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ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

MANAGING RISKS AND CRISES IN THE LOGISTICS SECTOR: A COMPREHENSIVE ANALYSIS OF STRATEGIES AND PRIORITIZATION USING AHP METHOD

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Abstract

In the fast-paced and intricate landscape of the logistics sector, the emergence of risks and crises presents a critical need for effective management strategies. This research undertakes an analysis of risk and crisis management practices within the logistics industry filling the gap in the literature and aims to identify viable strategies and prioritize them using the Analytic Hierarchy Process (AHP) method. Through literature review and insights gathered from interviews with five industry experts, this study unveils the challenges faced by logistics companies and unveils existing risk and crisis management approaches. Employing the AHP method, the research provides a systematic framework for prioritizing these strategies based on their significance and potential impact. The findings contribute to the development of a strategic risk and crisis management toolkit, empowering logistics firms to proactively address challenges, ensure adaptability, and bolster resilience amidst a dynamic business environment. The insights provided by this study will prove invaluable to logistics professionals, scholars, and policymakers, enabling them to take actionable measures that enhance operational efficiency and ensure long-term sustainability within the logistics sector.

Key Words: *Strategic Management, Logistics, Risk Management*

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LOJİSTİK SEKTÖRÜNDE RİSKLERİ VE KRİZLERİ YÖNETMEK: AHP YÖNTEMİYLE STRATEJİLERİN KAPSAMLI ANALİZİ VE ÖNCELİKLENDİRİLMESİ

Özet

Dinamik ve karmaşık lojistik sektöründe, risklerin ve krizlerin ortaya çıkışı etkili yönetim stratejilerine olan kritik ihtiyacı beraberinde getirmektedir. Çalışma literatürdeki boşluğu doldurmak amacıyla, lojistik endüstrisindeki risk ve kriz yönetimi uygulamalarını analiz ederek, uygun stratejileri belirlemeyi ve bunları Analitik Hiyerarşi Süreci (AHP) yöntemi ile önceliklendirmeyi amaçlamaktadır. Beş endüstri uzmanı ile yapılan görüşmeler aracılığıyla ve literatür taraması ile bu çalışma lojistik şirketlerinin karşılaştığı zorlukları ve mevcut risk ve kriz yönetimi yaklaşımlarını ortaya çıkarmaktadır. Araştırma, AHP yöntemi kullanılarak, bu stratejileri önem dereceleri ve olası etkileri temelinde sistemli bir çerçevede sıralamayı amaçlamaktadır. Bulgular, stratejik risk ve kriz yönetimi araç setinin gelişimine katkıda bulunmakta ve lojistik firmalarının zorluklarla etkin bir şekilde başa çıkmasını, uyum sağlamasını ve dinamik iş ortamında dayanıklılığını güçlendirmesini sağlamaktadır. Bu çalışma, lojistik profesyonelleri, akademisyenler ve politika yapıcılar için değerli bilgiler sunarak, onların lojistik sektöründe operasyonel verimliliği artırmak ve uzun vadeli sürdürülebilirliği sağlamak için harekete geçmelerine olanak tanıyacaktır.

Anahtar Kelimeler: *Stratejik Yönetim, Lojistik, Risk Yönetimi*

INTRODUCTION

The logistics sector plays a pivotal role in global supply chains, facilitating the efficient movement and distribution of goods and services. However, this dynamic industry is inherently exposed to various risks and susceptible to unforeseen crises that can disrupt operations, impact customer satisfaction, and undermine overall performance (Wu & Chaipiyaphan, 2020). From transportation delays and supply chain disruptions to natural disasters and security threats, logistics companies face a multitude of challenges that demand effective risk and crisis management strategies. Addressing these challenges in a proactive and systematic manner is essential for maintaining a competitive edge, ensuring business continuity, and fostering long-term sustainability in the logistics sector (Li et al., 2023).

