	Years of Experience	N	Mean Rank
Effectiveness in Cost Reduction (1–5)	Less than 1 Years	11	33.27
	1 - 3 Years	25	43.36
	3-5 Years	24	42.33
	5+ Years	17	31.59
	Total	77	

Test Statistics[a,b]

	Effectiveness in Cost Reduction (1–5)
Kruskal-Wallis H	4.615
df	3
Asymp. Sig.	.202

a. Kruskal Wallis Test

b. Grouping Variable: Years of Experience

Since the p-value (0.202) > 0.05, we fail to reject the null hypothesis. This means there is no statistically significant difference in the perceived effectiveness of cost reduction across different experience groups.

Although there are some differences in mean ranks (with 1–3 and 3–5 year groups rating effectiveness slightly higher), these differences are not strong enough to be statistically significant at the 95% confidence level.

Years of experience do not significantly influence how professionals perceive the cost-saving impact of sustainable logistics practices in this sample of 77 respondents.

2. Sustainability Implementation vs. Cost Reduction Effectiveness

- **H_0:** Mean effectiveness in cost reduction is equal across organizations that do and do not implement sustainability.
- **H_1:** Mean effectiveness in cost reduction differs.

Image 4.6

T-Test

Group Statistics

	Org Implements Sustainability	N	Mean	Std. Deviation	Std. Error Mean
Effectiveness in Cost Reduction (1–5)	Yes	52	3.31	1.020	.141
	Not Sure	10	3.10	.568	.180

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Effectiveness in Cost Reduction (1–5)	Equal variances assumed	4.621	.036	.623	60	.536	.208	.334	-.459	.875
	Equal variances not assumed			.909	22.145	.373	.208	.229	-.266	.682

Independent Samples Effect Sizes

		Standardizer[a]	Point Estimate	95% Confidence Interval	
				Lower	Upper
Effectiveness in Cost Reduction (1–5)	Cohen's d	.966	.215	-.464	.892
	Hedges' correction	.978	.212	-.458	.881
	Glass's delta	.568	.366	-.341	1.053

a. The denominator used in estimating the effect sizes.
Cohen's d uses the pooled standard deviation.
Hedges' correction uses the pooled standard deviation, plus a correction factor.
Glass's delta uses the sample standard deviation of the control group.

11

Since the p-value (0.373) > 0.05, we fail to reject the null hypothesis.

This means there is no statistically significant difference in perceived cost reduction effectiveness between those who say their organization implements sustainability and those who are unsure or do not.

Although the mean effectiveness is slightly higher for sustainability-adopting organizations (3.31 vs 3.10), the difference is not statistically meaningful, and the effect size is small.

Based on this sample, implementing sustainable logistics does not significantly alter perceptions of cost reduction effectiveness. This suggests that either the benefits are not yet visible to respondents or that perception is influenced by other contextual factors beyond actual implementation.

3. Industry vs. Effectiveness in Cost Reduction

- **H_0: Cost reduction effectiveness does not differ by industry.**
- **H_1: Cost reduction effectiveness differs by industry.**

Image 4.7

Kruskal-Wallis Test

Ranks

	Industry	N	Mean Rank
Effectiveness in Cost Reduction (1–5)	Manufacturing	15	37.57
	3PL/Logistics Provider	16	51.59
	Warehousing	23	33.35
	Retail	10	38.90
	E-commerce	13	35.23
	Total	77	

Test Statistics[a,b]

	Effectiveness in Cost Reduction (1–5)
Kruskal-Wallis H	7.904
df	4
Asymp. Sig.	.095

a. Kruskal Wallis Test

b. Grouping Variable: Industry

Since the p-value (0.095) > 0.05, we fail to reject the null hypothesis at the 5% significance level.

However, the result is borderline and may indicate a trend toward significance — suggesting that with a larger sample or more granular industry breakdown, statistical significance could emerge.

Notably, 3PL/Logistics Providers have the highest mean rank (51.59), suggesting they perceive the most benefit in cost reduction, while warehousing and e-commerce perceive the least.

There is no statistically significant difference in cost reduction effectiveness perceptions across industries at the 95% confidence level. However, the near-threshold p-value hints that industry context may influence perceptions, and this could warrant deeper analysis in future studies or with larger samples.

4. Industry Type vs. Biggest Barrier to Adoption

- **H_0: Industry type is not associated with the perceived biggest barrier to adoption.**

- **H_1: Industry type is associated with the perceived biggest barrier to adoption.**

Image 4.8

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Industry * Biggest Barrier to Adoption	77	100.0%	0	0.0%	77	100.0%

Industry * Biggest Barrier to Adoption Crosstabulation

Count

		Biggest Barrier to Adoption					
		Lack of Awareness	Lack of Infrastructure	Vendor Resistance	High Initial Cost	Regulatory Complexity	Total
Industry	Manufacturing	5	3	1	5	1	15
	3PL/Logistics Provider	5	5	1	3	2	16
	Warehousing	4	6	7	5	1	23
	Retail	1	0	6	2	1	10
	E-commerce	5	0	2	3	3	13
Total		20	14	17	18	8	77

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	24.287[a]	16	.083
Likelihood Ratio	27.218	16	.039
Linear-by-Linear Association	1.213	1	.271
N of Valid Cases	77		

a. 22 cells (88.0%) have expected count less than 5. The minimum expected count is 1.04.

