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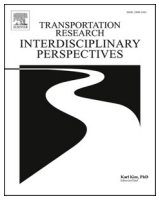

Adaptive resilience in freight: problem-solving strategies for the unexpected

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ABSTRACT

This study examines how Portuguese freight transport managers address operational disruptions, including delays, vehicle breakdowns, and fluctuating demand. Through eighteen semi-structured interviews with certified managers, the research identifies key challenges and managerial responses. Common disruptions cited were scheduling delays (16 participants), breakdowns (13), and last-minute client requests (10). Managers predominantly relied on adaptive, experience-based strategies - such as real-time rerouting, maintaining backup vehicles, and proactive Client Relationship Management to manage expectations and maintain service quality. Five core problem-solving competencies emerged: adaptability (90%), crisis management (65%), client relationship management (60%), resilience (50%), and strategic planning (45%). While these strengths were notable, the study found limited application of collaborative problem-solving (CoPS) and minimal integration of sustainability practices. Managers cited high costs and insufficient policy support as primary barriers to adopting greener strategies. Technological use was largely limited to basic tools like GPS tracking and digital documentation. More advanced systems were underutilized due to financial and technical constraints. The research aims to (1) identify primary disruption types, (2) evaluate response strategies, (3) assess sustainability integration, and (4) examine the role of technology. This study extends the Dynamic Capabilities and Purchasing and Supply Management (PSM) competency frameworks by showing how managers in small/medium logistics firms rely on context-specific, improvisational approaches to manage disruptions. A new conceptual framework is proposed, linking disruption types, managerial competencies, and moderating factors such as limited resources and sustainability pressures. Policy recommendations include targeted training, digital upskilling, supportive incentives to promote resilience and sustainable innovation.

Introduction

Freight transport is essential to the global economy. It connects suppliers and consumers, supporting economic activities (Rothengatter et al., 2021). In 2022, global exports totaled 25 billion USD, accounting for 25.3% of the world's GDP (UNCTAD, 2024). Road freight stands out in particular due to its flexibility and the growth of e-commerce (Szymczyk & Kadłubek, 2019).

In Portugal, the road freight sector is primarily composed of small and medium-sized enterprises that face challenges such as limited investment, modernization, and competitiveness (IBISWorld, 2014). The industry is also affected by shifting consumer demands, environmental regulations, and operational interruptions (Wide, 2020). In light of the supply chain vulnerabilities exposed by the pandemic, it is crucial to address these challenges to maintain service quality and sustainability (Szymczyk & Kadłubek, 2019; Rothengatter et al., 2021). These vulnerabilities underscore the importance of equipping managers in this sector with robust problem-solving skills, as resilience and competitiveness increasingly hinge on effective disruption management.

This research draws on theories addressing organizational adaptability and problem-solving in complex environments. Dynamic Capabilities Theory, as explained by Ritala et al. (2016), emphasizes that companies must develop flexible and proactive strategies to manage unexpected disruptions. Another critical theoretical foundation is collaborative problem-solving, which emphasizes the need for effective cooperation across teams and supply chains to ensure resilience and

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continuity, particularly in sectors prone to disruptions, such as freight transport (Bhardwaj et al., 2018). Additionally, creative problem-solving provides a valuable framework that emphasizes managers' ability to innovate within constraints. This flexibility allows managers to balance structured approaches with ad hoc solutions and address unique challenges as they arise (Pereira et al., 2021).

Although problem-solving in freight transport has been widely studied in broader international contexts (Bhardwaj et al., 2018), there has been limited research addressing how these techniques are applied by Portuguese freight transport managers (Katinienė et al., 2021). Therefore, the research problem is defined as investigating how Portuguese freight transport managers utilize problem-solving techniques to manage sector-specific disruptions. Closing this research gap is crucial for developing localized strategies that enhance operational resilience and sustainability.

The purpose of this study is to investigate and evaluate the knowledge and proficiency of Portuguese freight transport managers when it comes to employing problem-solving techniques.

Literature Review

This chapter reviews the literature on problem-solving in freight transport, focusing on five core themes: (1) types of disruptions in freight transport, (2) key problem-solving frameworks including dynamic capabilities and creative problem-solving, (3) competencies required for effective problem-solving, (4) sustainability challenges, and (5) previous contributions and limitations in this field. These themes were selected to guide a structured exploration of the theoretical and practical landscape relevant to freight management disruptions, and to identify key gaps that this study aims to address.

Problems and Disruptions in Freight Transport

The purpose of this study is to investigate and evaluate the knowledge and proficiency of Portuguese freight transport managers when it comes to employing problem-solving techniques. These companies face a wide range of disruptions that can significantly impact their operations. Wide (2020) defines disruptions as changes or deviations from the original transport plan caused by unexpected events, such as delays or operational issues. These disruptions affect the supply chain and necessitate real-time management and recovery actions. Primary categories of these issues include operational disruptions, capacity and demand fluctuations, urban logistical obstacles, environmental and regulatory limits, and the growing need for technological integration.

Operational Disruptions and Crisis Management

Frequent operational disruptions in freight transport, including traffic accidents, adverse weather conditions, vehicle breakdowns, and unforeseen events such as pandemics, affect service reliability and result in cost increases (Hrušovský et al., 2021; Karam & Reinau, 2022). These issues are especially important in line-haul networks because delays have ripple effects throughout the supply chain (Karam & Reinau, 2022).

In addition to physical disruptions, workforce shortages, regulatory changes, and strikes can exacerbate operational challenges. For instance, labor strikes or driver shortages can severely impact logistics schedules, resulting in longer lead times and increased costs (Wide, 2020). Furthermore, fluctuating fuel prices and regulatory shifts, such as stricter emissions standards, can create additional operational challenges for freight companies, especially those managing long-haul routes (Szymczyk & Kadłubek, 2019).

Capacity and Demand Fluctuations

Managing changes in capacity and demand is a major issue in freight transport, especially during times of crisis (Loske, 2020). For example, during the pandemic, freight transport faced unprecedented challenges due to sudden shifts in consumer demand and government restrictions. For example, "panic buying and increased home consumption had various impacts on transport volume and freight capacity dynamics in German food retail logistics" This resulted in capacity constraints and service delays (Loske, 2020, p.1). This crisis required the ability to handle high demand volatility and rapid re-planning (Rothengatter et al., 2021).

Urban Logistics and Last-Mile Delivery

Urban logistics poses serious challenges for freight transport companies, especially in highly congested cities. "Strategies and solutions should focus on solving the last-mile problem, which generally occurs in highly dense urban cores" (Szymczyk & Kadłubek, 2019, p. 526).

Logistics networks are under greater strain due to the growth of e-commerce and the increased demand for last-mile delivery. It is also difficult to adhere to delivery schedules and reduce expenses because of urban congestion, environmental regulations (e.g., zero-emission zones), and limited access to delivery locations (Szymczyk & Kadłubek, 2019). A study of the Portugal case (Correia et al., 2022) emphasizes the challenges of last-mile delivery in congested urban settings and focuses on the need for innovative solutions in stakeholder collaboration and resource sharing.

Environmental and Regulatory Constraints

Environmental regulations and sustainability are major concerns in the freight transport industry (Wide, 2020). The need to minimize greenhouse gas emissions and adhere to regulations like the European Union's transportation emission reduction targets has compelled logistics companies to explore more eco-friendly transportation solutions (Szymczyk & Kadłubek, 2019).

"Logistics activity should consider reducing the environmental impact of their supply chains, developing sustainable transportation, and implementing green supply chain strategies. However, what is easy to claim becomes hard to achieve" (Szymczyk & Kadłubek, 2019, p. 527). Hrušovský et al. (2021) reported that companies are increasingly turning to multimodal transportation to lower their carbon footprint by shifting from road to rail or water transportation. However, operating multimodal transportation networks is complex, involving the coordination of many operators and posing the risk of disruption (Hrušovský et al., 2021).

Technological Integration and Decision Support Systems (DSS)

DSS and information and communication technology (ICT) are becoming increasingly important in freight transport operations, particularly in those with complex supply chains. These systems help handle interruptions, optimize routes, and guarantee on-time delivery (Karam & Reinau, 2022; Wide, 2020). Nevertheless, many logistics companies struggle to incorporate these solutions into their daily operations (Karam & Reinau, 2022).

Another important problem is the lack of comprehensive, real-time data sharing across different supply chain stakeholders (Konstantakopoulos et al., 2020). Inadequate information flow and communication lead to ineffective disruption management, as logistics providers often do not receive timely updates from partners (Wide, 2020).

Problem-Solving Methods

According to Pereira et al. (2021), problem-solving frameworks offer various methods for diagnosing, addressing, and mitigating disruptions and problems.

Dynamic Capabilities

The framework of dynamic capabilities is a popular approach to managing and responding to disruptions. According to Ritala et al. (2016), dynamic capabilities are a company's ability to integrate,

develop, and reconfigure internal and external competencies in order to adapt quickly to changing circumstances.

This approach enables businesses to identify the essential components of an issue, integrate existing knowledge with dynamic capabilities and improvisational tactics, and develop more effective solutions for better long-term performance. In this context, identifying problems is more than finding answers; it's also about breaking down complexity to allow for new methods (Ritala et al., 2016). Companies with robust dynamic capabilities can reorganize supply networks, reallocate resources, and devise creative solutions to unforeseen issues more effectively. For example, firms must prevent capability rigidity by quickly and flexibly deploying resources in the event of interruptions, such as a pandemic (Ritala et al., 2016).

The ad hoc problem-solving approach complements dynamic capabilities by addressing unfamiliar, urgent problems that require quick solutions outside established organizational routines (Pereira et al., 2021). Often, these solutions must be created quickly, depending on improvisation and innovation when the available dynamic skills are insufficient (Ritala et al., 2016).

Creative Problem-Solving (CPS)

Creative problem-solving (CPS) emphasizes creativity and investigating new solutions, offering an alternative to traditional techniques. When new difficulties arise that conventional systems cannot adequately address, creative problem-solving and unconventional thinking are essential to identifying new opportunities (Kuo et al., 2014). CPS involves systematic exploration, brainstorming, and ideation stages that help organizations and teams generate solutions to ambiguous and ill-defined problems.

