



Evaluation of Sustainable Logistics Activities of Logistics Service Provider Companies from A Thematic Perspective

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Abstract

Environmental sustainability has become a central concern for logistics service providers as they face increasing pressure to reduce environmental impacts while maintaining operational efficiency within globalized, trade-dependent logistics networks. Despite growing attention to sustainability in logistics, empirical understanding remains limited regarding how companies interpret sustainability, which practices they prioritize, and the challenges they encounter, particularly in cross-border operations supporting international trade. Existing studies have largely emphasized technical solutions or macro-level indicators, leaving practitioner perspectives underexplored. Accordingly, this study examines how logistics professionals conceptualize environmental sustainability and how sustainability-oriented practices evolve within logistics companies involved in export-import operations. Using in-depth interviews and an exploratory, inductive qualitative thematic analysis, the study examines current practices, planned initiatives, and implementation challenges. Rather than offering prescriptive solutions, the research identifies recurring themes, shared experiences, and operational difficulties expressed by practitioners, contributing to the literature by framing sustainable logistics as a trade-relevant operational capability in real-world practice.

Keywords: Sustainability, Logistics Service Providers, Content Analysis, MAXQDA

1. Introduction

Logistics is widely recognized as a critical enabler of global trade and economic growth, facilitating the movement of goods, information, and services across increasingly complex and geographically dispersed supply chains. As global integration accelerates, the reliability and efficiency of logistics systems have become essential for sustaining business competitiveness and economic resilience (Rodrigue et al., 2017; Durugbo & Al-Balushi, 2022). At the same time, the rapid expansion of logistics activities has intensified concerns regarding their environmental footprint. The sector's strong dependence on fossil fuels, positions logistics as a major contributor to greenhouse gas emissions and air

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pollution, placing it at the center of sustainability debates (IPCC, 2022; Ritchie & Roser, 2024).

Beyond emissions, logistics operations generate broader environmental risks, including waste generation, water contamination, and ecosystem degradation. Chemical leakages, marine pollution, and habitat fragmentation associated with transport infrastructure highlight the growing need for environmentally responsible logistics practices (Peretti & Ekwall, 2018; Liu & Xie, 2019). In response, firms and researchers have increasingly focused on integrating ecological considerations into transport planning, warehousing, and supply chain coordination.

Parallel to these pressures, the adoption of low emission transport modes, green warehousing, digital energy monitoring tools, and circular economy oriented logistics models reflects a broader transition toward sustainable logistics systems (Vienožindienė, 2021; Muchenje, 2024). Regulatory requirements and ESG oriented reporting further reinforce the link between environmental performance and firms' operational and financial outcomes (Kim et al., 2024). Technological advances, such as transportation management systems, IoT-based monitoring, artificial intelligence, and digital twins, also offer new opportunities to reduce environmental impacts and enhance supply chain transparency (Romagnoli et al., 2023; Musau, 2024; Sun et al., 2021).

In international trade, logistics service providers (LSPs) function not only as executors of transport activities but also as key operational actors shaping the cost, reliability, and efficiency of cross-border trade flows. Sustainability-related decisions concerning fleet composition, modal choice, energy use, and network design directly influence export–import performance and regulatory compliance. Despite this strategic role, logistics companies continue to face persistent barriers to sustainability adoption, including cost constraints, heterogeneous customer expectations, network uncertainties, and managerial limitations (Lieb & Lieb, 2010; Wolf & Seuring, 2010).

Understanding how LSPs conceptualize sustainability, operationalize sustainability-oriented practices, and perceive implementation challenges is therefore critical for advancing sustainability debates beyond abstract policy goals. To address this gap, the present study is guided by the following research questions:

RQ1: *How do LSPs conceptualize environmental sustainability within their operational and organizational contexts?*

RQ2: *What types of current and future sustainability-oriented activities do LSPs plan or adopt?*

RQ3: *What challenges do LSPs perceive in implementing and expanding environmental sustainability practices?*

These research questions structure the empirical inquiry and frame the thematic analysis presented in the subsequent sections.

Against this backdrop, the present study investigates the environmental sustainability practices of LSPs in Türkiye by examining both their current activities and long-term sustainability expectations. By analyzing insights from practitioners directly involved in logistics operations, the study offers an empirical perspective on emerging sustainability practices, perceived priorities, and operational challenges. Through this approach, the research contributes to the literature by illuminating how LSPs interpret, plan, and implement sustainability initiatives in a developing market. The subsequent sections detail the theoretical foundations of sustainable logistics, describe the study's methodological approach, present the qualitative findings, and conclude with implications for researchers, practitioners, and policymakers.

This study makes several contributions to the literature on sustainable logistics. First, it provides context-specific empirical evidence from LSPs operating in Türkiye, a developing-market setting that is underrepresented in sustainability research. Second, by examining current practices, long-term sustainability expectations (2030 and 2050), and perceived operational challenges, the study offers a multi-temporal perspective rarely addressed in previous qualitative studies. Finally, the study integrates discussions on digital transformation, renewable energy, and logistics network design into the sustainability narrative, thereby expanding the conceptual understanding of how technological and organizational factors jointly influence environmental performance in logistics.