The analysis explores whether industry type influences the perceived biggest barrier to adopting sustainable logistics practices. While the Pearson Chi-Square test yields a p-value of 0.083—slightly above the conventional 0.05 threshold—suggesting no statistically significant association, the Likelihood Ratio test produces a p-value of 0.039, indicating a potential relationship. This implies that industry context may indeed shape how organizations perceive challenges such as high initial investment, lack of infrastructure, or vendor resistance. For instance, retail respondents most commonly cited vendor resistance, while warehousing respondents reported infrastructure limitations and vendor issues almost equally. However, due to a high number of low expected cell counts (88% below 5), caution must be exercised when interpreting these results. Overall, the findings suggest a possible industry-based variation in sustainability adoption barriers, warranting further investigation with a larger sample size.

While the Pearson test doesn't confirm a significant relationship, the **Likelihood Ratio test suggests that industry type may influence the perceived biggest barrier to adopting sustainable logistics**. Differences in operations, scale, and maturity across industries likely shape how they perceive and prioritize challenges. Further analysis with a larger sample would strengthen these findings.

5. Green Practice Adoption vs. Training Frequency

- **H_0: Training frequency does not affect adoption of green practices.**
- **H_1: Training frequency affects adoption of green practices.**

Image 4.9

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.008	.229		8.783	<.001
	Training Provided to Staff	-.230	.104	-.247	-2.205	.031

a. Dependent Variable: Organization Adopts Green Logistics Practices

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Training Provided to Staff[b]	.	Enter

a. Dependent Variable: Organization Adopts Green Logistics Practices

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.247[a]	.061	.048	.800

a. Predictors: (Constant), Training Provided to Staff

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.111	1	3.111	4.862	.031[b]
	Residual	47.980	75	.640		
	Total	51.091	76			

a. Dependent Variable: Organization Adopts Green Logistics Practices

b. Predictors: (Constant), Training Provided to Staff

The p-value (0.031) < 0.05, so we reject the null hypothesis. This indicates a statistically significant relationship between training frequency and the adoption of green logistics practices.

Interestingly, the negative B value (-0.230) suggests an inverse relationship: as training frequency increases (if coded ordinally from “No” to “Yes”), the likelihood of green practice adoption decreases slightly, which is counterintuitive and may signal either:

- Coding issues (e.g., "Yes" = 1 vs "No" = 3)
- Nonlinear patterns
- Confounding factors like organizational size or leadership priorities

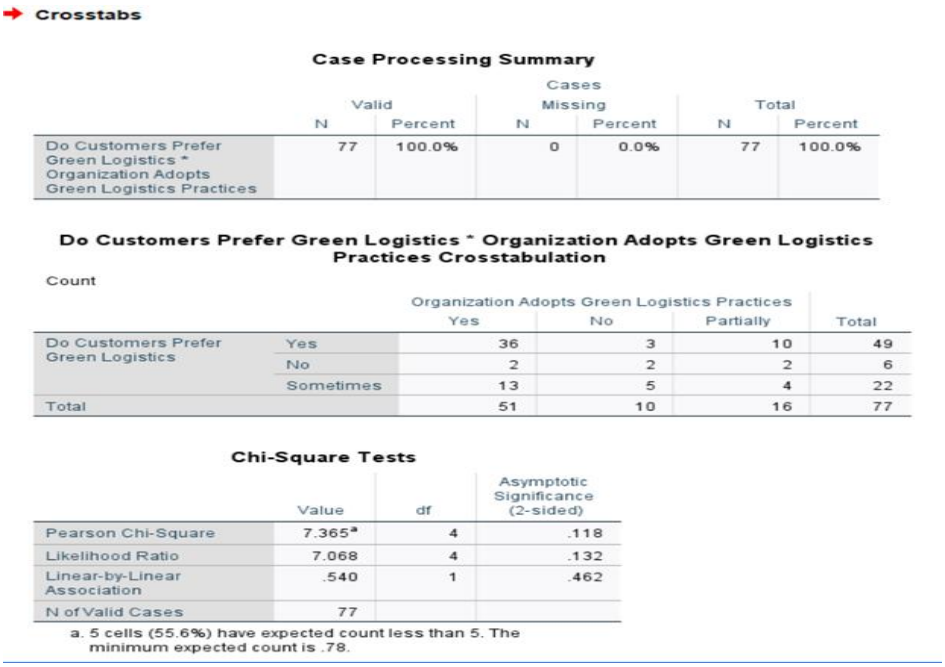
Despite the statistical significance, the low R^2 value (0.061) implies that training explains only about 6.1% of the variance in green practice adoption, meaning other variables also play a major role.

Training frequency has a statistically significant but weak effect on the adoption of green logistics practices. However, the negative direction and low explanatory power suggest that training alone is not a strong driver, and further investigation is needed into how training is delivered, perceived, and complemented by other organizational enablers.