This study aims to fill in the gap literature and delve into the intricate world of risk and crisis management within the logistics industry, focusing on identifying strategic approaches that enable logistics companies to navigate uncertainties and crises with resilience. The research seeks to comprehensively analyze existing risk and crisis management practices in the logistics sector, examining their effectiveness and applicability in real-world scenarios. The study seek answer to the questions;

What are the possible risks that logistic companies face? and what strategies they can apply to mitigate them?

Specifically, the AHP analysis of the study focuses on the risk of natural disaster for logistic sector and prioritizes the strategies.

To achieve the research objectives, the study employs the Analytic Hierarchy Process (AHP) method, a widely recognized multi-criteria decision-making technique. AHP enables systematic comparisons and evaluations of different risk and crisis management strategies by establishing hierarchies of criteria and sub-criteria. By involving stakeholders and experts in the decision-making process, AHP generates relative weights for each criterion, facilitating the identification of the most critical and impactful strategies. This rigorous and data-driven prioritization approach ensures that the resulting framework aligns with the unique needs and challenges faced by logistics companies, ultimately enhancing their ability to withstand disruptions and emerge stronger from crises.

Subsequently, the research will focus on the common risks and strategies in logistic sector and consults to experts to gather real-world insights, and apply AHP for prioritizing strategies. Findings from the interviews will be presented, highlighting key challenges faced by logistics companies and expert perspectives on effective management strategies. The prioritization process using AHP will be thoroughly explained, leading to the development of a strategic risk and crisis management framework tailored to the logistics sector. The study's implications and potential applications will be discussed, emphasizing its relevance for logistics professionals, scholars, and policymakers in enhancing operational efficiency and long-term

sustainability. The study will conclude by summarizing key findings, acknowledging limitations, and proposing avenues for future research in this critical field.

1. LITERATURE REVIEW

The literature review section delves into key aspects of risk and crisis management within the logistics industry, exploring various facets that underpin effective mitigation strategies. Through an examination of relevant studies, this section sheds light on the identification of common risks and crises faced by logistics companies, delving into the complexities that characterize this dynamic sector. To gather information, keywords such as "risk and crisis management," "logistics industry," "common risks," "mitigation strategies," were utilized. This literature review endeavors to provide an understanding of the landscape of risk and crisis management within the logistics domain, setting the stage for informed analysis and discussions in subsequent sections.

1.1. Risk and Crisis Management in the Logistics Industry

Risk and crisis management are essential components of effective logistics operations, as the industry is inherently exposed to a multitude of uncertainties and potential disruptions. This section provides a comprehensive overview of risk and crisis management practices in the logistics sector, highlighting their significance in ensuring smooth and resilient supply chain operations (Amin et al., 2022). The logistics industry faces a diverse range of risks, including transportation delays, inventory management challenges, supplier disruptions, regulatory changes, and geopolitical events. Each of these risks can have far-reaching consequences on the timely and cost-efficient delivery of goods, as well as customer satisfaction. Therefore, logistics companies must adopt proactive risk management strategies to identify, assess, and prioritize potential risks to their operations (Panjehfouladgaran & Lim, 2020).

With globalization, complex networks, and increased interdependencies, supply chains have become susceptible to a wide array of

risks, ranging from natural disasters and geopolitical uncertainties to demand fluctuations and supplier disruptions. Effective risk management in supply chains involves proactive strategies to minimize the impact of these risks on operations, enhance resilience, and maintain customer satisfaction. This involves not only understanding the types of risks but also developing contingency plans, diversifying suppliers, optimizing inventory, and fostering collaboration and transparency among partners (Gurtu & Johny, 2021).

Risk management in logistics involves the use of various tools and techniques, such as risk assessments, risk mapping, and scenario planning, to develop contingency plans and risk mitigation strategies. It aims to strike a balance between minimizing the impact of identified risks and optimizing operational efficiency (Nimmy et al., 2022). Crisis management, on the other hand, focuses on effectively handling unforeseen and severe disruptions that can significantly impact logistics operations. Crises in the logistics industry can arise from natural disasters, supply chain disruptions, security breaches, cyber-attacks, and public health emergencies, among other events. The ability to respond swiftly and efficiently to crises is crucial for mitigating damages and ensuring business continuity (Çiçek, 2020).