Remainder of the paper organized as follows: Section 2 reviews the current literature for the related topic. Section 3 made a comprehensive explanation of employed methodology. Findings of the proposed study were given in Section 4. Obtained findings were discussed in Section 5. Lastly, Section 6, concludes the study.

2. Literature Review

The existing literature offers a substantial body of work on the environmental aspects of logistics systems; however, sustainability is predominantly examined from a macro supply chain perspective or through the lenses of manufacturers and retailers. Studies focusing specifically on logistics service providers (LSPs) remain relatively limited. To establish a clear conceptual foundation, the literature is synthesized under two main themes: (1) environmental sustainability activities implemented by LSPs, and (2) the challenges they face in integrating sustainability into their operations.

2.1 LSPs' Environmental Sustainability Activities

Research on sustainable logistics has evolved from early discussions of environmentally responsible logistics practices toward more integrated sustainability frameworks. Early work by Wu and Dunn (1995) introduced the concept of environmental logistics, emphasizing waste reduction, recycling, and energy efficiency. Subsequent studies expanded this focus by highlighting green logistics practices aimed at reducing transport-related emissions, promoting alternative fuels, and improving warehouse sustainability (McKinnon et al., 2015).

More recent frameworks emphasize that environmental sustainability in logistics is embedded within broader organizational dimensions such as risk management, transparency, strategic alignment, and corporate culture. Studies on corporate social responsibility and sustainability reporting demonstrate increasing institutional pressures for firms to integrate environmental considerations into strategic decision-making (Keating et al., 2008).

Within this context, LSPs are increasingly viewed as strategic actors rather than mere executors of physical distribution. Selviaridis and Spring (2007) highlight the role of LSPs in value creation through information sharing, reliability, and relationship management, all of which influence the diffusion of sustainable practices. Empirical research documents a range of sustainability-oriented activities undertaken by LSPs, including eco-driving programs, multimodal transport optimization, green warehousing, and energy-efficient route planning (Muchenje, 2024; Vienažindienė, 2021). In parallel, ESG-related disclosure requirements increasingly link environmental performance with financial outcomes, further accelerating sustainability adoption (Kim et al., 2024).

Technological advancements also play a critical enabling role. Transportation management systems, IoT-based monitoring, machine learning applications, and digital twins support real-time energy monitoring, emission reduction, and improved network efficiency (Romagnoli et al., 2023; Musau, 2024; Sun et al., 2021).

2.2 Challenges Faced by LSPs in Environmental Sustainability Activities

Despite growing attention to sustainable logistics, the literature identifies persistent barriers that constrain effective implementation. Sustainability is often treated as a secondary priority due to cost pressures, limited customer willingness to pay, and tight operational requirements (Wolf & Seuring, 2010). Narrow profit margins and stringent service-level agreements further limit LSPs' capacity for long-term environmental investments.

Key challenges highlighted in prior studies include cost and capital constraints, lack of standardized measurement and reporting systems, transparency and accountability gaps, regulatory complexity, and operational inefficiencies such as network imbalances and infrastructure bottlenecks (Centobelli et al., 2017; Karaman et al., 2020; Dzwigol et al., 2021; Szentesi & Nagy, 2024).

Moreover, the multi-stakeholder nature of logistics systems complicates environmental coordination, requiring alignment among shippers, carriers, customers, and regulators (Pratavia et al., 2024). Nevertheless, much of the existing research continues to prioritize manufacturers and retailers, often overlooking the specific constraints and decision-making contexts of LSPs (Huemer, 2012).

This imbalance points to a critical research gap: although LSPs are central to transport, warehousing, and distribution activities with significant environmental impacts, their perspectives on sustainability practices, priorities, and barriers remain underexplored. Addressing this gap is essential for developing more realistic and operationally grounded approaches to sustainable logistics.

3. Methodology

Adopting a qualitative research design, this study explores how LSPs in Türkiye interpret, plan, and implement environmental sustainability activities, and identifies the challenges they experience during this process. Qualitative methods are well suited for examining complex organisational phenomena and capturing practitioners' interpretations, and contextual experiences (Morgan, 1996; Merriam & Grenier, 2019). Consistent with this perspective, the study adopts an interpretivist stance, focusing on the subjective meanings that participants attribute to sustainability-related practices (Baltacı, 2019).

3.1 Research Design

This study employed an exploratory and inductive qualitative thematic analysis. The analysis aimed to identify recurring meanings, patterns, and relationships in the interview data without imposing a predetermined coding framework. Themes were developed progressively from participants' accounts of current sustainability activities, future plans, and implementation challenges.

The research design integrated semi-structured, in-depth interviews with an iterative analytic process. Consistent with Kvale and Brinkmann's (2009) seven-stage interview model as; thematizing, designing, interviewing, transcribing, analysing, verifying, and reporting. The study followed a systematic protocol to ensure methodological

transparency. Data collection and analysis were conducted concurrently: concepts emerging from early interviews informed the probing depth of subsequent interviews, enabling analytical refinement over time.