6. Customer Preference vs. Green Practice Adoption

- **H_0: Customer preference for green logistics does not predict green practice adoption.**
- **H_1: Customer preference predicts adoption.**

Image 4.10



Crosstabs

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Do Customers Prefer Green Logistics * Organization Adopts Green Logistics Practices	77	100.0%	0	0.0%	77	100.0%

Do Customers Prefer Green Logistics * Organization Adopts Green Logistics Practices Crosstabulation

Count

		Organization Adopts Green Logistics Practices			
		Yes	No	Partially	Total
Do Customers Prefer Green Logistics	Yes	36	3	10	49
	No	2	2	2	6
	Sometimes	13	5	4	22
Total		51	10	16	77

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	7.365[a]	4	.118
Likelihood Ratio	7.068	4	.132
Linear-by-Linear Association	.540	1	.462
N of Valid Cases	77		

a. 5 cells (55.6%) have expected count less than 5. The minimum expected count is .78.

Since the p-value (0.118) > 0.05, we fail to reject the null hypothesis.

This means there is no statistically significant association between customer preference for green logistics and whether or not an organization adopts green practices.

However, a practical trend is visible:

- A large proportion of organizations whose customers prefer green logistics have already adopted such practices (36 out of 49).
- But the lack of statistical significance may be due to small subgroup sizes (e.g., only 6 in the "No" group), as 55.6% of the cells have expected counts below 5.

While the data suggests a possible association between customer preference and organizational adoption of green logistics, the relationship is not statistically significant based on this sample. The trend hints at influence, but larger or more balanced samples are needed to confirm this with confidence.

7. Support Needed vs. Sustainability Implementation

- **H_0: The type of support needed is not associated with whether sustainability is implemented.**
- **H_1: Support needs differ by sustainability implementation status.**

Image 4.11

Nominal Regression

Case Processing Summary

		N	Marginal Percentage
Org Implements Sustainability	Yes	52	67.5%
	No	15	19.5%
	Not Sure	10	13.0%
Support Needed	Better EV infrastructure	25	32.5%
	Incentives/subsidies from government	16	20.8%
	Stronger policy enforcement	19	24.7%
	Awareness campaigns	17	22.1%
Valid		77	100.0%
Missing		0	
Total		77	
Subpopulation		4	

Model Fitting Information

Model	Model Fitting Criteria -2 Log Likelihood	Likelihood Ratio Tests Chi-Square	df	Sig.
Intercept Only	26.114			
Final	21.724	4.390	6	.624

Pseudo R-Square

Cox and Snell	.055
Nagelkerke	.068
McFadden	.034

Image 4.12

Likelihood Ratio Tests

Effect	Model Fitting Criteria: -2 Log Likelihood of Reduced Model	Likelihood Ratio Tests: Chi-Square	df	Sig.
Intercept	21.724[a]	.000	0	.
Support Needed	26.114	4.390	6	.624

Image 4.13

Parameter Estimates

Org Implements Sustainability[a]		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp (B): Lower Bound	Upper Bound
Yes	Intercept	2.398	1.044	5.271	1	.022			
	[Support Needed=1]	-1.174	1.162	1.021	1	.312	.309	.032	3.013
	[Support Needed=3]	-.606	1.294	.219	1	.639	.545	.043	6.889
	[Support Needed=4]	-.606	1.294	.219	1	.639	.545	.043	6.889
	[Support Needed=5]	0[b]	.	.	0	.	.	.	.
No	Intercept	1.609	1.095	2.594	1	.142			
	[Support Needed=1]	-2.120	1.317	2.594	1	.107	.120	.009	1.584
	[Support Needed=3]	-1.609	1.483	1.177	1	.278	.200	.011	3.661
	[Support Needed=4]	-.693	1.378	.253	1	.615	.500	.034	7.452
	[Support Needed=5]	0[b]	.	.	0	.	.	.	.

Double-click to activate

a. The reference category is: Not Sure.

b. This parameter is set to zero because it is redundant.

The model is not statistically significant (Chi-square = 4.390, p = 0.624), and the pseudo R^2 values are very low (Nagelkerke = 0.068), indicating that the model explains less than 7% of the variance in sustainability implementation.

Additionally, none of the support categories significantly predict whether an organization implements sustainability practices.

There is no statistically significant relationship between the type of support needed (e.g., EV infrastructure, government incentives, awareness) and whether an organization

implements sustainable logistics. This suggests that support preferences are broadly shared across organizations regardless of their sustainability adoption status, or that other contextual factors may be more influential.

8. Industry vs. Support Needed

- **H_0: Industry does not influence the type of support needed for sustainability.**
- **H_1: Industry influences the support needed.**

Image 4.14

Correspondence Table

Support Needed	Industry: Manufacturing	3PL/Logistics Provider	Warehousing	Retail	E-commerce	Active Margin
Better EV infrastructure	6	5	8	1	5	25
Training programs for logistics staff	0	0	0	0	0	0
Incentives/subsidies from government	1	4	6	2	3	16
Stronger policy enforcement	5	3	3	4	4	19
Awareness campaigns	3	4	6	3	1	17
Active Margin	15	16	23	10	13	77

Summary

Dimension	Singular Value	Inertia	Chi Square	Sig.	Proportion of Inertia: Accounted for	Proportion of Inertia: Cumulative	Confidence Singular Value: Standard Deviation	Confidence Singular Value: Correlation 2
1	.239	.057			.502	.502	.106	-.080
2	.202	.041			.357	.859	.093	
3	.127	.016			.141	1.000		
Total		.114	8.782	.922[a]	1.000	1.000		

a. 16 degrees of freedom

Overview Row Points[a]