Logistics companies must establish crisis management protocols that outline the roles and responsibilities of key personnel, communication channels, and escalation procedures (Akbal, 2023). Preparedness and regular crisis drills are essential to ensure that the organization can respond effectively to unexpected events (Karli & Tanyaş, 2020). The COVID-19 pandemic is a recent example that underscores the importance of robust risk and crisis management in the logistics industry. The outbreak caused widespread disruptions in global supply chains, forcing logistics companies to adapt rapidly and implement contingency plans to maintain operations amidst unprecedented challenges (Zimon & Madzík, 2020).

In conclusion, the overview of risk and crisis management in the logistics industry highlights the need for proactive risk identification and mitigation strategies, as well as efficient crisis response protocols. By effectively managing risks and crises, logistics companies can enhance their

resilience, maintain customer trust, and ensure the smooth flow of goods throughout the supply chain.

1.2. Common Risks and Crises Faced by Logistics Companies

In the fast-paced and interconnected world of logistics, companies encounter a plethora of risks and potential crises that can disrupt their operations and supply chain networks. Identifying these common risks and crises is essential for logistics firms to develop proactive strategies and contingency plans to safeguard their business continuity (Deng et al., 2019).

Transportation delays and disruptions are among the most prevalent risks faced by logistics companies. Unforeseen weather events, traffic congestion, or mechanical issues can cause transportation delays, impacting the timely delivery of goods to their destinations (Eygü & Karabacak,2017). Moreover, labor strikes and disruptions in transportation networks, such as port closures or railway blockades, can also lead to significant delays, further complicating logistics operations (Sawyerr & Harrison, 2020). Effective inventory management is critical for logistics companies to maintain efficient operations. However, inaccurate demand forecasting can result in overstocking or understocking, leading to excess inventory costs or lost sales opportunities (Korucuk & Erdal, 2018). Additionally, supply chain disruptions, such as delays in supplier shipments or production issues, can disrupt the flow of goods, leading to inventory shortages or surpluses, which may require careful management to avoid financial losses (Cerabona et al., 2021).

Supplier disruptions pose another significant risk for logistics companies. Suppliers facing production issues, financial difficulties, or quality problems can disrupt the supply of critical components or materials, leading to delays in production or shipments. To mitigate this risk, logistics companies must carefully evaluate their supplier relationships and establish alternative sourcing options to reduce overreliance on a single supplier (Yang et al., 2021).

Logistics companies operating in multiple regions must navigate various regulatory and compliance risks. Changes in trade regulations, customs requirements, or environmental standards can impact cross-border logistics operations, requiring logistics firms to stay updated and compliant with evolving regulations. Non-compliance with regulatory requirements can lead to fines, penalties, or shipment delays, emphasizing the importance of a robust compliance framework (Sawyerr & Harrison, 2020). Geopolitical risks are inherent in global logistics operations. Political instability, civil unrest, or trade disputes in different regions can affect logistics operations and supply chain routes. Geopolitical events, such as changes in trade agreements or sanctions, can create uncertainties for logistics companies and necessitate agility in adapting to geopolitical shifts (Kumar et al., 2021)

In today's digital age, logistics companies face a growing threat of cybersecurity breaches. Cyber-attacks targeting logistics companies' IT systems and networks can lead to data breaches, operational disruptions, and financial losses. Ransomware attacks, in particular, can paralyze logistics operations and compromise sensitive information, highlighting the need for robust cybersecurity measures and incident response plans (Yu et al., 2021). Natural disasters and emergencies present a significant risk for logistics companies. Events like earthquakes, hurricanes, floods, or public health emergencies can damage infrastructure, disrupt transportation, and hinder logistics operations. To prepare for such occurrences, logistics companies should develop disaster recovery plans and establish communication protocols to ensure swift response and recovery (Feng & Cui, 2021). Lastly, market volatility and economic fluctuations can impact logistics operations. Changes in economic conditions, currency exchange rates, or market demands can lead to fluctuations in logistics demand and costs. Managing such uncertainties requires logistics companies to remain agile and adaptable to changing market conditions (Fonseca & Azevedo, 2020).