3.2 Sampling and Participants

The study focused on logistics service providers operating in Türkiye, an underexamined context in sustainable logistics research. Fifteen companies were selected using purposive sampling based on the following inclusion criteria: (1) company scale, (2) operational characteristics, and (3) demonstrated engagement or interest in sustainability-related activities. Small firms were excluded because many lacked formalized sustainability structures, which would limit their ability to contribute meaningfully to addressing the study's research questions.

The participants included operations specialists, managers, coordinators, and process development professionals whose roles provided direct insight into sustainability-related decision-making. Table 1 presents the participants according to their position and professional experience, and company size and transportation mode. Company size was defined according to the number of employees and the company's share in its sector. The sample predominantly represented firms operating in road transport, reflecting the modal distribution of Türkiye's logistics sector.

Table 1: Logistics Professionals' and Companies' Key Characteristics

<i>Participant No</i>	<i>Company Size</i>	<i>Transportation Mode</i>	<i>Position</i>	<i>Sectoral Experience (Years)</i>
1	Large	Road	Senior Operations Specialist	2
2	Medium	Road	Operation Manager	20
3	Large	Air and Road	Logistics Coordinator	2
4	Medium	Maritime and Air	Assistant Manager of Export Operations	4
5	Large	Road	Operations Process Development Manager	2
6	Medium	Road	Operations Executive	3
7	Medium	Road and Rail	Operations Executive	4
8	Large	Road	Operations Manager	10
9	Large	Road	Operations Specialist	3
10	Medium	Road	Operations Specialist	2
11	Large	Road	Operations Manager	5
12	Medium	Road	Operations Executive	2
13	Medium	Maritime	Operations Executive	2
14	Large	Road	Operations Manager	7
15	Medium	Road	Operations Executive	4

The interviews were conducted with professionals from logistics service provider companies, primarily operations specialists and managers working in medium- and large-scale road transport LSPs. Data collection continued until data saturation was reached, defined as the point at which no new themes or categories emerged from additional interviews. Saturation was monitored throughout the iterative coding process.

Data collection was based on semi-structured, in-depth interviews conducted with logistics service providers. Three main documents were created during this process: an interview protocol, an interview database, and an interview report. Prior to the interviews, all participants were informed about the purpose and scope of the study, and their consent was obtained. The interviews were conducted in Turkish using open-ended questions designed to explore how logistics service providers conceptualize environmental sustainability, which sustainability-oriented practices they currently implement, how they plan future sustainability initiatives, and what challenges they encounter during implementation. The questions were deliberately formulated to avoid theoretical presuppositions and to encourage logistics professionals to reflect on their own operational experiences.

Each interview was audio-recorded, transcribed verbatim, and subsequently shared with the logistics professionals for verification and approval, thereby enhancing the credibility and transparency of the data. The interview transcripts were analyzed line by line to generate initial descriptive codes. Codes reflecting similar meanings were systematically compared and grouped into broader categories.

To illustrate the coding process, the participant statement “We want to switch to electric vehicles, but the investment cost is very high, and the infrastructure is still insufficient” was initially coded as high investment cost and infrastructure inadequacy. These codes were subsequently grouped under the sub-theme technological and structural constraints, which in turn contributed to the broader theme high costs and technological uncertainties. This stepwise coding process facilitated the transparent development of themes directly in the interview data.

The entire coding and analysis process was supported by MAXQDA software. Codes and themes were examined using frequency and co-occurrence analyses to explore the strength and relationships among emerging categories. Code frequencies and co-occurrence patterns were used as analytical aids to identify issues that were repeatedly emphasized and discussed in relation to other categories. These indicators were interpreted together with the interview narratives and were not treated as substitutes for qualitative interpretation. Categories that appeared repeatedly and occupied a central position in participants’ accounts were classified as primary categories. Less frequently discussed or more peripheral categories were classified as secondary categories. Secondary activities were defined as themes that appeared less frequently or were less strongly related to the main themes, indicating practices viewed as supportive rather than strategic priorities.

MAXQDA’s co-occurrence analysis tool was used to generate relationship maps illustrating the interconnections among themes. In these visualizations, the thickness of the connecting lines represents the frequency and strength of relationships between codes. This visual and analytical process enabled a systematic and transparent evaluation of how sustainability activities, future plans, and perceived challenges are interrelated within LSP operations. To enhance reliability, the suitability of the codes, sub-themes, and final themes was independently reviewed by another researcher with expertise in sustainability studies.

4. Findings of the Study

This section presents the findings in three groups: current sustainability activities of logistics service providers, sustainability activities planned for the future, and problems encountered in sustainability activities.

The findings of this study contribute to existing discussions on sustainable logistics by offering empirically grounded insights into how sustainability practices are shaped in day-to-day logistics operations. Instead of deriving conclusions from abstract theoretical models, the study emphasizes context-specific dynamics and practitioner interpretations that remain underexplored in much of the existing literature.

4.1 Current Activities of Companies

Although the LSPs included sustainable activities as one of their goals, very few included them in their company missions, and none based their business model entirely on green and environmentally friendly offerings. The analysis of current activities identified ten categories. As outlined earlier, primary activities were those conducted by most companies, while secondary activities were conducted by fewer. Table 2 categorizes the sustainability activities mentioned by the logistics professionals.