Support Needed	Mass	Score in Dimension 1	Score in Dimension 2	Inertia	Contribution: Of Point to Inertia of Dimension 1	Contribution: Of Point to Inertia of Dimension 2	Contribution: Of Dimension to Inertia of Point 1	Contribution: Of Dimension to Inertia of Point 2	Contribution: Of Dimension to Inertia of Point Total
Better EV infrastructure	.325	.095	.609	.026	.012	.597	.027	.932	.959
Training programs for logistics staff	.000	.	.	.	.	.	.	.	.
Incentives/subsidies from government	.208	.565	-.178	.025	.277	.033	.637	.053	.690
Stronger policy enforcement	.247	-.802	-.151	.040	.664	.028	.947	.028	.975
Awareness campaigns	.221	.225	-.560	.023	.047	.343	.117	.610	.726
Active Total	1.000			.114	1.000	1.000			

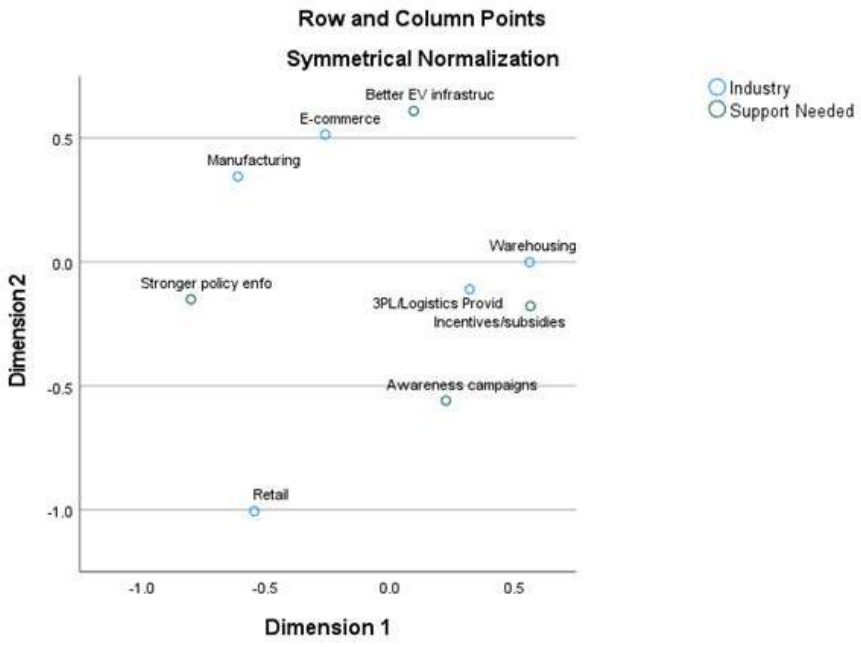
a. Symmetrical normalization

Overview Column Points[a]

Industry	Mass	Score in Dimension 1	Score in Dimension 2	Inertia	Contribution: Of Point to Inertia of Dimension 1	Contribution: Of Point to Inertia of Dimension 2	Contribution: Of Dimension to Inertia of Point 1	Contribution: Of Dimension to Inertia of Point 2	Contribution: Of Dimension to Inertia of Point Total
Manufacturing	.195	-.613	.345	.028	.306	.115	.618	.165	.782
3PL/Logistics Provider	.208	.321	-.111	.006	.089	.013	.909	.091	1.000
Warehousing	.299	.562	-.001	.023	.394	.000	.978	.000	.978
Retail	.130	-.547	-1.006	.036	.162	.651	.256	.730	.987
E-commerce	.169	-.261	.514	.021	.048	.221	.133	.436	.569
Active Total	1.000			.114	1.000	1.000			

a. Symmetrical normalization

Image 4.15



The correspondence analysis examined the relationship between industry type and the type of support needed for sustainable logistics implementation. Statistically, the association was found to be insignificant (Chi-square = 8.782, p = 0.922), indicating that the type of industry does not have a meaningful impact on the support preferences expressed by organizations. However, visual insights from the plot suggest subtle patterns—for instance, manufacturing and e-commerce organizations tend to align with the need for better EV infrastructure, while warehousing shows proximity to incentives and awareness campaigns. Retail, on the other hand, appears relatively isolated, showing no strong alignment with any particular support category. Although these spatial groupings imply practical trends, the lack of statistical significance suggests that such preferences are not strongly dictated by industry type and may be influenced by other contextual or organizational factors.

Based on the correspondence analysis, industry type does not significantly influence the type of support needed for sustainable logistics. However, visual proximity in the plot hints at practical associations, like warehousing's inclination toward awareness and

incentives, or retail's weak alignment with specific supports. These trends may be explored further in larger or more segmented samples to uncover meaningful patterns.