A defining feature of CPS is its future-oriented focus, prompting teams to transition from considering "what is" to "what could be" (Rindova & Martins, 2021, p. 1). Further characteristics of CPS include stakeholder involvement and iterative procedures that test and refine ideas. These processes are especially helpful when freight transport faces complex difficulties, such as supply chain interruptions (Bridoux & Stoelhorst, 2020).

Rubenstein et al. (2020) emphasize the importance of problem identification tactics and perspective-taking in promoting creative problem-solving. These tactics help individuals approach problems from diverse angles, thus improving creativity and solution quality. Furthermore, creative problem-solving is crucial for improving stakeholder communication and integrating diverse perspectives when addressing disruptions (Rindova & Martins, 2021).

Collaborative Problem-Solving (CoPS)

Collaborative Problem-Solving (CoPS) has been recognized as an essential framework in settings such as logistics and freight transportation, where cooperation and teamwork are critical (Pereira et al., 2021). CoPS is particularly useful when many supply chain links are disrupted and a coordinated effort is needed to resume operations (Sun et al., 2020).

CoPS "refers to the coordinated attempt between two or more people to share their skills and knowledge to construct and maintain a unified solution to a problem" (Sun et al., 2020, p. 2). In freight transport, for example, disruptions often require input from logistics teams, suppliers, customers, and regulatory authorities. The OECD (2017) framework emphasizes the importance of maintaining a shared understanding and effective communication to align the interests of diverse stakeholders (Sun et al., 2020).

Griffin et al. (2012) further highlight CoPS's role in setting task goals, monitoring progress, and ensuring shared responsibilities among team members (Sun et al., 2020). This collaborative effort fosters a unified approach to problem solving, which is particularly beneficial in complex logistics environments.

Problem-Solving through Knowledge Management

During disruptions in the freight transport industry, the ability to quickly distribute and utilize organizational information can mean the difference between failure and success, as knowledge sharing is a crucial capability for problem-solving (Zhang et al., 2021). To ensure that lessons learned from past disruptions are effectively applied to future situations, managers must foster a culture of continuous learning and encourage the exchange of best practices among teams (Pereira et al., 2021).

Competencies Required for Problem-Solving

Effective problem-solving in freight transport management requires specific skills that address the difficulties caused by disruptions (Bals et al., 2019). Methodical examination and analytical and strategic thinking help break down complicated problems and develop long-term solutions while avoiding biases (Rubenstein et al., 2020). Dynamic capabilities emphasize flexibility and adaptability, enabling managers to swiftly modify tactics in response to disruptions (Bhardwaj et al., 2018).

Value co-creation ensures that stakeholder engagement results in sustainable solutions, making collaboration crucial (Aarikka-Stenroos & Jaakkola, 2012). When conventional methods fail, creative and innovative thinking is essential for identifying new opportunities. Knowledge sharing and team-based problem solving support efficient team coordination (Katinienė et al., 2021). In addition to technical talents, empathy and interpersonal skills are useful for managing relationships and resolving issues (Kuo et al., 2014). Finally, scientific, data-driven problem solving ensures that decisions are informed by structured analysis, thereby optimizing business processes and responses to challenges (Katinienė et al., 2021).

Table 2.1 presents a detailed alignment between problem-solving competencies and their corresponding theoretical frameworks. This mapping helps clarify the foundation upon which freight transport managers build their disruption responses. For instance, "Flexibility and Adaptability" is linked to Dynamic Capabilities Theory, highlighting its role in enabling rapid adjustment to operational shocks.

As the logistics landscape becomes more complex due to variables such as digital transformation, sustainability demands, and global economic uncertainties, management skills will need to change (Bals et al., 2019).

According to Bals et al. (2019), the future will require integrating additional competencies, such as technological literacy, sustainability management, and proactive risk management. These future competencies focus on the use of data-driven tools, long-term value creation, and the integration of environmentally friendly procedures into logistical operations (Bals et al., 2019).

The following table (Table 2.2) illustrates the shift from current to future competency needs by comparing current problem-solving competencies with those outlined by Bals et al. (2019).

Sustainable and Smart Transport Strategies: Relevance to Freight Problem-Solving and Resilience

The evolution of sustainable and smart transportation strategies provides a crucial backdrop for understanding how freight transport managers can strengthen their disruption management capabilities—particularly in contexts shaped by rapid urbanization, tightening environmental regulation, and accelerating technological transformation. These challenges are not isolated: they directly support this study's objectives by linking managerial problem-solving with sustainability integration and the adoption of digital tools in Portuguese freight transport. In this sense, sustainability emerges not as a separate issue, but as an embedded competence that shapes resilience in logistics systems.

Almatar (2023b) investigates the expansion of electric vehicle (EV) infrastructure across multiple global urban settings, demonstrating how

Table 2.1
Competencies and theories for strategic problem-solving

Competence	Theory/Concept	Description/ Justification	References
Analytical and Strategic Thinking	CPS & Dual-Process Theory	Emphasizes systematic analysis, strategic planning, and the avoidance of cognitive biases for robust decision-making.	Rubenstein et al., 2020; Katinienė et al., 2021; Bhardwaj et al., 2018
Flexibility and Adaptability	Dynamic Capabilities & Ad Hoc Problem-Solving	Necessitates adapting to changing situations and using flexible strategies to handle unforeseen challenges effectively.	Ritala et al., 2016; Bhardwaj et al., 2018; Rubenstein et al., 2019; Dörner & Funke, 2017
Collaboration and Value Co-Creation	Service-Dominant Logic & Stakeholder Governance	Focuses on creating value through stakeholder collaboration and shared governance in problem-solving processes.	Bridoux & Stoelhorst, 2020; Aarikka-Stenroos & Jaakkola, 2012
Creative and Innovative Thinking	Design Science Approach & AI-Enhanced Problem-Solving	Encourages the use of innovative techniques, generative AI, and design-oriented strategies to explore novel solutions.	Rindova & Martins, 2021; Boussioux et al., 2024
Team-Based Problem-Solving and Knowledge Sharing	Collaborative Problem-Solving & Knowledge Management	Highlights the importance of teamwork, knowledge exchange, and managing interpersonal dynamics for effective outcomes.	Sun et al., 2020; Parveen et al., 2021
Empathy and Interpersonal Skills	Frontline Problem-Solving	Enhances problem resolution through empathy, negotiation skills, and relationship management within teams and suppliers.	Marinova et al., 2018; Kuo et al., 2014
Scientific and Data-Driven Problem Solving	Scientific Management Methodology & Systematic Problem-Solving	Promotes using data-driven methods and structured approaches to find solutions and optimize business processes.	Pereira et al., 2021; Mohaghegh & Furlan, 2020

Source: Self-elaborated.

increased charging access encourages renewable energy adoption, reduces congestion, and lowers emissions. This evidence underscores a critical challenge mirrored in the Portuguese freight sector: the tension between sustainability goals and limited infrastructure or investment capacity. By explicitly connecting infrastructure development with emission-reduction outcomes, Almatar's findings highlight the need for freight managers to build strategic competencies in sustainable planning, energy optimization, and long-term investment alignment. These skills are increasingly indispensable for managers facing both market pressures and EU decarbonization directives.

In a complementary study, Almatar (2023c) explores green mobility transitions in Saudi Arabian cities, identifying systemic challenges—particularly cost barriers and fragmented policy

Table 2.2
Comparison of Current Problem-Solving Competencies vs. Future PSM Competencies.

Competence Area	Future PSM Competencies	Explanation
Strategic Thinking	Strategic Risk Management	Proactively identifying and mitigating risks in an increasingly uncertain environment.
Flexibility and Adaptability	Technological Literacy	Leveraging data analytics, AI, and automation to improve decision-making and adaptability.
Collaboration and Communication	Collaborative Leadership	Building long-term, value-driven partnerships for sustainable and strategic outcomes.
Creative Thinking and Innovation	Sustainability Management	Prioritizing eco-friendly solutions and integrating sustainable practices into logistics.
Data-Driven Problem Solving	Digital Transformation & Data Analytics	Applying AI and real-time data for decision-making and automation.
Empathy and Negotiation	Ethical and Empathetic Leadership	Focus on ethical leadership and long-term stakeholder relationships.

Source: Adapted from Bals et al., 2019.

environments—that often constrain the adoption of low-carbon solutions. The Portuguese context reflects similar barriers: interviewees in this research pointed to financial pressures and regulatory complexity as major obstacles to implementing sustainable logistics practices. These findings emphasize that sustainable problem-solving in freight transport requires not only managerial agility and innovation capacity, but also robust institutional support and policy coherence.

Transit-Oriented Development (TOD) strategies also provide conceptual insights for freight efficiency. Almatar (2022) illustrates, through a Riyadh case study, how integrated land use and transport planning reduces reliance on private vehicles. While TOD primarily targets passenger mobility, its principles have significant spillover value for freight systems. Concepts such as urban consolidation centers, shared logistics infrastructure, and last-mile delivery integration can enhance freight resilience while simultaneously reducing environmental impact. For Portuguese freight managers, this implies the development of competencies in analytical thinking, cross-sectoral coordination, and strategic urban planning, aligning managerial practice with broader sustainability and resilience goals.

Sustainability challenges are also deeply intertwined with the issue of congestion. Almatar (2023a) analyzes traffic congestion patterns in Dammam, proposing predictive and infrastructural interventions to mitigate systemic bottlenecks. Congestion was identified in this study as one of the most frequent disruptions cited by Portuguese freight managers, making the parallel particularly relevant. Both contexts demonstrate the importance of adopting predictive analytics, real-time routing systems, and infrastructure responsiveness as core tools in disruption mitigation. From a competency perspective, these findings reinforce the critical role of technological fluency and data-driven decision-making.

The role of smart transport technologies further illustrates the link between sustainability and resilience. Almatar (2024a) provides an in-depth analysis of the new Riyadh public transportation system, highlighting the strategic planning and governance frameworks necessary to support large-scale mobility transformation. In another study, Almatar (2024b) outlines the potential and limitations of integrating ICT systems into smart transportation planning. These insights resonate strongly with the Portuguese freight context, where managers reported the growing - though still limited - use of GPS, satellite tracking, and digital documentation systems. They underline the urgent need for investment in DSS and the development of digital literacy among managers as

prerequisites for sustainable and resilient freight operations.