Table 2: LSPs' Categorization of Current Activities in the Development of Environmentally Sustainable Logistics Activities

<i>Primary Activities</i>	<i>Secondary Activities</i>
Efficient Use of Fuels	Taking the Initiative on Environmental Issues
Efforts to Spread the Concept of Sustainability Within the Corporate Culture	Compliance with Regulations and Standards
Measuring Sustainable Activities	Efficient Use of External Logistics Infrastructure
	Product Optimization and Use of Multimodal Transport Modes
	Cooperation Across the Network
	Waste Management
	Use of Environmentally Friendly Vehicles

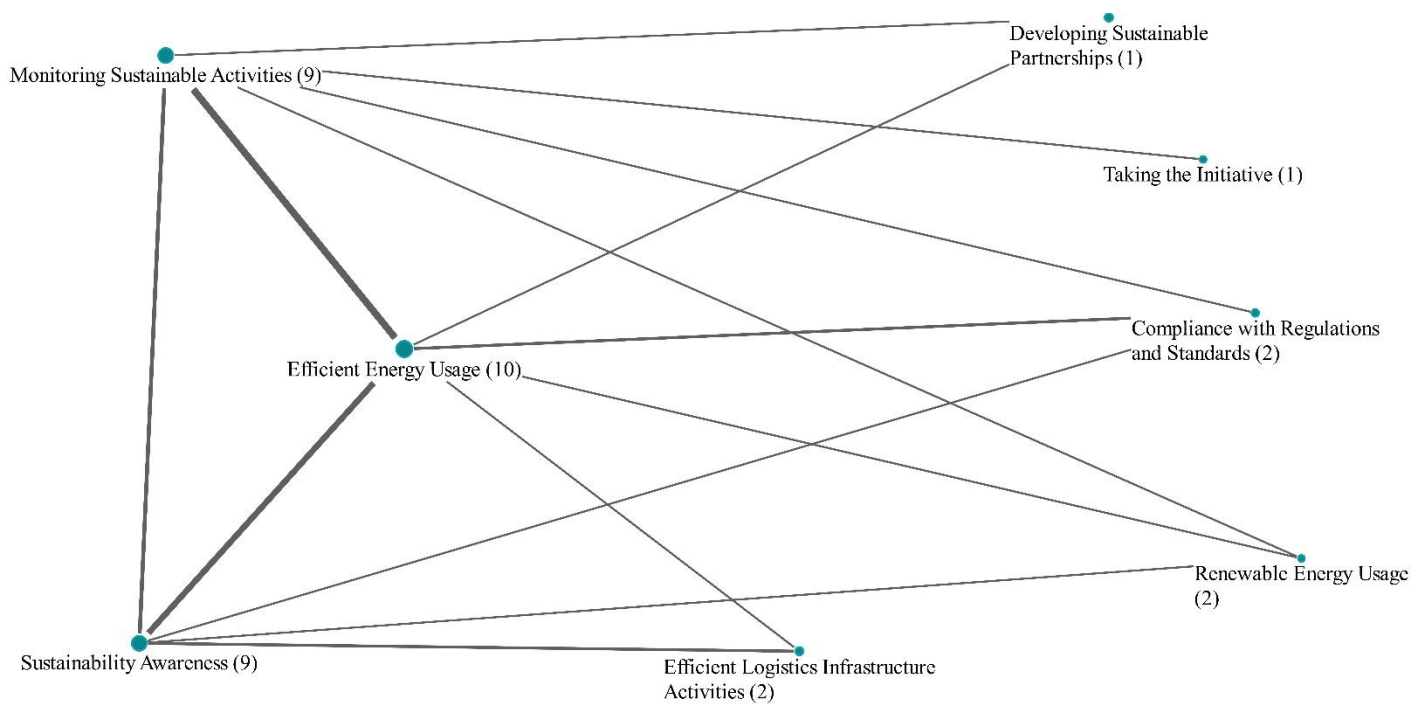


Figure 1: Relationship map of current activities in the development of environmentally sustainable logistics activities from the perspective of LSPs

Figure 1 shows the relationships between LSPs' current activity categories for developing environmentally sustainable logistics activities. The connections between the activities reveal the relationships between specific categories and how sustainability efforts are shaped. The central category is Efficient Energy Usage (10), along with Monitoring Sustainable Activities (9) and Sustainability Awareness (9). While still included as supporting factors, the other categories were mentioned less frequently. The categories assigned the lowest importance were Taking the Initiative (1) and Developing Sustainable Partnerships (1).

Efficient Energy Usage, which was the most frequently mentioned category, concerns reducing energy consumption through the correct combination of transportation modes. For these LSPs, road transport was the most preferred mode due to cost and time constraints, with priority given to reducing vehicle energy consumption.

The weak co-occurrence between Developing Sustainable Partnerships and Efficient Energy Usage suggests that energy-efficiency practices are approached predominantly as internal operational measures rather than as collaborative sustainability initiatives. This interpretation could be illustrated by participant statements such as, "Energy efficiency is something we mainly manage within our own operations (LP5)", and "We currently have very limited cooperation with external partners specifically on environmental sustainability (LP12)". Such a pattern would indicate that firm-level efficiency measures are more developed than inter-organizational sustainability practices.