4.4 Finding and Recommendation

Key Findings:

- **Sustainable logistics practices** like EV adoption, eco-packaging, and solar-powered warehousing are increasingly adopted, but their implementation varies significantly by industry and organization size.
- **Cost savings and brand reputation** are the top motivators for adopting green practices, while **unclear ROI and high initial investment** are the most cited barriers.
- Though many organizations believe sustainability reduces logistics costs, **experience level and industry type** did not significantly affect this perception.
- **Training staff** has a statistically significant but weak influence on green practice adoption, suggesting it should be part of a broader strategy.
- **Customer preference** for green logistics shows a positive trend but lacks a strong statistical link with organizational adoption.
- **Support needs** (e.g., EV infrastructure, government subsidies) are not significantly associated with whether a company has adopted sustainability or with industry type, although visual patterns hint at contextual preferences.

Recommendations:

- **Invest in visibility and ROI tracking** for sustainable logistics to strengthen business cases and overcome uncertainty.
- **Provide targeted financial incentives** for high CAPEX green infrastructure (e.g., EVs, solar warehouses) especially for warehousing and retail sectors.
- **Expand awareness and technical training** programs to improve staff engagement and operational readiness.
- **Encourage customer-facing green options** like eco-delivery badges to align with growing sustainability preferences.

- **Promote cross-sector partnerships and policy dialogues** to address industry-specific support needs and scale sustainable logistics nationally.

4.5 Limitation of Study

Despite providing valuable insights into sustainable logistics practices, this study is subject to several limitations:

1. **Sample Size and Scope**: The survey was conducted with a relatively small sample size (77 respondents), which may limit the generalizability of findings across the broader logistics sector in India or globally.
2. **Self-Reported Data**: Much of the data relies on self-reported perceptions from professionals, which can be influenced by personal bias, organizational culture, or a lack of full visibility into company-wide sustainability initiatives.
3. **Limited Industry Representation**: While the study includes respondents from manufacturing, 3PL, warehousing, retail, and e-commerce, other key sectors like cold-chain logistics, agriculture, and pharmaceuticals were not represented, potentially missing unique challenges or practices.
4. **Cross-sectional Design**: The study captures a single point in time and does not reflect how sustainability practices or perceptions may evolve over time. Longitudinal data would offer deeper insights into trends and the impact of interventions.
5. **Measurement Constraints**: Variables like "training frequency," "effectiveness in cost reduction," and "support needed" were treated as categorical or ordinal for simplicity, which may oversimplify more complex organizational dynamics.
6. **Missing Geographic Context**: The lack of geographic (e.g., metro vs. Tier 2/3 city) data prevents analysis of how infrastructure or regional policy environments may impact sustainable logistics adoption.
7. **Statistical Power**: Several statistical tests showed non-significant results, which may be due to underpowered group sizes or high variability within responses.

28 In light of these limitations, future research should aim to include a more diverse and larger sample, incorporate longitudinal tracking, and capture detailed organizational and regional characteristics to enhance the depth and applicability of findings.

5. CONCLUSION

This research set out to explore the role and impact of sustainable logistics within modern supply chains, with a focus on practices, motivators, challenges, and organizational 42 responses. Through a combination of literature review, survey analysis, and case-based evidence from leading firms like Flipkart and DHL Express India, the study offers a

comprehensive understanding of how sustainability is being integrated into logistics functions in the Indian context.

36 The findings highlight that while adoption of green practices such as electric vehicles, sustainable packaging, and solar-powered infrastructure is gaining momentum, it is largely driven by business-centric motives like cost savings and brand reputation rather than purely ethical or regulatory pressures. Challenges such as unclear ROI, high capital investment, and lack of infrastructure continue to act as significant barriers, particularly for smaller firms or those in less digitally mature sectors.

Statistical analysis revealed that variables like years of experience, industry type, and customer preference showed limited or no significant influence on perceptions of cost effectiveness or adoption, suggesting that sustainability decisions are shaped more by strategic priorities and internal commitment than by demographic or external pressures. Training, while statistically significant, showed only a modest influence on green practice adoption—indicating that capability building should be part of a broader sustainability strategy.

Ultimately, the study underscores the need for clearer measurement of sustainability outcomes, targeted policy support, and wider organizational engagement to scale sustainable logistics meaningfully. While the transition to green logistics is underway, it remains uneven, and its success will depend on the ability of stakeholders to align economic goals with long-term environmental and social commitments. Future research should build on these findings with deeper industry segmentation, longitudinal tracking, and integration of geographic and operational performance metrics to inform both policy and practice.