Almatar (2024a) identifies systemic barriers to smart transportation implementation in Saudi Arabia, including infrastructure deficits and low digital readiness. These findings parallel those of Portuguese freight companies, particularly SMEs, which often struggle with financial constraints and limited institutional capacity for digital transformation. Such evidence strengthens the case for treating sustainability not only as an environmental goal but also as a strategic competency domain where technological adoption, institutional reform, and managerial problem-solving converge.

Taken together, these studies expand the theoretical and practical foundation for freight disruption management by emphasizing the transformative role of sustainability-oriented planning and technological innovation. They confirm that the competencies required to navigate disruptions—adaptability, strategic foresight, cross-sectoral collaboration, and technological fluency—are not unique to Portugal, but part of a broader global shift in logistics and mobility systems. In this way, sustainability challenges act as both constraints and catalysts, pushing freight managers toward new problem-solving models that simultaneously advance resilience and environmental responsibility.

Previous Contributions and Respective Limitations

Research on freight transport management has yielded insightful conclusions about DSS, operational disturbances, and sustainability issues. For example, Wide (2020) examines significant supply chain disruptions, while Szymczyk and Kadłubek (2019) address sustainability concerns in urban logistics. Loske (2020) examines the effect of the pandemic on transport capacity, while Katinienė et al. (2021) emphasize the significance of logistics capabilities. Furthermore, Hrušovský et al. (2021) and Karam & Reinau (2022) contribute by presenting frameworks for disruption management and decision support systems, respectively.

However, despite these contributions, gaps remain that hinder the practical application of these findings in real-world scenarios. Many authors acknowledge limitations in their studies, such as insufficient focus on real-time solutions, lack of data on long-term impacts, and limited exploration of problem-solving competencies in freight transport.

The following table (Table 2.3) summarizes key studies, detailing their methodologies, main contributions, and limitations. These gaps point to the need for further research in Portuguese freight transport to address the shortcomings of existing studies.

Table 2.3
Previous studies about problem-solving competencies in freight transport: contributions and limitations.

Author(s)	Method	Contributions (Main Topics)	Authors' Recognized Limitations (Research Gaps)
Wide, 2020	Case study in freight transport using qualitative interviews	-Identified key operational disruptions and their impact on supply chain performance.	-Lack of focus on real-time management solutions.-The role of technology in handling disruptions.
Szymczyk & Kadłubek, 2019	Comparative analysis of major logistics operators in the EU	-Highlighted challenges in urban logistics and last-mile delivery with a focus on sustainability.	-Limited investigation into how companies implement sustainable solutions in urban logistics.
Loske, 2020	Empirical analysis of transport volume and freight capacity during COVID-19	-Examined the impact of the pandemic on transport capacity dynamics.-The shift in consumer behavior.	-Insufficient long-term data on capacity management post-COVID-19.-Focus limited to Germany.
Katinienė et al., 2021	Qualitative research on logistics competencies using expert interviews	-Emphasized the importance of problem-solving competencies for logistics specialists.	-Did not investigate practical applications of problem-solving in freight transport management.
Hrušovský et al., 2021	Simulation-optimization approach for intermodal freight transportation	-Proposed real-time disruption management techniques for intermodal freight transport.	-Focuses on simulation without extensive real-world testing.
Karam & Reinau, 2022	Real-time decision support framework based on hybrid simulation-optimization	- DSS to manage line-haul disruptions in freight transport networks.	-Limited discussion on integrating DSS in smaller, less resourced logistics companies.

Source: Self-elaborate.

While previous studies have made substantial contributions to understanding operational disruptions and problem-solving competencies in freight transport, most of this research has focused on large-scale logistics systems in developed economies with advanced digital infrastructures—such as Germany, the United States, or multi-national EU logistics operators (e.g., Loske, 2020; Szymczyk & Kadłubek, 2019; Wide, 2020). These studies often assume access to high levels of technology, robust policy frameworks, and significant capital investment, which may not hold true in other national contexts.

However, the Portuguese freight transport sector is dominated by small and medium-sized enterprises (SMEs), which face distinct challenges: limited access to digital tools, fragmented supply chain coordination, and strong financial constraints. These characteristics are underrepresented in current literature, creating a meaningful gap in understanding how freight managers adapt and apply problem-solving strategies under resource-limited conditions.

This study addresses that gap by empirically exploring how Portuguese freight transport managers deploy problem-solving competencies - such as adaptability, strategic planning, and crisis management - in a setting marked by operational unpredictability, constrained infrastructure, and emerging regulatory pressures around sustainability. The aim is not only to extend theoretical models like Dynamic Capabilities and the PSM Competencies Framework but to contextualize them within a logistics environment where improvisation and experience-based decision-making are often more practical than formalized systems. In doing so, this study offers a novel, context-sensitive contribution to the growing body of logistics and disruption management research.

While the literature offers valuable insights into operational disruptions, problem-solving strategies, and logistics competencies, significant gaps remain - particularly in the context of Portuguese freight transport. Few studies address how managers apply these frameworks in real-world scenarios under resource constraints. These gaps directly inform the research design of this study, which adopts a qualitative methodology to explore the practical application of problem-solving competencies. The review also guides the development of the study's conceptual framework, which integrates the dynamic capabilities and PSM competency models to assess the real-world problem-solving approaches used by freight managers.

To address the research objectives, semi-structured interviews were conducted with freight transport managers in Portugal. The selected participants were chosen based on their managerial roles and their direct involvement in operational decision-making processes within the freight transport industry. These interviews aimed to close the knowledge gap regarding how managers use problem-solving tools and how their competencies must evolve to handle disruptions effectively. The Table 2.4 summarizes the main research issues from the literature review, the corresponding research questions, and the associated research objectives.

Table 2.4
Research questions and objectives.

Key Research Question:	**How can the know-how and proficiency of Portuguese freight transport managers in employing problem-solving techniques be investigated and evaluated?**
Main Issues from Literature Review	**Research Question and Objective**
Operational disruptions in freight transport, such as demand fluctuations, capacity issues, and environmental constraints, are common (Wide, 2020).	**RQ1:** What are the primary operational disruptions experienced by freight transport managers in Portugal?
Problem-solving techniques like dynamic capabilities and creative problem-solving are necessary to manage unexpected disruptions (Ritala et al., 2016; Rubenstein et al., 2020).	**RQ2:** What problem-solving methods do Portuguese freight transport managers use to address disruptions?
Incorporating sustainability into logistics operations, particularly in urban and last-mile delivery, poses challenges (Szymczyk & Kadłubek, 2019).	**RQ3:** In what ways do Portuguese freight managers incorporate sustainability into their problem-solving approaches?
The integration of technological tools such as DSS remains insufficient for managing freight transport disruptions (Karam & Reinau, 2022).	**RQ4:** What role do DSS and other technological tools play in solving problems caused by disruptions?

Source: Self-elaborated.

Research Methodology

Qualitative research significantly contributes to our understanding of the competencies necessary for efficient problem-solving, particularly in sectors such as freight transportation. While the majority of prior research has focused on theoretical frameworks, such as collaborative problem-solving and dynamic competencies, there is a lack of information in the literature regarding how freight transport managers apply these competencies. Building on frameworks such as the PSM Competencies and other problem-solving methods, this research aims to evaluate current and future competency requirements from a strategic management perspective.

Interviews were conducted over the phone in October 2024 to accommodate participants' availability. Eighteen interviews were conducted, each lasting between 10 and 20 minutes. Before each interview, participants were informed of the study's objectives, and consent was obtained to ensure anonymity and confidentiality. Audio recordings were made for each session and transcribed using Transkriptor. As explained in Annex A, a structured interview script served as the basis for the interviews.

The interview guide was carefully structured to align with the research questions and objectives. It was divided into three main sections:

Participant Background – focusing on job roles and experience to confirm the relevance of the sample.
Core Research Topics – addressing specific questions about operational disruptions, sustainability, and technological tools.
Competency Reflection – exploring the key competencies managers consider crucial for solving problems in the freight transport sector.

To ensure the interview questions were clear and effective, a pretest was conducted with three selected participants representative of the target population: freight transport managers. These initial interviews provided an opportunity to discuss the participants' understanding of and feedback on the clarity of the questions. Based on the feedback received during the pretest interviews, the instrument was refined to clarify the questions and ensure they aligned with the research objectives (Table 3.1).

Purposive sampling was employed to ensure that participants were directly involved in managing freight transport disruptions and had substantial experience in the field. This approach yielded a diverse sample representing different regions and companies in the Portuguese freight transport industry.

Table 3.1
Research objectives, questions, and type of question.

Objective	**Interview Question**	**Question Type**
Confirm participant's role and experience in freight transport management	What is your current job role and your professional category?	Descriptive
Assess the participant's years of experience in the industry.	How many years of experience do you have in freight transport management?	Descriptive
Confirm compliance with regulatory certification	Do you hold a Professional Capacity Certificate for the Transport of Goods?	Descriptive
Understanding company size and structure	How many employees does your company have?	Descriptive
Identify common types of disruptions in operations	Can you describe a recent disruption in your freight transport operations and how you managed it?	Descriptive
Explore approaches used for problem-solving	What methods or strategies do you use to address disruptions in freight transport?	Exploratory
Examine sustainability integration in problem-solving	How important is sustainability in your approach to managing freight transport issues?	Interpretive
Understand role of technology in managing disruptions	What role does technology play in your efforts to resolve operational issues?	Descriptive
Identify critical skills for effective problem-solving	What skills do you believe are essential for effectively solving problems in freight transport?	Exploratory

Source: Self-elaborated.

Participants were selected using purposive sampling to ensure their direct relevance to the research objectives. All interviewees were certified freight transport managers holding a Professional Capacity Certificate issued by the Portuguese Institute for Mobility and Transport (IMT), a regulatory requirement for managerial roles in the sector. The sample included a balanced mix of company sizes and geographic regions, ensuring a diversity of operational contexts. This selection strategy ensured that all participants had the practical experience and regulatory knowledge necessary to provide reliable, context-specific insights. Thematic saturation was achieved by the twentieth interview, confirming the adequacy of the sample for this qualitative study.