Sustainability Awareness: The majority of the interviewees said that their company had launched various programs to make stakeholder behavior more environmentally friendly and sustainable. These programs included eco-driving, eco-sailing, and green takeoff and

landing training. Some stated that their company analyzes environmental risks when selecting suppliers.

Monitoring Sustainable Activities: According to the interviewees, a fundamental element of sustainable development is measuring the environmental impact of logistics activities, and the increasing use of independent verification authorities. They also recommended collaboration to increase the reliability of emissions calculations.

Secondary Category Activities: Some of the specific activities that were less frequently mentioned included employee initiative, compliance with regulations and standards, efficient use of external logistics infrastructure, product optimization and multimodal transport, collaboration, waste management, and use of environmentally friendly vehicles.

4.2 LSPs' Future Activities

The interviewed LSP employees discussed the difficulty of planning future strategies for sustainability activities. These activities were grouped under eight headings, with the three most frequently mentioned listed as primary activities and the others as secondary activities (Table 3).

Table 3: LSPs' Categorization of Logistics Companies' Future Environmental Sustainability Activities

<i>Primary Activities</i>	<i>Secondary Activities</i>
Technology and Innovation	Technology and Infrastructure Development
Natural Energy Resources	Logistics Network Design for Sustainability
Increasing Sustainability Awareness in Businesses	Alignment with Future Policies and Corporate Governance
	Collaboration with Supply Chain Stakeholders
	Improvement of Waste and Disposal Processes in Terms of Environmental Sustainability

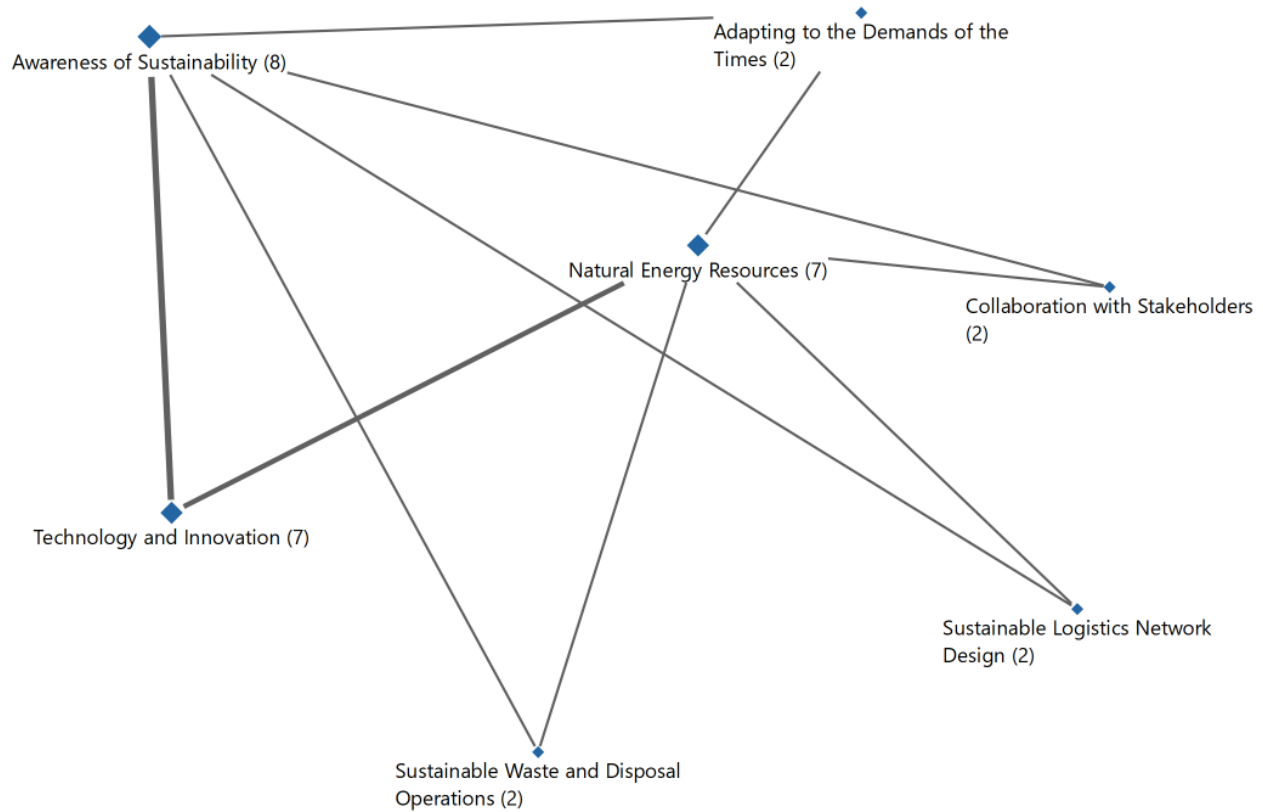


Figure 2: Relationship map of logistics service providers' future sustainability activities

Figure 2 shows the sustainable logistics activities that, according to the interviewees, LSPs' plan to focus on in the future and the relationships between them. The most frequently mentioned was Awareness of Sustainability (8), followed by Natural Energy Resources (7) and Technology and Innovation (7). These three categories were also strongly connected, which indicates that the logistics professionals believe that the logistics sector must prioritize innovative solutions and energy management to achieve environmental sustainability. The other categories were assigned lesser importance, although still evaluated as supporting elements for future sustainable logistics activities.