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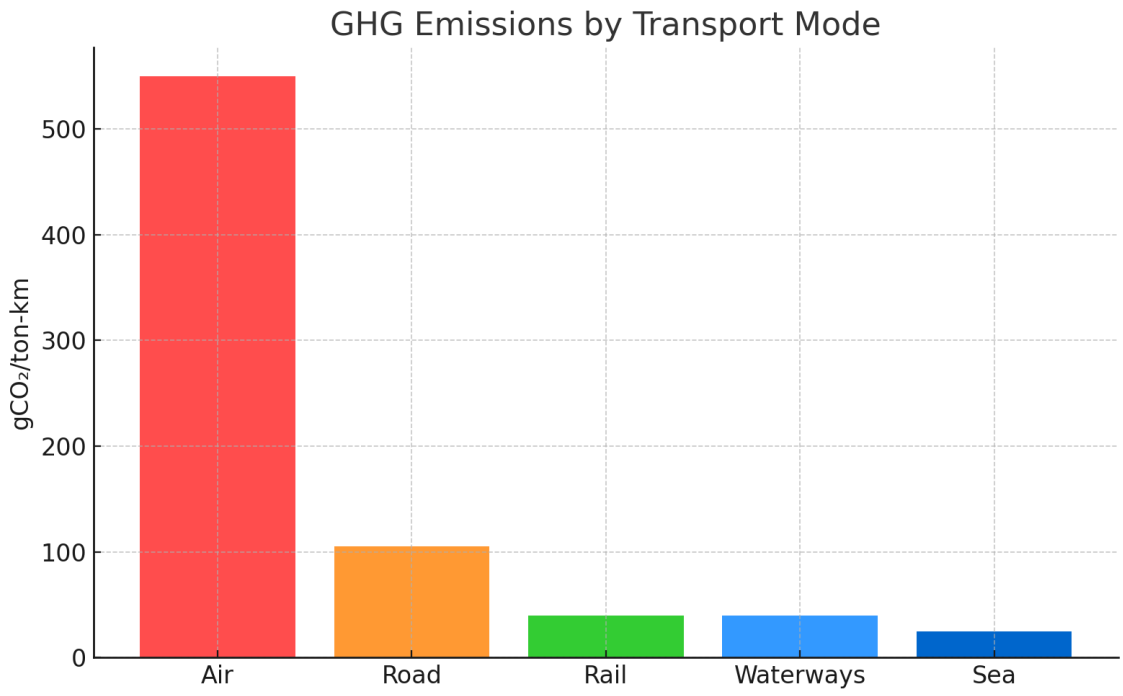
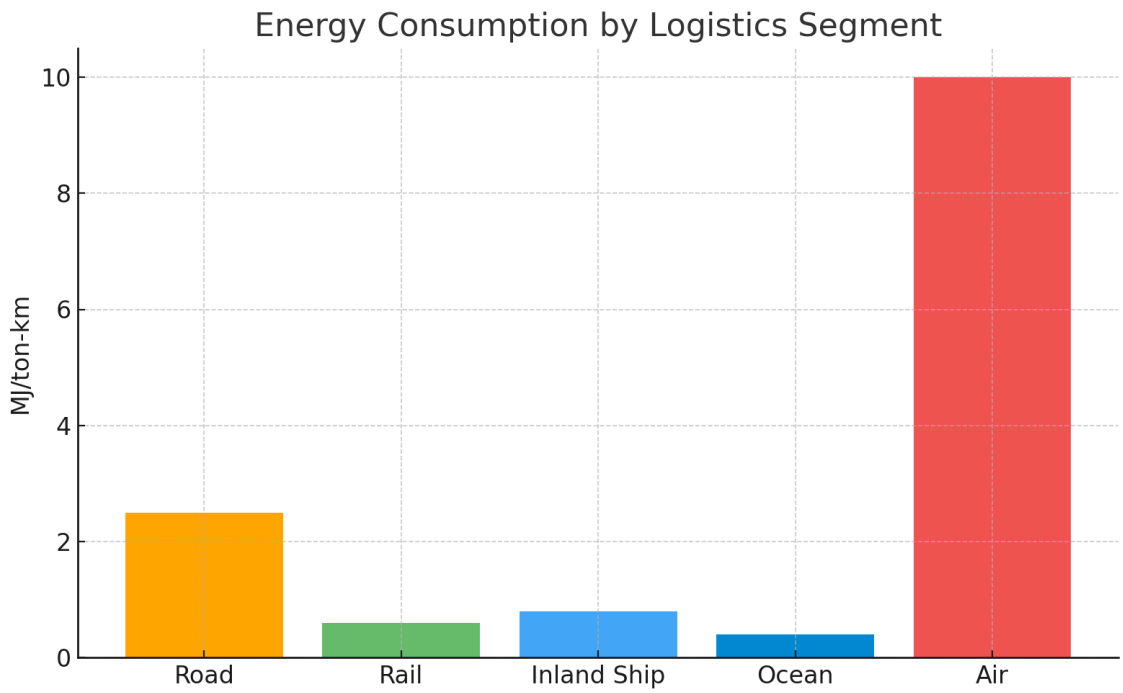
7. ANNEXURE