To ensure the data collected was comprehensive, this study adhered to the principle of thematic saturation. According to Rahimi & Khatooni (2024), thematic saturation occurs when additional interviews yield no new themes, indicating that the sample size is sufficient to capture the necessary insights. After eighteen interviews, it became evident that participants were providing similar responses, indicating that thematic saturation had been reached. Consequently, the sample size was deemed adequate to thoroughly understand freight transport managers' problem-solving competencies, eliminating the need for a larger dataset. This approach aligns with the recommendations of Plakoyiannaki and Budhwar (2021) and allows the research to focus on depth and relevance rather than quantity, ensuring robust and meaningful insights.

To assist with data visualization and analysis, this study used Orange Data Mining. Orange facilitated thematic analysis by providing intuitive visualizations that supported identifying recurring themes and patterns within the interview data.

This study uses the PSM Competencies framework (Bals et al., 2019) to evaluate freight transport managers' problem-solving skills. PSM competency clusters, such as analytical skills, strategic sourcing, and negotiation, were adapted to the context of freight transport, providing a structured assessment of the current and emerging skills necessary for managing operational disruptions. The interview questions were

formulated using this framework, ensuring a systematic approach to evaluating the competencies needed to address present and future sector challenges.

The study employs a qualitative approach grounded in thematic analysis. Eighteen certified freight transport managers were selected through purposive sampling, representing a cross-section of operational roles and company sizes. Data were collected using a structured interview guide (Annex A) and analyzed using coding and visualization tools provided by Orange Data Mining. This methodology ensures alignment with the research objectives, enabling a grounded, context-specific understanding of problem-solving competencies in disruption management.

Data analysis

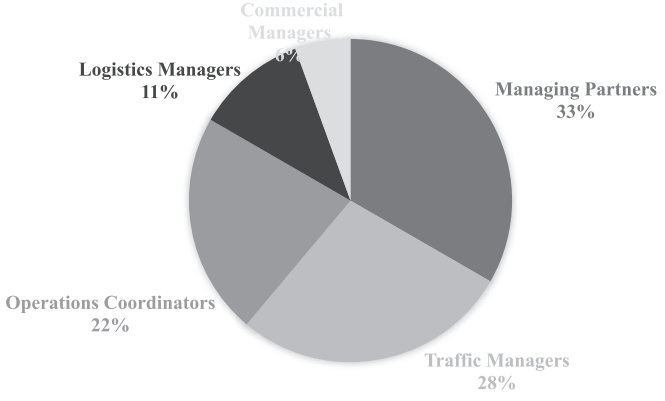
This chapter explains the data processing and qualitative analysis of the interviews, as well as the resulting commentary. The analysis focused on common themes regarding freight transport management problem-solving using qualitative coding techniques. Orange Data Mining software supported data processing and visualization, aiding in categorizing themes and highlighting redundancies that confirmed thematic saturation with the eighteen interviews conducted.

Sample characterization

This study is based on eighteen interviews with managers in the freight transport sector in Portugal. Sample characterization is essential to qualitative research because it influences the context and depth of the insights obtained. By carefully defining the sample, researchers can ensure that the data is pertinent and representative of the various viewpoints within the phenomenon under study. This procedure facilitates the development of significant, contextually grounded conclusions and strengthens the validity of the findings. "The qualitative researcher identifies participants who can provide information (data) to answer the research question" (Gill, 2020, p. 1). The three primary aspects covered in this study's sample are job role, freight transport experience, and company size and scope.

Job role

Five professional categories were developed for the interviewees' roles: Managing Partner, Traffic Manager, Operations Coordinator, Logistics Manager, and Commercial Manager. As shown in Fig. 4.1, the sample includes six managing partners, five traffic managers, four operations coordinators, two logistics managers, and one commercial manager. Eleven people (61% of the sample) fall into the higher-level professional categories of managing partners and traffic managers. The other seven individuals (39% of the sample) fit into professional categories such as commercial manager, logistics manager, and operations coordinator.



Source: Self-elaborated

Fig. 4.1. Job Role (N = 18).

This distribution provides an in-depth understanding of the problem-solving challenges and competencies required at different levels within the freight transport industry, emphasizing the balance between higher-level and operational professional categories. By incorporating participants from both higher-level and operational professional categories, the study provides a more thorough understanding of how problem-solving techniques differ based on position and degree of responsibility in this highly disruptive environment.

Experience in Freight Transport

The interviewees have varying levels of experience in freight transport, ranging from three to fifty years. This provides insight into how problem-solving competencies evolve over time in the industry. This variation enables a nuanced understanding of the evolution of approaches to managing operational challenges, from emerging to established. Specifically, eight participants have less than ten years of experience, making up 44% of the sample, while five participants have between ten and twenty years, representing 28%. The remaining five participants have more than 20 years of experience, making up 28% of the sample.

Table 4.1 illustrates this distribution, showing a mix of people with different degrees of experience who provide unique solutions to industry problems.

Professional capacity certificate

All participants in this study hold a Professional Capacity Certificate for the Transport of Goods on Behalf of Others. This certificate is issued by the Portuguese Institute for Mobility and Transport (IMT) under Decree-Law No. 257/2007. This certification is a prerequisite for obtaining a Freight Transport Company License and ensures that each certified individual meets the technical and professional standards required to operate within the industry. The course covers essential topics such as road safety, freight vehicle technology, business and financial management, and road freight transport regulations.

This certification is crucial because it provides transport managers with the foundational knowledge necessary to handle industry-specific challenges effectively. Their expertise in safety protocols, the technical aspects of freight vehicles, and regulatory compliance enhances their ability to address and solve operational disruptions. Additionally, their understanding of business and financial management principles allows them to make informed decisions that mitigate risks and optimize resource allocation during crises.

All eighteen of the interviewees in this study are certified, which reflects a consistent professional standard across the sample. This also reinforces their preparedness to apply their knowledge to practical problem-solving scenarios within the freight transport sector.

Company size and scope

The companies represented by the interviewees in this study range in size from small businesses with fewer than ten employees to large organizations with more than fifty. The diversity of participating companies reflects the range of operational scales within the freight transport industry. For example, small business managers often have to

Table 4.1
Experience in freight transport.

Years of Experience	Absolute Value	Percentage Value
$0 \leq x < 10$	8	44%
$10 \leq x < 20$	5	28%
$20 \leq x < 30$	3	17%
$x \geq 30$	2	11%

X – number of years of experience in freight transport.
Source: Self-elaborated.

perform various tasks, such as daily operations and strategic planning. In contrast, larger businesses typically have more specialized resources, freeing up managers to concentrate on particular tasks, such as logistics coordination or compliance. Table 4.2 illustrates this breakdown.

Analytical approach

This chapter explores the essential competencies for effective freight management, with a focus on problem-solving, sustainability practices, and technology use. Thematic analysis was chosen as the method of study due to its ability to identify recurring patterns and insights across in-depth interviews with freight professionals. Inspired by the PSM framework, the analysis categorizes competencies based on real-world challenges such as operational disruptions and resource constraints. Using tools such as Orange Data Mining, text mining, and competency mapping, the analysis organizes the professionals' responses into thematic categories such as adaptability and Client Relationship Management and maps them against the PSM framework.

Competencies are visually represented through mind maps and flow charts to clarify how specific skills interconnect and are applied at different stages of disruption management. Examining these themes aims to provide a comprehensive understanding of the daily skills of freight managers.

The participant clustering analysis, visualized through the distance map (Fig. 4.2), groups interviewees based on the similarity of their responses. This clustering reveals shared perspectives among participants, especially regarding sustainability efforts and operational challenges. The clusters reveal common views on certain topics, such as the role of technology in freight management and the importance of sustainable practices. Participants within the same cluster tend to discuss similar approaches to managing disruptions and sustainability, suggesting a cohesive set of values and priorities across the sample.

The Participant Clustering analysis was performed using Orange Data Mining's hierarchical clustering widget. Interview responses were first coded thematically and transformed into a document-term matrix using TF-IDF (term frequency-inverse document frequency). The resulting matrix was used to compute pairwise Euclidean distances between participants, which were then visualized as a distance map. This allowed us to group participants based on response similarity and identify thematic patterns across clusters.

Types of disruptions in freight management

Disruptions are frequent challenges in freight management that require quick, adaptive responses. The interviews identified several common types of disruptions and how often they occur. The most frequently cited disruption was scheduling delays, which 16 participants mentioned. These delays often stem from external factors such as port congestion, customs issues, and traffic. These factors can affect multiple deliveries in succession. For example, one participant stated, "Delays at the port or customs can affect our entire schedule, pushing back other deliveries" (SPK_12).

Fig. 4.3 shows the three most common three-word phrases. Trigrams such as "manager around years" emphasize the importance of experience and longevity in management positions in the transportation sector, suggesting that accumulated expertise is highly valued in these roles. Other phrases, such as "transport sector challenging" and "keeping fleet updated," highlight the industry's ongoing challenges and the need for operational efficiency.

To complement the thematic coding of disruptions, we conducted a trigram frequency analysis using Orange Data Mining. While the absolute word counts for the top trigrams were relatively low and similar across terms, they offer additional insight into recurring themes expressed by participants. Trigrams such as "transport sector challenging" and "keeping fleet updated" were highlighted in the text because they align directly with key disruption types discussed in this section - specifically, the challenges of maintaining service levels and fleet reliability in unpredictable environments. Although these trigrams are not used as standalone evidence, they support the qualitative findings by indicating linguistic patterns that echo the managers' broader concerns. We have therefore used them selectively to reinforce specific points in the narrative, rather than as the basis fr drawing statistical conclusions.

Note: The trigrams are presented in the order in which they first emerged during the interview sequence, based on thematic coding. This chronological arrangement reflects the natural flow of insights as they appeared across participants, rather than ranking by frequency or theoretical weight.

Thirteen participants discussed vehicle breakdowns, which were common, particularly with older fleets. Breakdowns halt operations and necessitate immediate adjustments, so contingency planning with backup vehicles is essential to minimize downtime. For example, one participant said, "When a vehicle breaks down, we activate our contingency plan with a backup truck" (SPK_4). Route changes and traffic conditions were another recurring issue noted by 15 participants. These issues often required last-minute adjustments to avoid congestion or road closures, as one participant explained: "Traffic jams or roadblocks force us to find alternative routes, sometimes at the last minute" (SPK_17).