The three activities identified as primary reflect the need for innovation and technology to achieve sustainable development, particularly the need to base strategies to reduce energy consumption on long-term investments in research and innovation. The interviewees viewed renewable energy sources as an important part of environmentally sustainable activities. To increase sustainable awareness, the interviewees noted the need to create awareness among suppliers, customers, carriers, and logistics companies; on the other hand, they viewed cost and time as obstacles to their company's activities becoming more environmentally friendly.

The future-oriented findings indicate a stronger emphasis on Technology and Innovation, Natural Energy Resources, and Sustainability Awareness than on collaborative and governance-related activities. This pattern suggests that participants perceive technological transformation and organizational awareness as more immediate drivers of future sustainability than broader stakeholder coordination. This orientation is illustrated by statements such as, "We expect technological innovation to play a much greater role in reducing emissions in the future (LP3)" and "Renewable energy will

become increasingly important for our logistics operations (LP8)” whereas collaborative change was expressed through statements such as, “Greater cooperation among customers, carriers, and logistics companies will be necessary in the future (LP2)”.

Among the secondary activities identified by the interviewees were technology and infrastructure development, logistics network design, adaptation to future policies, collaboration with supply chain stakeholders, and waste management development. The interviewees reported that the LSPs were planning to develop transportation management systems and use technologies like Intelligent Transportation Systems along with increasing sustainability in waste and disposal management.

The prominence of technology and energy related themes over stakeholder collaboration indicates a predominantly firm-level view of future sustainability transformation, reflected in statements such as “Renewable energy will become increasingly important for our logistics operations (LP9)” and “Greater cooperation among customers, carriers, and logistics companies will be necessary in the future (LP6)”.

4.3 Challenges Faced by LSPs in Developing Sustainable Logistics Activities

The logistics professionals identified a number of challenges faced by LSPs in conducting their operations in a more environmentally sustainable manner. Five were defined as primary and three as secondary (Table 4).

Table 4: LSPs’ Categorization of the Challenges Hindering Environmental Sustainability Activities

<i>Primary Challenges</i>	<i>Secondary Challenges</i>
Customer Demands	Insufficient Information, Capital, and Infrastructure
Management Shortcomings and Complexity	Lack of Technical Service Providers
Uncertainties in the Logistics Network	Dynamic Nature of Labor Turnover
Technological and Legal Uncertainties	
High Costs	

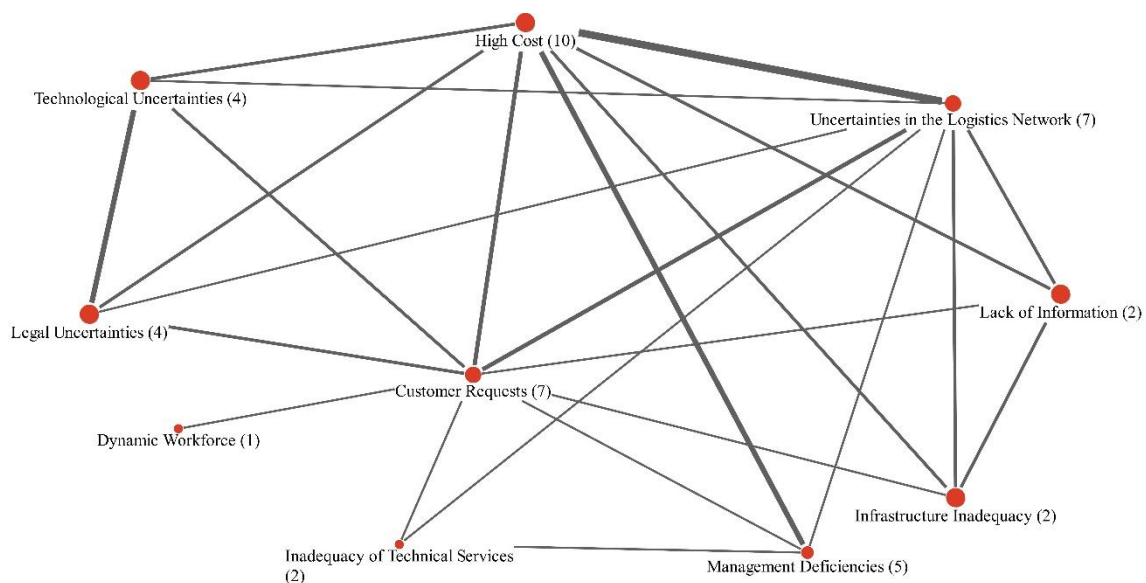


Figure 3: Display of the Frequency with Which LSP Mention Challenges Encountered in Sustainability Processes

Figure 3 shows the interviewees' perspectives regarding the challenges hindering the LSPs' sustainability activities and the relationships between these challenges. The most frequently mentioned and most strongly linked category was High Cost (10), followed by Customer Requests (7) and Uncertainties in the Logistics Network (7), which were also among the most significant challenges.