Identifying and understanding these common risks and crises is the first step for logistics companies to build resilience and preparedness. By implementing proactive risk management strategies, developing crisis response plans, and fostering collaboration within their supply chain networks, logistics firms can enhance their ability to navigate challenges and

sustain their operations in an increasingly complex and uncertain business landscape. Through effective risk and crisis management, logistics companies can position themselves for long-term success and maintain a competitive edge in the industry.

1.3.Risk and Crisis Management Strategies in The Logistics Sector

The logistics industry operates in a highly dynamic and unpredictable environment, requiring robust risk and crisis management strategies to safeguard operations and ensure supply chain continuity. In this section, we review the existing risk and crisis management strategies employed by logistics companies to address the challenges they face.

Proactive Risk Identification and Assessment:

Leading logistics companies recognize the importance of identifying risks early on to develop appropriate mitigation strategies. They conduct comprehensive risk assessments to evaluate the potential impact and likelihood of various risks, including transportation delays, supplier disruptions, and market volatility. Utilizing data analytics and historical performance data, logistics firms gain insights into their vulnerabilities, enabling them to prioritize and address critical risks efficiently (Smith & Merritt, 2020).

Supply Chain Diversification and Redundancy:

To minimize the impact of supplier disruptions and transportation delays, many logistics companies adopt supply chain diversification and redundancy measures. By partnering with multiple suppliers and maintaining redundant distribution centers or transportation routes, these firms can quickly pivot in the face of unexpected disruptions. Such strategies enhance the resilience of the supply chain, allowing for smoother operations even during crises (Azadegan et al., 2021).

Collaborative Risk Management:

Logistics companies often collaborate with key stakeholders, including suppliers, customers, and industry partners, to collectively manage risks. Open communication channels and collaboration platforms enable real-

time sharing of information, which is crucial in rapidly responding to emerging risks. Collaborative risk management fosters a sense of shared responsibility and ensures that all parties work towards mutual risk reduction and crisis mitigation (Ahmed, Najmi & Khan, 2020).

Advanced Technology and Data-Driven Solutions:

The logistics sector leverages cutting-edge technology to enhance risk and crisis management capabilities. Real-time tracking systems, predictive analytics, and AI-powered algorithms enable logistics companies to monitor their operations, detect potential risks, and make data-driven decisions. By adopting innovative technologies, logistics firms can identify inefficiencies, forecast disruptions, and implement preventive measures more effectively (Gutierrez-Franco, Mejia-Argueta & Rabelo, 2021).

Business Continuity Planning:

To ensure continuity during crises, logistics companies develop comprehensive business continuity plans (BCPs). These plans outline procedures for various crisis scenarios and delineate the roles and responsibilities of employees during emergencies. BCPs also encompass communication strategies, supply chain mapping, and resource allocation to facilitate smooth operations in adverse circumstances (Gupta & Singh, 2021).

Crisis Communication and Stakeholder Engagement:

Effective crisis communication is vital for logistics companies to manage reputational risks and maintain stakeholder confidence during crises. Clear and transparent communication with customers, suppliers, employees, and the public helps alleviate concerns and ensures timely information dissemination. Engaging stakeholders and addressing their needs proactively fosters trust and enhances the company's credibility during challenging times (Almoradie, Cortes & Jonoski, 2015).

Scenario Planning and Simulation Exercises:

Leading logistics companies conduct scenario planning and simulation exercises to assess their preparedness for potential crises. Through

simulated crisis situations, logistics firms test their response strategies, identify gaps in their crisis management plans, and fine-tune their approach. These exercises enhance the company's ability to respond swiftly and decisively when actual crises arise (Symstad et al., 2017).

In conclusion, the logistics sector continuously evolves to meet the challenges of an ever-changing business landscape. Effective risk and crisis management strategies are crucial for logistics companies to navigate uncertainties, protect their operations, and ensure the seamless flow of goods in both stable and crisis situations. By adopting proactive risk identification, supply chain diversification, advanced technology solutions, collaborative approaches, and crisis preparedness, logistics firms can strengthen their resilience and uphold their commitments to customers and stakeholders.