Client-specific requests added further complications, as 10 participants mentioned. They highlighted the challenge of balancing last-minute client demands, such as early deliveries or location changes, with existing schedules. For instance, one participant said, "Clients often request last-minute changes. We do our best to accommodate them without impacting others" (SPK_8).

Finally, nine participants cited weather conditions, and seven cited legal or regulatory delays. Extreme weather, such as storms or heavy rain, affects transit times ("Heavy rain or snow can slow us down significantly, and we have to adapt on the go" (SPK_10)), while regulatory checks and customs delays impact cross-border shipments ("Cross-border shipments sometimes face delays due to customs checks and regulatory issues" (SPK_5)). As shown in Fig. 4.4, the most frequently cited operational disruptions include scheduling delays, route changes, and vehicle breakdowns. This visual reinforces the interview data, where 80% of participants highlighted scheduling issues as their primary concern—pointing to a core area for improvement in resilience planning.

Problem-solving competencies

Problem-solving skills are essential for effective freight management. These competencies enable professionals to address common challenges such as vehicle breakdowns, delivery delays, and communication gaps with clients. These competencies allow managers to handle disruptions while maintaining client satisfaction and operational efficiency, from adaptability to strategic planning.

In freight management, adaptability is essential because managers must respond to unexpected issues, such as scheduling delays, route changes, and sudden client requests. All eighteen participants emphasized the importance of quickly adjusting plans to avoid operational impacts. Twelve of the eighteen participants identified Client Relationship Management as a vital competency, particularly during disruptions.

Crisis management skills enable managers to handle emergencies such as vehicle breakdowns or traffic delays. Thirteen participants

Table 4.2
Company size distribution among participants.

Company Size (Employees)	Number of Participants	Percentage
1–9	6	33 %
10–30	8	44 %
31–50	3	17 %
51+	1	6 %

Source: Self-elaborated.

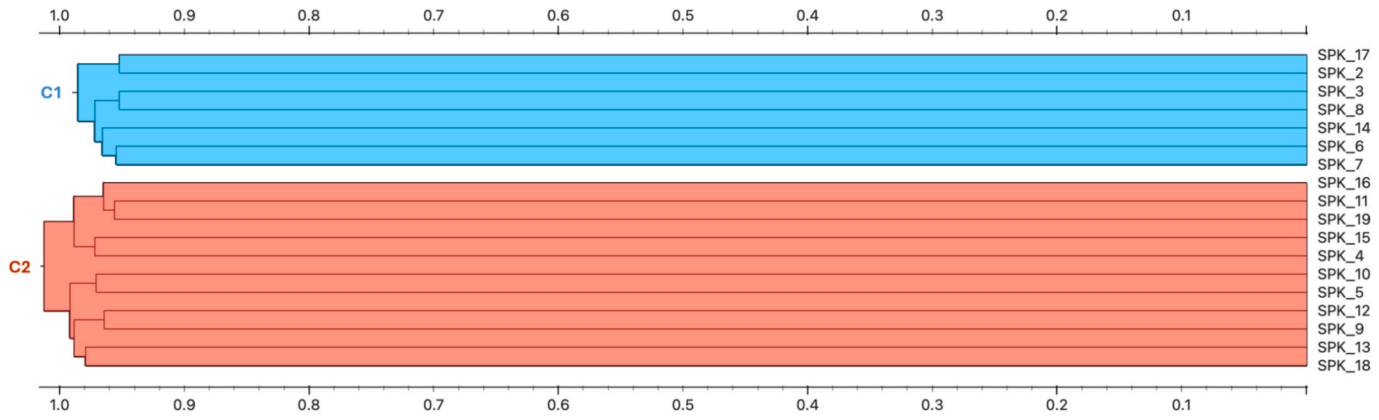


Fig. 4.2. Participant Distance Map (N = 18). *Source: Orange Data Mining.*

	Word	Word Count
1	manager around years	2
2	congratulations experience manager	2
3	environmentally friendly possible	2
4	rising fuel prices	2
5	transport sector challenging	2
6	managing partner ten	2
7	partner ten years	2
8	long waiting times	2
9	thirty one years	2
10	keeping fleet updated	2
11	environmental sustainability try	2

Fig. 4.3. Trigram Frequency Analysis (N = 18). *Source: Orange Data Mining.*

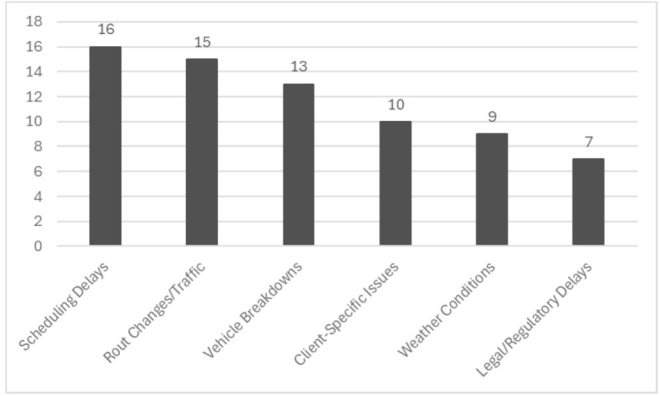


Fig. 4.4. Types of Disruptions and Frequency Mentioned by Participants (N = 18). *Source: Self-elaborated.*

discussed the importance of relying on contingency plans, such as having backup vehicles or repair services ready. Nine participants discussed strategic planning as a key competency for managing freight transport operations. Anticipating potential disruptions and incorporating buffer times into schedules allows managers to mitigate the impact of minor issues.

Additional competencies mentioned by interviewees include analytical skills, conflict resolution, and resilience. Table 4.3 summarizes all the competencies and provides examples of each.

Sustainable practices

Although companies recognize the importance of sustainability, they encounter financial and operational constraints that hinder the implementation of large-scale sustainable practices. Despite these obstacles, all participants stated that they are working to make their business more sustainable. These efforts include reducing emissions, optimizing fuel

Table 4.3
Problem-solving competencies and participant frequency.

Competency	Frequency	Example Statements
Adaptability	18	"In case of a minor delay, we reschedule for another day. For breakdowns, we replace the truck or transfer the load."(SPK_8)."We sometimes reroute at the last minute if there's a major traffic issue, keeping the client informed along the way."(SPK_17)."It's not unusual for a plan to change mid-route; we're constantly monitoring and adapting based on traffic, client requests, or weather."(SPK_16).
Client Relationship Management	12	"When delays are likely, we notify clients with estimated arrival times, ensuring transparency."(SPK_3)."If something unexpected comes up, like a traffic hold-up, we update the client immediately. They appreciate knowing what's going on." (SPK_18).
Crisis Management	13	"We keep a backup vehicle ready, swapping when there's a breakdown to avoid client impact."(SPK_4)."Our 24-hour maintenance service is on call for breakdowns, so we can get back on the road quickly."(SPK_2).
Strategic Planning	9	"We pre-plan transit times to include potential delays, managing within these to satisfy clients."(SPK_10)."Building in extra time helps us avoid rushing; we get drivers to rest if delays happen, so they're not overextended"(SPK_19).
Analytical Skills	8	"Analyzing trends in delivery times helps us identify bottlenecks and adjust routes accordingly."(SPK_9)."Data tracking shows us where delays are happening most; this info shapes how we plan routes in the future"(SPK_5).
Conflict Resolution	7	"When there's a disagreement over delivery schedules, I mediate between the client's needs and driver availability."(SPK_20)."Sometimes clients push for earlier deliveries; we explain why that isn't feasible but work out the best timing for both."(SPK_12).
Resilience	10	"With constant delays, resilience is vital; staying calm and finding immediate solutions keeps us moving."(SPK_15)."There's no time to panic when things go wrong—you just focus on the next step to get back on track."(SPK_7)."Problems are part of the job; what matters is being able to roll with them and keep things moving."(SPK_6).

Source: Self-elaborated.

consumption, and adopting environmentally friendly technologies within feasible limits. The uniform commitment to sustainability among this group reflects an awareness of environmental responsibilities within the freight transport sector. However, cost considerations, infrastructure readiness, and the economic realities of the industry often limit the scale and impact of these practices.

Fig. 4.5, a word cloud visualization, provides an intuitive view of the prominent concepts within the interview data. Larger words in the cloud represent terms that were mentioned more frequently, providing a quick overview of the most discussed topics. This visualization supports the thematic analysis by highlighting terms such as "sustainability" and "experience." Together, the word cloud and word frequency graph show that participants consistently emphasized these topics, reflecting a shared focus on sustainable practices and experienced management within the freight transport industry.

Fig. 4.6 illustrates the most common two-word phrases. Frequent bigrams, such as "managing partner" and "environmental sustainability," reveal areas of interest related to management roles and sustainability practices in the transportation sector.

This figure illustrates frequently occurring two-word combinations (bigrams) from the interview transcripts. While some bigrams (e.g., "could give", "try keep") may appear generic, they reflect the conversational tone and cautious language often used when describing problem-solving under uncertainty—supporting the study's emphasis on adaptability and real-time decision-making.

As a result, managers typically focus on practical, cost-effective steps within their means, such as fuel-efficient routing and Euro 6 vehicles. This lays the foundation for more significant improvements as resources allow. This section examines current sustainability practices, such as fuel-efficient routing and Euro 6 vehicles, as shown in Table 4.4, as well as aspirations for more advanced technologies, like electric fleets.

Fig. 4.7 illustrates this journey, mapping the progression from basic, attainable practices to ambitious, long-term goals.

A notable aspect emerging from the interviews is the strong preference for fully electric fleets as a future-oriented solution. While this is not yet the prevailing reality in Portuguese freight companies, managers framed electric fleets as strategically advantageous for meeting anticipated EU sustainability regulations, reducing long-term fuel costs, and improving corporate reputation. This preference therefore reflects not only managerial intuition but also a forward-looking orientation towards regulatory and market pressures. These findings directly connect with the sustainability challenges outlined in Subsection 2.4, reinforcing the view that sustainability is gradually being integrated into disruption management strategies, even if implementation remains constrained by infrastructure limitations and investment capacity.

	Word	Word Count
1	managing partner	14
2	traffic manager	12
3	environmental sustainability	12
4	environmentally friendly	8
5	could give	8
6	transport sector	8
7	try keep	8
8	ten years	8
9	route planning	8
10	loading unloading	8

Fig. 4.6. Bigram Frequency Analysis (N = 18). *Source: Orange Data Mining.*

Table 4.4
Current and potential sustainability practices.