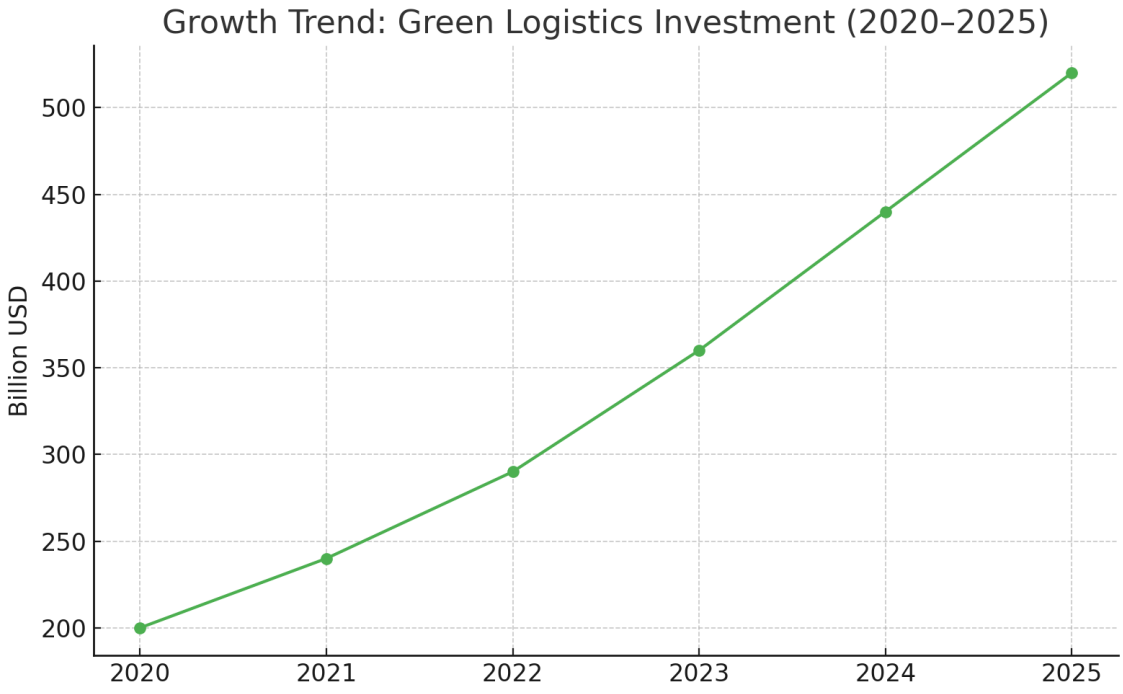
Annexure I – Sample Interview Questions for Logistics Professionals

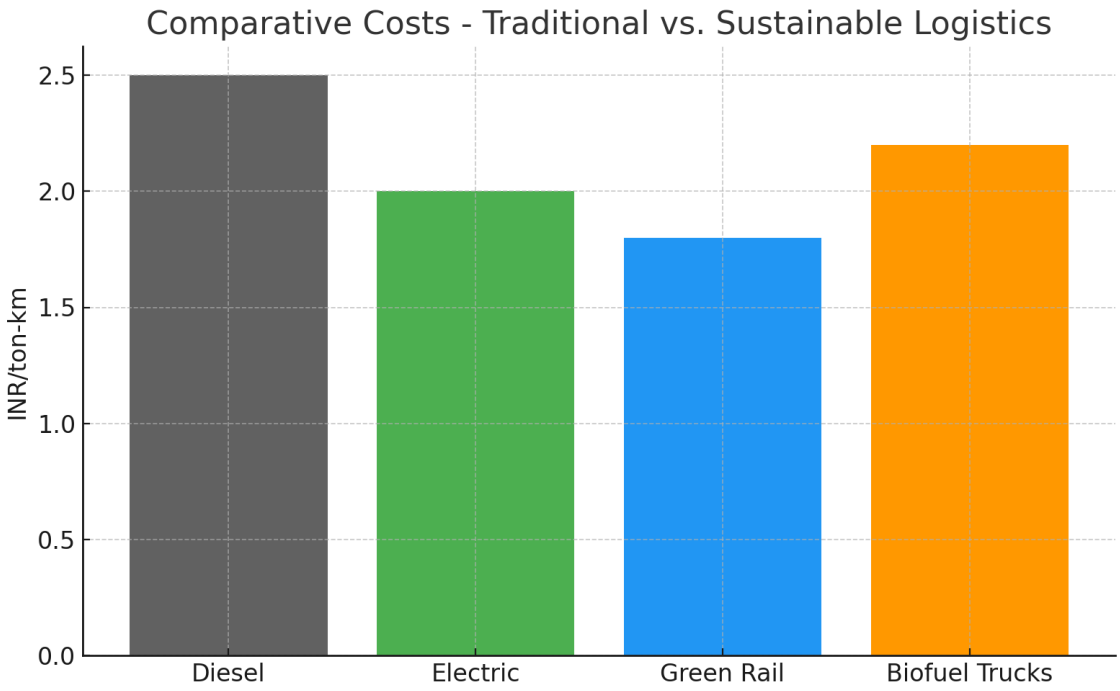
1. What sustainable practices has your organization implemented in logistics?
2. What challenges do you face in transitioning to green logistics?
3. How do customers respond to sustainable logistics initiatives?
4. What are your future sustainability goals in logistics?