Regarding the specific primary challenges, the interviewees considered customer demands in terms of the need to offer sustainable solutions but noted that customers tended to show little interest. This makes the LSPs less efficient while increasing environmental damage. According to the interviewees, management deficiencies and complexity stem from the use of different standards for measuring greenhouse gas emissions, while the flexibility required by logistics systems creates difficulties. They linked uncertainties in the logistics network to imbalances in the flow of goods and resources, which then increase environmental impacts. Regarding the transition to fossil-free fuels, they suggested that sustainability is also hindered by technological and legal uncertainties, lack of infrastructure, regulatory gaps, and high costs.

Among the secondary challenges, the interviewees mentioned insufficient information and infrastructure, lack of technical services, and workforce turnover. They noted that small- and medium-sized enterprises in particular are postponing sustainability investments and lack sufficient knowledge in this area.

The prominence of High Costs, Customer Demands, and Logistics Network Uncertainty compared with secondary challenges suggests that sustainability barriers are perceived primarily through economic and operational pressures rather than through organizational support deficiencies alone. This is reflected in statements such as, "Customers ask for greener logistics services, but they are generally reluctant to pay the additional cost (LP4)" and "Cargo imbalances and empty return trips make it difficult to reduce the environmental impact of transport operations (LP7)".

Beyond their environmental and operational implications, the challenges identified by the logistics professionals also carry important consequences for international logistics and trade operations. The predominance of high costs as a primary barrier directly affects freight rates and price competitiveness in export and import markets, particularly for firms operating in cost-sensitive trade corridors. Similarly, uncertainties in logistics networks, stemming from imbalances in cargo flows, infrastructural constraints, and operational disruptions, translate into delivery delays and reduced reliability in cross-border trade. From a trade perspective, such uncertainties weaken supply chain predictability and increase transaction risks for international shippers.

Customer-related pressures further highlight the trade dimension of sustainability challenges. While global customers increasingly articulate sustainability expectations, their limited willingness to absorb additional costs constrains LSPs' ability to implement environmentally oriented practices without jeopardizing trade competitiveness. Regulatory and technological uncertainties, especially regarding emission standards, alternative fuels, and reporting frameworks, also create compliance risks in cross-border operations, where inconsistent rules across jurisdictions complicate trade execution. Taken together, these findings suggest that sustainability-related challenges faced by LSPs are not merely internal operational issues, but trade-relevant constraints that shape the efficiency, cost structure, and reliability of international logistics flows.

Taken together, the findings address the study's research questions by illustrating how sustainability is conceptualized by LSPs, how sustainability practices are operationalized over time, and which constraints most strongly shape implementation in practice.

These trade-related implications are particularly relevant to Türkiye–EU supply chains. Although the participants did not refer directly to specific European regulatory instruments, the identified barriers—including limited emissions data, high transition costs, infrastructural inadequacies, and regulatory uncertainty—may affect the ability of LSPs to support exporters facing increasingly demanding environmental compliance requirements in the EU market. In this respect, the findings provide an operational basis for discussing the implications of the EU Carbon Border Adjustment Mechanism and the Corporate Sustainability Due Diligence Directive in the following section.

5. Discussion

This study provides empirical insights into how logistics service providers in Türkiye conceptualize and operationalize environmental sustainability, as well as the constraints that shape implementation in practice. The findings indicate that although sustainability has increasingly entered the strategic discourse of LSPs, its translation into day-to-day logistics operations remains uneven and highly context-dependent. Environmental initiatives are frequently negotiated within narrow operational margins shaped by cost pressures, service-level expectations, technological readiness, and institutional uncertainty. This observation is consistent with previous studies suggesting that sustainability practices in logistics are often constrained by operational and economic realities rather than driven by proactive environmental strategies (Lieb & Lieb, 2010; Wolf & Seuring, 2010). However, the present study extends this literature by illustrating how such constraints are interpreted and managed by practitioners directly involved in logistics operations.

A central insight emerging from the analysis is the persistent tension between sustainability aspirations and operational feasibility. While logistics professionals articulated long-term ambitions related to digitalization, renewable energy use, alternative fuels, and sustainable network design, these aspirations were frequently accompanied by concerns regarding high investment costs, insufficient infrastructure, and regulatory ambiguity. Similar tensions have been reported in prior logistics and supply chain research, particularly in sectors characterized by tight margins and high performance expectations (McKinnon et al., 2015; Centobelli et al., 2017). The findings of this study reinforce this view by demonstrating that, even as sustainability awareness increases, implementation remains contingent on short-term operational constraints and risk considerations. From this perspective, sustainability in logistics should be understood not as a linear transformation process but as a gradual and negotiated adaptation shaped by multiple, interacting pressures.

The analysis further reveals that sustainability-related decisions made by LSPs extend beyond firm-level environmental performance and have direct implications for international logistics and trade operations. As LSPs play a critical role in organizing export and import flows, decisions concerning energy use, modal choice, fleet investments, and network configuration influence delivery reliability, freight costs, and service continuity across borders. High sustainability-related investment costs and network uncertainties may weaken exporters' price competitiveness in international markets, while importers may face longer lead times and increased supply variability.