Practice Type	Speaker	Example Statement
Current Practice	SPK_6	"We use Euro 6 vehicles to reduce emissions, but beyond that, options are limited for a small fleet like ours."
	SPK_4	"Minimizing idling times and planning fuel-efficient routes are small steps, but they do make a difference."
	SPK_15	"Switching to digital documentation has helped us save on paper and streamline processes."
Future Desired Practice	SPK_3	"An electric fleet would be ideal, but the infrastructure and high costs make it challenging for us right now."

Source: Self-elaborated.

Technology integration

Technology plays a critical role in streamlining freight management. It allows managers to optimize routes, monitor vehicle status, and manage logistics in real time. All participants expressed positive views on the value of technology, emphasizing its ability to enhance efficiency and provide better operational control. This unanimous support highlights the essential role of technological tools, such as GPS tracking and digital documentation, in modern freight operations.

Fig. 4.5. Word Cloud Visualization. *Source: Orange Data Mining.*

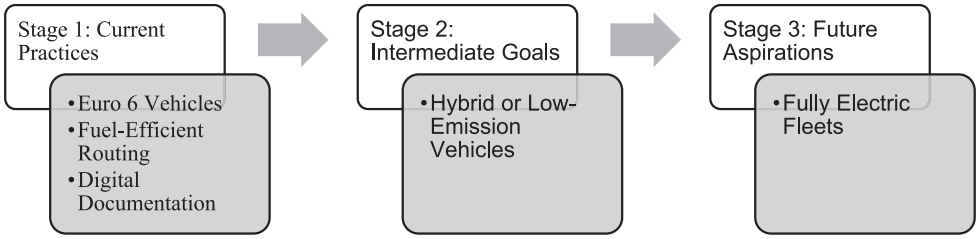


Fig. 4.7. Journey map of freight disruption management practices (emerging from interview data). *Note: The map was constructed from the coded insights of the 18 valid interviews, illustrating common steps, pain points, and managerial responses reported by participants.* Source: Self-elaborate.

This section explores the current applications of technology and the challenges companies face when adopting more advanced tools. While basic digital solutions have been widely adopted and appreciated, the further integration of sophisticated systems is limited by cost and infrastructure constraints.

Technologies like GPS tracking, satellite monitoring, and digital documentation have greatly enhanced operational efficiency in freight management. For example, GPS tracking enables managers to monitor vehicle locations and make real-time route adjustments to avoid delays. Satellite monitoring further supports efficient route planning by providing traffic insight. Digital documentation plays a significant role as well, helping companies reduce paperwork and streamline communication. This shift to digital tools saves time and enhances data accuracy, ensuring smoother logistics. Table 4.5 summarizes the technologies utilized in freight transport management.

Despite the benefits of these technologies, smaller companies often face limitations in adopting advanced tools due to financial or resource constraints. For example, although GPS tracking and digital documentation are widely used, some participants expressed the need for more sophisticated tools, such as predictive analytics and enhanced real-time tracking. However, they noted that these tools are cost-prohibitive. As SPK_7 mentioned, "Advanced predictive tracking would help us avoid delays, but it's costly for small operations."

Fig. 4.8 illustrates the flow from preemptive tracking using GPS, to real-time adjustments through satellite monitoring, to crisis management with load applications and maintenance services.

Key insights

The following mind map (Fig. 4.9) summarizes the main themes identified in the analysis of the interview data. This visual tool illustrates the connections between competencies in freight transport management, sustainability, operational challenges, and technology's role. Mapping these areas reveals how industry-specific competencies interact and overlap, especially in problem-solving and resource optimization.

Each branch of the mind map represents a major theme identified in the study and illustrates the relationships and dependencies between them. The mind map underscores the importance of a holistic approach to freight management where problem-solving, sustainable practices, and technological integration all play critical roles in achieving operational efficiency and regulatory compliance.

Table 4.5
Technologies utilized in freight transport management.

Technology	Speaker	Example Statement
GPS Tracking	SPK_10	"GPS helps track vehicle locations and adjust routes for delays or other issues."
Satellite Monitoring	SPK_3	"Satellite gives us real-time traffic insights, which helps us make better route decisions."
Digital Documentation	SPK_4	"Switching to electronic documents has cut down on paperwork and improved efficiency."
Load Applications	SPK_2	"Using load apps ensures quick route matching and efficient load adjustments."
Preventative Maintenance	SPK_6	"We conduct preventative maintenance checks to minimize breakdowns and unexpected delays."

Source: Self-elaborated.

Discussion and findings

This chapter is organized by research question and integrates data analysis and theoretical perspectives to interpret the findings. References to figures and tables provide specific evidence that reinforces the discussion. Comparisons with the PSM Competencies framework and other studies reveal areas of alignment and gaps, offering insights into the distinctive context of Portuguese freight transport management.

Research questions

RQ1: What are the primary operational disruptions experienced by freight transport managers in Portugal?

Fig. 4.4 shows that operational disruptions, including delays due to traffic congestion, vehicle breakdowns, and fluctuations in demand, were identified as the most common issues. These findings align with those of Wide (2020), who categorizes such disruptions as frequent issues in logistics that often require quick, real-time management solutions.

The word frequency analysis (Fig. 4.9) and word cloud (Fig. 4.5) show the prominence of terms such as "transport" and "issues," underscoring the centrality of these challenges for managers. Fig. 4.9, the Mind Map of Key Insights, provides an overarching visual summary of these recurring themes, with "Operational Challenges" as a primary branch.

A comparative analysis with existing literature reveals that the adaptability and flexibility of Portuguese freight managers aligns strongly with Ritala et al.'s (2016) dynamic capabilities framework. This framework emphasizes the need for adaptable resource allocation in response to disruptions, as seen in Table 4.3. Portuguese managers have demonstrated an ability to flexibly allocate resources, adapting their approach to shifting circumstances as disruptions arise.

Moreover, as outlined by Karam and Reinau (2022), real-time disruption management emphasizes the value of immediate data access in effectively managing freight issues. Although some real-time tracking technology is used in the Portuguese logistics sector, as shown in Fig. 4.8, "Conditional Map of Technology Utilization in Freight Management," limitations persist. This is particularly notable in smaller companies, where limitations in technological resources hinder large-scale implementation.

Finally, a comparison of these practices with PSM competencies reveals a clear preference for proactive disruption management, as highlighted by the focus on strategic risk management (Bals et al., 2019). However, as shown in Fig. 4.8, "Journey Map of Sustainability Adaptation in Freight Transport," Portuguese freight managers often adopt a reactive approach to disruption, largely due to resource limitations. This reactive stance suggests a potential need for scalable, adaptable solutions tailored to the Portuguese logistics environment.

The findings suggest contextual adaptations of dynamic capabilities

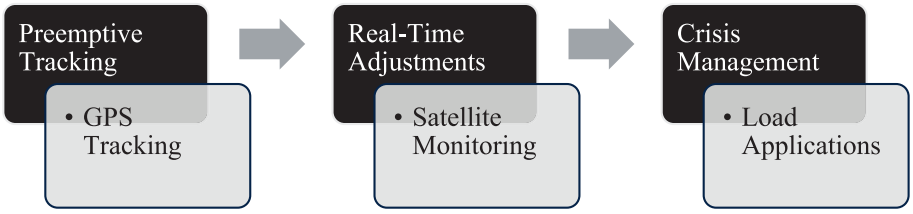


Fig. 4.8. Conditional Map of Technology Utilization in Freight Management. Source: Self-elaborated.

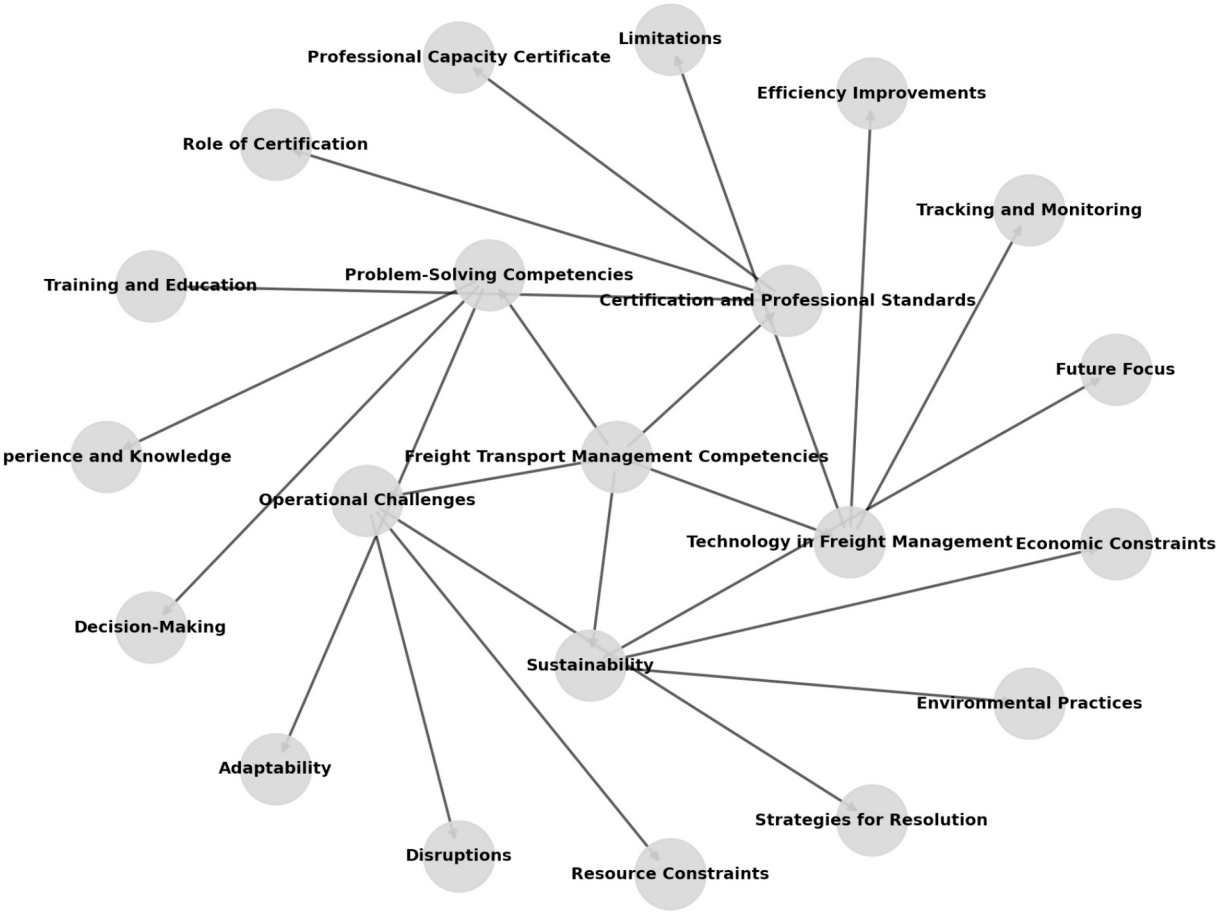


Fig. 4.9. Mind Map of Key Insights in Freight Transport Management. *Source: Self-elaborated.*

and advocate for low-cost, scalable solutions for smaller logistics companies to effectively address operational disruptions.