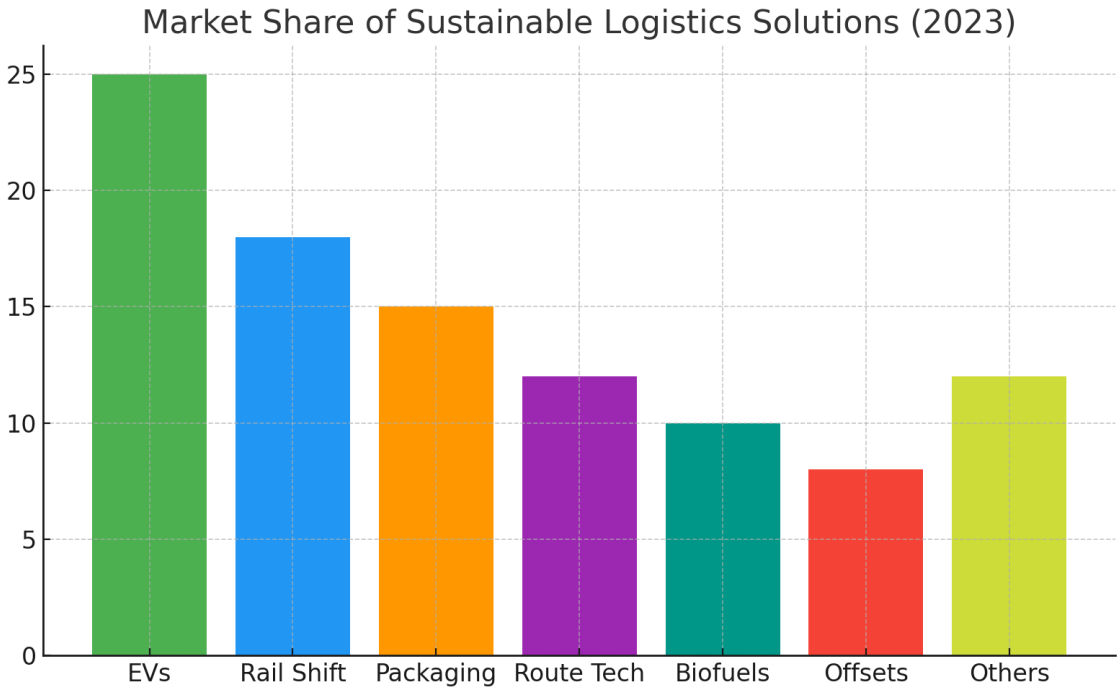
Annexure II – Charts and Graphs




Energy Consumption by Logistics Segment
MJ/ton-km
0
2
4
6
8
10
Road
Rail
Inland Ship
Ocean
Air


Growth Trend: Green Logistics Investment (2020–2025)
Billion USD
200
250
300
350
400
450
500
2020
2021
2022
2023
2024
2025


Comparative Costs - Traditional vs. Sustainable Logistics
INR/ton-km
2.5
2.0
1.5
1.0
0.5
0.0
Diesel
Electric
Green Rail
Biofuel Trucks


Market Share of Sustainable Logistics Solutions (2023)
25
20
15
10
5
0
EVs
Rail Shift
Packaging
Route Tech
Biofuels
Offsets
Others

Annexure III – Survey Questionnaire for Logistics Professionals

The following questionnaire is designed to collect insights from logistics professionals on the adoption, effectiveness, and challenges of sustainable logistics practices in their respective organizations.

Survey on Adoption of Sustainable Logistics Practices

Section A: Respondent Information

1. **What is your total work experience in the logistics/supply chain industry?**
    - <1 year
    - 1–3 years
    - 3–5 years
    - 5+ years
2. **Which industry does your organization belong to?**
    - Manufacturing
    - Retail
    - Warehousing
    - 3PL/Logistics Provider
    - Others (please specify)

Section B: Sustainability Adoption

3. **Does your organization implement sustainability initiatives in its logistics operations?**
    - Yes
    - No
4. **What green logistics practices does your organization follow?** *(Select all that apply)*
    - Electric Vehicles
    - Solar-powered Warehousing
    - Biodegradable Packaging
    - Optimized Routing
    - Reverse Logistics
    - SAF (Sustainable Aviation Fuel)
    - Others (please specify)
5. **What are the main motivations behind adopting sustainable logistics?** *(Select all that apply)*
    - Regulatory Compliance
    - Brand Reputation

- ○ Cost Savings
- ○ Consumer Demand
- ○ Environmental Responsibility
- ○ Others (please specify)

6. **What challenges does your organization face in implementing sustainable logistics?** *(Select all that apply)*
   - ○ Lack of Infrastructure
   - ○ Resistance to Change
   - ○ Lack of Skilled Workforce
   - ○ High Costs
   - ○ Vendor Resistance
   - ○ Others (please specify)

7. **How effective have the sustainability practices been in reducing logistics costs?** *(Scale of 1 to 5, where 1 = Not Effective, 5 = Highly Effective)*
   - ○ 1
   - ○ 2

- 3
- 4
- 5

Section C: Future Readiness and Support

8. **What kind of support would help your organization improve sustainable logistics adoption?**
    - Stronger policy enforcement
    - Incentives/subsidies from government
    - Awareness campaigns
    - Technology support
    - Others (please specify)
9. **Does your organization monitor its carbon footprint?**
    - Yes
    - No
    - Not Sure
10. **Is sustainability-related training provided to staff?**

- Yes
- No
- Occasionally

11. **Do your customers prefer green logistics options?**

- Yes
- No
- Sometimes

12. **What is your level of awareness about sustainable logistics practices?**

- High
- Moderate
- Low

13. **Has your organization adopted any green logistics practices?**

- Yes
- No

14. **What key practices have been adopted?** *(Select all that apply)*

- Eco-packaging
- Solar-powered Warehousing
- Reverse Logistics
- Electric Vehicles
- SAF
- Others (please specify)

15. **What is the biggest barrier to adoption of sustainable logistics in your organization?**

- Lack of Awareness
- High Costs
- Vendor Resistance
- Lack of Infrastructure
- Resistance to Change
- Others (please specify)

Section D: Additional Feedback

16. **Any additional comments or suggestions regarding sustainable logistics?** *(Open-ended)*