This observation aligns with recent research emphasizing the growing interdependence between logistics sustainability and international trade performance, where environmental decisions increasingly affect cost structures, compliance, and resilience in cross-border supply chains (Rodrigue & Notteboom, 2017; Pratavia et al., 2024).

Regulatory and technological uncertainties identified in the study further complicate cross-border logistics operations. Inconsistent environmental standards, evolving reporting requirements, and limited infrastructure for alternative fuels increase compliance complexity and operational risk for LSPs engaged in international trade. These findings suggest that sustainability practices in logistics cannot be treated solely as internal environmental or operational concerns. Rather, they represent trade-relevant capabilities that shape the efficiency, reliability, and resilience of global supply chains. Improving sustainability performance in logistics, therefore, should be viewed not only as an environmental objective but also as a strategic enabler of competitive and resilient international trade.

These challenges acquire greater significance in the context of the European Union's evolving sustainability framework. The Carbon Border Adjustment Mechanism (CBAM) requires EU importers of covered products to account for the greenhouse gas emissions embedded in imported goods and, under the definitive regime, to meet the associated declaration and certificate obligations. Although the formal obligations principally fall on EU importers or their customs representatives, exporters outside the EU are increasingly expected to provide accurate and verifiable emissions information. For Turkish exporters supplying CBAM-covered sectors, the availability, traceability, and reliability of emissions data may therefore become closely connected to market access and customer requirements. LSPs can support this process through shipment-level data management, emissions monitoring, documentation, and coordination between exporters, carriers, customs representatives, and EU customers. However, the present findings indicate that insufficient information systems, infrastructure limitations, technological uncertainty, and high implementation costs may constrain this supporting role.

A related implication arises from the Corporate Sustainability Due Diligence Directive (CSDDD), which establishes sustainability due-diligence obligations concerning adverse human-rights and environmental impacts across the operations and chains of activities of companies within its scope. As large companies operating in the EU examine risks connected with their subsidiaries and business partners, logistics providers participating in their supply chains may face more extensive requests for environmental information, operational transparency, risk documentation, and evidence of corrective action. Turkish LSPs are not automatically subject to the Directive merely because they transport goods to the EU; nevertheless, they may be indirectly affected through contractual and information requirements imposed by EU customers or supply-chain partners. The study's findings concerning limited measurement capacity, inconsistent standards, weak stakeholder coordination, and cost pressures therefore indicate that sustainability compliance is becoming not only an internal environmental concern but also a capability affecting participation in European supply chains.

The findings contribute to the sustainable logistics literature by moving beyond abstract policy goals and technology-focused prescriptions and by foregrounding the lived experiences and decision-making realities of logistics practitioners. By adopting a practitioner-centered perspective, the study complements existing quantitative and policy-oriented research and highlights the importance of aligning sustainability ambitions with operational capacities and institutional contexts. In doing so, the study

offers a nuanced understanding of how sustainability practices are shaped, constrained, and gradually embedded within logistics operations that support international trade.

6. Conclusion

This study examined the environmental sustainability practices of logistics service providers in Türkiye by analyzing practitioners' perceptions of current activities, long-term expectations, and implementation challenges. Using a qualitative research design the study provided an empirical understanding of how sustainability is conceptualized and enacted within logistics operations. The systematic coding of interview transcripts, comparison of recurring patterns across participants, and MAXQDA-supported thematic analysis enabled the identification of key themes derived from practitioners' experiences.

The findings indicate that although LSPs have begun to integrate environmental sustainability into their operations, these efforts remain uneven and are frequently constrained by cost pressures, technological limitations, customer expectations, and institutional uncertainty. While interest in digital technologies, renewable energy, and sustainable network design is increasing, structural barriers continue to hinder long-term investment and organizational transformation.

The study has several limitations. First, due to its qualitative and exploratory design, the findings are not statistically generalizable. Second, the reliance on self-reported data may underrepresent less visible sustainability challenges or introduce social desirability bias. Third, the focus on a single national context limits cross-country comparability and the examination of temporal change. Accordingly, the findings should be interpreted as indicative rather than comprehensive.

Future research could extend this work through comparative analyses across logistics subsectors, mixed-method approaches integrating qualitative insights with quantitative performance indicators, and multi-actor perspectives incorporating shippers, regulators, and customers. In addition, further research on policy instruments, financial incentives, and public-private collaboration mechanisms could provide guidance for accelerating sustainability transitions in emerging markets.

In the context of global commitments to carbon reduction and sustainable supply chain development, logistics service providers will remain central actors in the transition toward environmentally responsible operations. Strengthening alignment among industry stakeholders, policymakers, and researchers will be critical to advancing sustainable logistics practices and enhancing the sector's long-term contribution to international trade and environmental sustainability.

Consent for Publications

We do not have any personal data of individuals (including individual details, images, or videos), and logistics professionals have provided their consent.

Competing Interests/Authors' Contributions

We declare that we have no competing interests or other interests that might be perceived to influence the results and/or discussion reported in this paper.

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Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request. Restrictions apply to the availability of these data due to commercial reasons.

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