RQ2: What problem-solving methods do Portuguese freight transport managers use to address disruptions?

The data revealed a preference for experience-based, practical approaches to managing disruption, with managers relying on improvisational tactics rather than formal processes. Fig. 4.3 emphasizes the importance of experience and longevity in management positions in the transportation sector. Fig. 4.8 illustrates that technological tools are primarily used for tracking rather than structured problem solving. Fig. 4.2 shows clusters among participants reflecting shared approaches to real-time adjustments to disruptions. Fig. 4.9, the Mind Map of Key Insights, visually represents "Problem-Solving Competencies" as a core branch with sub-nodes related to adaptability and experience.

Table 4.3 indicates that limited collaborative engagement was observed in Portuguese logistics management, where most responses pointed to isolated decision-making rather than collective efforts. This contrasts with PSM competencies, which prioritize collaborative leadership to enhance resilience. Sun et al. (2020) emphasize the importance of collaboration in logistics; however, Portuguese managers often lack the necessary support structures to foster teamwork and resource sharing.

Regarding knowledge management and competency needs, knowledge sharing is critical, as Zhang et al. (2021) emphasize. However, managers indicated that it is not systematically practiced, as shown in Table 4.2, "Company Size Distribution Among Participants," where smaller companies reported limited capacity for knowledge exchange.

Furthermore, the correlation heatmap (Fig. 4.7) reveals connections between important methods, such as technology use and sustainability practices. This suggests that managers tend to use technology to balance efficiency and environmental goals.

Table 2.1 — Competencies and Theories for Strategic Problem-Solving — illustrates the competencies necessary for problem-solving in this sector, including analytical and strategic thinking, adaptability, and knowledge sharing.

The findings suggest that fostering structured collaboration and providing systematic problem-solving training would promote resilience in Portuguese freight logistics, aligning with CPS and PSM

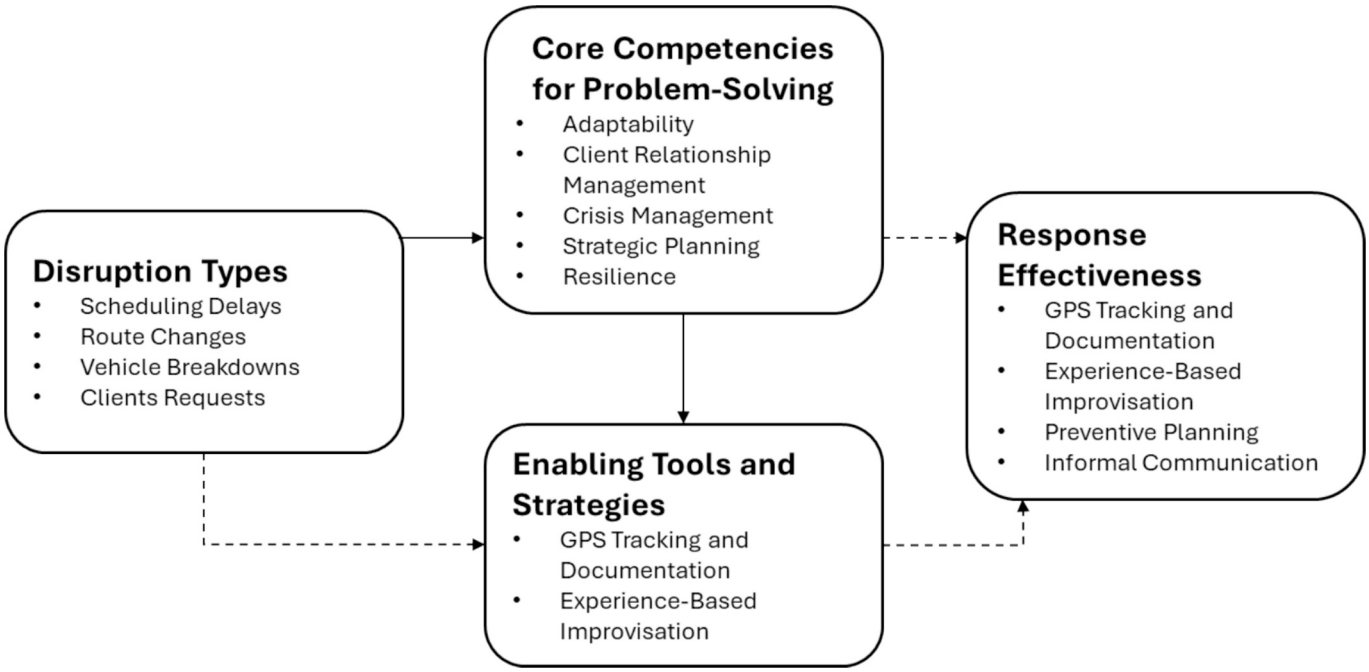


Fig. 6.1. Conceptual Framework for Problem-Solving in Portuguese Freight Disruption Management. *Source: Self-elaborated.*

competencies.

RQ3: In what ways do Portuguese freight managers incorporate sustainability into their problem-solving approaches?

Although many managers expressed difficulty implementing sustainability practices due to high costs, they made an effort. Practical concerns often took precedence, which is consistent with the findings of Szymczyk and Kadłubek (2019), who highlighted similar sustainability challenges in urban logistics. Additionally, Hrušovský et al. (2021) suggest using multimodal transport to reduce the carbon footprint. However, Portuguese managers noted logistical and cost barriers to implementing these changes.

Fig. 4.5's word cloud reflects sustainability as a frequently mentioned theme, and Fig. 4.6 reveals recurring phrases such as "environmental sustainability." The mind map of key insights (Fig. 4.9) includes "sustainability" as a significant branch with sub-nodes on "environmental practices" and "economic constraints."

Although sustainability management is central to PSM competencies, findings in Fig. 4.8, the Journey Map of Sustainability Adaptation in Freight Transport, indicate that Portuguese managers typically default to cost-effective rather than sustainable practices. This reflects the economic challenges faced by smaller companies.

Marinova et al. (2018) propose that sustainability can be gradually integrated into logistics practices through small changes, such as fuel-efficient driving, in their study of frontline problem-solving effectiveness. However, Table 4.4: Current and Potential Sustainability Practices shows that Portuguese managers prioritize immediate, low-cost options over long-term sustainability goals.

This research suggests that integrating sustainability into Portuguese freight logistics requires economic incentives and tailored approaches that accommodate smaller, cost-conscious companies.

RQ4: What role do DSS and other technological tools play in solving problems caused by disruptions?

Technology, particularly GPS, plays an important role in disruption management. Karam and Reinau (2022) emphasize DSS for real-time decision-making. However, Portuguese managers reported challenges with full utilization due to regulatory and infrastructure barriers. This issue was also noted by Konstantakopoulos et al. (2020) regarding limited data sharing.

Fig. 4.9, "The Mind Map of Key Insights," places "Technology in Freight Management" as a primary branch with sub-nodes focused on tracking, efficiency, and limitations. Fig. 4.7's Correlation Heatmap illustrates the relationship between technology and efficiency. Managers highlighted DSS limitations due to incomplete data-sharing networks, as shown in Table 4.5, "Technologies Utilized in Freight Transport Management." This contrasts with PSM competencies, which prioritize technological literacy and data-driven decision-making.

The real-time disruption management approach (Wide, 2020) provides a structured model for using real-time data in logistics. However, Portuguese managers primarily use DSS for tracking and reactive responses, indicating a gap in proactive disruption management.

Enhancing digital literacy and establishing data-sharing frameworks among Portuguese logistics firms would improve the effectiveness of DSS and real-time disruption management.

Problem-solving approaches: theory vs. practice

Literature on Dynamic Capabilities (Ritala et al., 2016) and Creative Problem-Solving (Kuo et al., 2014) emphasizes structured, proactive strategies for managing disruptions. Our findings partially support this: while managers demonstrated adaptability and resilience, most responses were experience-based and reactive rather than systematically planned. This contrasts with Bals et al. (2019), who stress the importance of data-driven and collaborative problem-solving in procurement contexts. The gap between theoretical ideals and practical application may be explained by resource limitations in SMEs, as also noted by Szymczyk & Kadłubek (2019).

Technology use: limited but consistent with constraints literature

Studies by Karam & Reinau (2022) and Konstantakopoulos et al. (2020) highlight the growing role of DSS in freight disruption management. Our results confirm the use of basic digital tools like GPS tracking and electronic documentation, but show limited adoption of advanced DSS, consistent with previous findings on digitalization gaps in smaller firms. This limitation aligns with Hrušovský et al. (2021), who note that simulation-based DSS are often impractical for under-resourced logistics companies.

In summary, the empirical results validate much of the literature on

the types of disruptions and the need for adaptability, but reveal a persistent gap between recommended practices (e.g., collaborative planning, DSS usage) and what is feasible in smaller, cost-sensitive logistics firms. This suggests a need to revise theoretical models to account for contextual limitations such as firm size, infrastructure access, and regulatory environment.

Contributions and novelty

This study makes several original contributions to the literature on logistics, disruption management, and problem-solving competencies:

1. Contextual contribution: While problem-solving in freight logistics has been studied in broader, international contexts, this research is the first to empirically examine these competencies in the Portuguese freight transport sector—an underexplored yet economically significant domain. This local focus uncovers context-specific managerial challenges and responses under resource constraints.
2. Theoretical contribution: The study extends the application of Dynamic Capabilities and Collaborative Problem-Solving (CoPS) frameworks by empirically showing how freight managers adapt and operationalize these concepts in ad hoc, practical ways. Additionally, the integration of the PSM Competencies model into the disruption management context provides a novel lens for assessing freight sector resilience.
3. Methodological contribution: Through the use of semi-structured interviews and Orange Data Mining tools, the research delivers a structured thematic analysis that maps competencies to disruption types, something not systematically done in previous qualitative logistics studies. The Participant Clustering, Word Frequency, and Journey Maps further visualize how freight managers process and respond to real-world challenges.
4. Practical contribution: This research provides actionable insights for policymakers and freight companies, especially SMEs, by offering concrete strategies to build resilience—such as targeted training in digital literacy, contingency planning, and sustainability adaptations. It also highlights the urgent need for systemic collaboration and policy-based incentives to overcome technological and environmental barriers.

By addressing both a geographical and conceptual gap, this study pushes the boundaries of logistics management literature and lays a foundation for comparative research across different national contexts.

Key differences between this study and previous research

While this study confirms several findings in the existing literature—such as the prevalence of scheduling delays and the importance of adaptability—it also reveals key differences that contribute new insights to the field of freight disruption management.

First, unlike many studies that highlight structured, technology-supported problem-solving (e.g., Ritala et al., 2016; Karam & Reinau, 2022), our findings show that Portuguese freight managers primarily rely on ad hoc, experience-based solutions. Advanced decision-support systems and predictive tools were not widely used, reflecting a practical gap between academic models and the operational realities in smaller, resource-constrained firms.

Second, while the literature often promotes collaborative problem-solving (Sun et al., 2020; Bhardwaj et al., 2018), this study found limited evidence of inter-organizational collaboration among Portuguese freight companies. Problem-solving was mostly performed individually or within company boundaries, rather than across supply chain partners. This suggests a missed opportunity for resilience through cooperative strategies.

Third, sustainability integration was acknowledged by all participants, but practices were minimal and cost-driven, contrasting with studies like Szymczyk & Kadłubek (2019) that assume progressive green logistics integration. Managers expressed support for environmental improvements but lacked the financial means or policy incentives to adopt them fully—indicating a need for public intervention or funding schemes.

Lastly, many previous studies focus on highly developed logistics ecosystems (e.g., Germany, USA, or simulation-based systems), whereas this study provides a localized, empirical view of freight transport management in Portugal, where market fragmentation, regulatory pressure, and company size present unique structural challenges.

These differences underscore the importance of contextualizing theoretical models in real-world conditions. By doing so, this research contributes a grounded understanding of disruption response under constraints, offering a framework that is both practically applicable and theoretically informative.

Conceptual framework based on findings

This study originally drew on Dynamic Capabilities Theory, Collaborative Problem-Solving (CoPS), and the PSM Competencies framework to guide the investigation of disruption management in Portuguese freight transport. Following qualitative analysis of 20 interviews, a refined and empirically grounded conceptual framework is proposed to capture how managers in this sector address operational disruptions in real-world conditions.

The framework (see Fig. 6.1) is structured around **four key dimensions** emerging from the data:

1. **Disruption Types**Managers most frequently encounter disruptions such as scheduling delays, route changes, vehicle breakdowns, and client-specific last-minute requests.
2. **Core Competencies for Problem-Solving**Respondents highlighted the following as most critical:
   - o Adaptability
   - o Client Relationship Management
   - o Crisis Management
   - o Strategic Planning
   - o Resilience(as shown in Table 4.3)
3. **Moderating Constraints**The deployment of these competencies is shaped by:
   - o Resource limitations (small company size, fleet age)
   - o Sustainability barriers (cost of green alternatives)
   - o Limited access to advanced technology
   - o Fragmented knowledge-sharing
4. **Enabling Tools and Strategies**Despite constraints, managers leverage:
   - o GPS tracking and digital documentation
   - o Experience-based improvisation
   - o Preventive planning (buffer times, backup vehicles)
   - o Informal communication networks

These four dimensions are dynamically interconnected. Competencies act as mediators between disruption types and outcomes, while tools and constraints moderate the degree to which competencies can be applied effectively.

This conceptual framework (Fig. 6.1) thus illustrates a context-responsive model of disruption management in freight transport. Unlike prescriptive or formalized models, it reflects practical improvisation under constraint, making it particularly relevant to small and medium-sized logistics firms in resource-constrained environments.

Conclusion

This study examined the essential problem-solving competencies for managing operational disruptions in the Portuguese freight transport sector. The central research question was how managers in this sector use these competencies to address frequent challenges. The findings suggest that managers primarily use experience-based, flexible strategies to react to disruptions rather than plan for them systematically.

Influenced by resource constraints, this approach reflects the sector's unique demands and suggests a need for enhanced skills in collaborative and systematic problem-solving.

Key findings revealed the prevalence of specific disruptions, such as traffic delays, vehicle breakdowns, and demand fluctuations. These disruptions are managed through adaptability and immediate responses, as demonstrated by the analysis of tables and figures in Chapter 4. However, collaboration and systematic knowledge sharing are limited, with many managers operating independently. Regarding sustainability, economic constraints prompt managers to adopt low-cost, sustainable practices, such as fuel-efficient routing, rather than more ambitious efforts, like upgrading to an electric fleet. Technology plays a limited role, with basic tools like GPS and digital documentation in use. Advanced systems, such as predictive analytics, remain largely inaccessible due to financial limitations.

Fig. 4.9, the Mind Map of Key Insights, visually summarizes the main themes of operational challenges, sustainability, technology, and problem-solving competencies. The mind map highlights the connections between these areas, emphasizing the complex, interdependent nature of managing disruptions in the freight sector.

The study makes a theoretical contribution by extending the Dynamic Capabilities and Collaborative Problem-Solving (CoPS) frameworks to the Portuguese freight sector. While dynamic capabilities support adaptive responses, limited collaboration restricts strategic problem-solving capacity. Additionally, this research integrates the PSM competency model into the sector, emphasizing the necessity of collaborative leadership and digital literacy as fundamental competencies for effectively managing disruptions. The findings emphasize the importance of providing Portuguese freight managers with targeted training to enhance their systematic problem-solving skills and digital literacy. They also highlight the potential benefits of collaborative structures that facilitate knowledge sharing during disruptions. Advocacy for economic incentives, such as government support, could help make sustainable practices more viable in cost-sensitive logistics operations.

Looking ahead, future research in freight transport disruption management should explore the role of data-driven tools—such as AI-enabled decision-support systems and predictive analytics - in enhancing problem-solving capacity, especially for SMEs. Comparative studies across different countries or regions can also offer insights into how cultural, economic, and regulatory factors shape managerial responses to operational challenges. Moreover, there is a growing need to examine the effectiveness of collaborative platforms and cross-organizational knowledge sharing in building collective resilience. Lastly, longitudinal research could track how freight transport firms evolve their problem-solving competencies over time in response to shifts in digital infrastructure, environmental policy, and urban mobility trends. These directions offer fertile ground for expanding both theoretical and applied knowledge in the logistics and supply chain management fields.

While the proposed conceptual framework offers valuable insight into freight disruption management under resource constraints, its real-world applicability is influenced by certain limitations. As discussed in Chapter 7, the qualitative nature and sample size ($n = 20$) limit broad generalizability. Moreover, the framework is rooted in the Portuguese logistics context, where small and medium enterprises dominate and access to technology is uneven. These contextual factors may restrict the framework's direct transferability to other regions or highly digitized logistics ecosystems. Future research should therefore test and adapt this model across diverse national and organizational settings, integrate longitudinal data to assess how competencies evolve over time, and examine the effectiveness of proposed solutions—such as training and collaboration—in dynamic market conditions. These efforts will help refine and extend the framework, enhancing its utility in practice and theory.

Limitations

The limitations of this research are closely tied to the problem statement and research objectives, presenting certain constraints on interpretation and generalizability. While this study reached thematic saturation after eighteen interviews - meaning that no new themes emerged and responses became repetitive - the relatively small sample size still presents limitations regarding broader generalizability. Saturation confirms that the sample was adequate to explore the study's core objectives within the defined population of Portuguese freight transport managers. However, the diversity of the freight transport sector suggests that a larger and more varied sample, including participants from different regions, company sizes, and types of logistics operations (e.g., international carriers, multimodal providers), could enhance the robustness and transferability of the findings. Future research with a broader participant base would allow for comparative analyses across subgroups and may reveal additional nuances not captured within the scope of this study.

Additionally, the study relied on self-reported data from interviews, which carries the risk of response bias or incomplete information. Although efforts were made to mitigate this, variations in individual managerial experiences and organizational practices could affect the reliability of the findings and limit their applicability to other sectors.

Finally, the lack of prior research addressing problem-solving competencies specifically within the Portuguese freight transport sector created challenges for comparative analysis. While this research provides new insights, a more extensive literature on this topic would help contextualize the findings and draw stronger conclusions in different logistics contexts.

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CRediT authorship contribution statement

Dora Morgado: Investigation, Formal analysis, Data curation, Conceptualization. **Leandro F. Pereira:** Project administration, Conceptualization. **Álvaro L. Dias:** . **José Crespo de Carvalho:** Resources, Investigation, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix

Annex A – Interview Script

Interview Format

Duration: 10 to 20 minutes
Part A: Introductory Questions Objective: Sample Characterization

What is your current job role and your professional category?
How many years of experience do you have in freight transport management?
Do you hold a Professional Capacity Certificate for the Transport of Goods?
How many employees does your company have?

Part B: Investigation Key Questions

Objective: Evaluate problem-solving competencies in freight transport using core competency analysis.In this section, each question

should be answered with a clear Yes/No response, along with a justification supporting the answer.

Can you describe a recent disruption in your freight transport operations and how you managed it?
What methods or strategies do you use to address disruptions in freight transport?
How important is sustainability in your approach to managing freight transport issues?
What role does technology play in your efforts to resolve operational issues?
What skills do you believe are essential for effectively solving problems in freight transport?

End of Interview Thank you for your collaboration in this interview. Your insights are highly valuable.

Data availability

Data will be made available on request.

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