1.4.Studies in Literature on Risk Management in Logistic Sector

The following table provides an overview of selected research articles retrieved from Google Scholar, focusing on the topic of risk management within the logistics industry. The compiled studies delve into various aspects of risk and crisis management strategies, offering insights into how logistics companies address uncertainties and disruptions in their operations. The keywords "risk and crisis management," "logistics industry," "common risks," and "mitigation strategies" guided the search and selection of these articles. Arranged chronologically by publication year, the summaries of these studies highlight key findings, methodologies employed, and the practical implications they offer for enhancing resilience and effective management within the dynamic logistics landscape.

Table 1. Literature Table on Risk Management in Logistic Sector

Authors & Year	Publication	Content Summary
Albertijn, S., Bessler, W., & Drobetz, W. (2011)	Journal of Applied Corporate Finance, 23(4), 70-82	Examines risk management and financing strategies in the shipping industry. Discusses the shift of shipping risks from banks to capital markets. Explores value-maximizing combination of modifying operations, employing derivatives, and adjusting capital structures in shipping risk management.
Manuj, I., & Mentzer, J. T. (2008)	International Journal of Physical Distribution & Logistics Management, 38(3)	Investigates risk management strategies in global supply chains. Explores six risk management strategies and their applicability to different environmental conditions. Emphasizes the role of moderators in choosing strategies. Builds a foundation for risk management theory in global supply chains.
Natarajarathinam, M., Capar, I., & Narayanan, A. (2009)	International journal of physical distribution & logistics management, 39(7)	Reviews literature on managing supply chains during crises. Introduces a five-dimensional framework to classify literature. Discusses extensive research in proactive crisis approaches. Identifies gaps in the literature, particularly in managing internal crises like supplier bankruptcy or client loss. Provides directions for supply chain managers and outlines a research agenda.

Authors & Year	Publication	Content Summary
Colicchia, C., & Strozzi, F. (2012)	Supply Chain Management: An International Journal, 17(4)	Presents a new methodology combining systematic literature review with citation network analysis for studying supply chain risk management (SCRM). Classifies literature into a five-dimensional framework. Reveals key themes and contributions in SCRM research. Proposes future research directions in SCRM.
Bartosova, T., Taraba, P., & Peterek, K. (2021)	Chemical engineering transactions, 86, 403-408	Investigates risk management approaches in Czech Republic logistics companies. Explores the effect of company size on risk management processes, expenditure, personnel involvement, and external input. Identifies scenario planning and What-If Analysis as crisis management methods.
Wu, P. J., & Chaipiyaphan, P. (2020)	The International Journal of Logistics Management, 31(1), 43-58	Investigates delivery vulnerability in logistics using operations data. Applies pragmatic business analytics to extract insights. Identifies vulnerabilities in tightly coupled logistics systems, highlighting both multi-component and interactive vulnerabilities.
Choi, T. M., Chiu, C. H., & Chan, H. K. (2016)	Transportation Research Part E: Logistics and Transportation Review, 90	Explores risk management of logistics systems. Discusses disruption risk management, operational risk control, disaster and emergency management, and logistics service risk analysis. Introduces key themes in the field and

Authors & Year	Publication	Content Summary
		outlines the contributions featured in the special issue. Presents research directions for advancing risk management of logistics systems.
Bezpartochna, O. (2023)	Food security: modern challenges and mechanisms to ensure, 127	Identifies and categorizes risks in logistics activity of agricultural enterprises. Advocates for a comprehensive approach to risk management in the agrarian sector. Proposes measures to level risks in logistics activities of agricultural enterprises. Addresses risks related to material support, economic processes, transportation, and more.
Denga, E. M., & Rakshit, S. (2022)	In Global Risk and Contingency Management Research in Times of Crisis	Explores supply chain logistics risk mitigation in the context of the COVID-19 pandemic. Investigates uncertainties, tactics, and strategies employed by businesses in Nigeria's supply chain logistics. Discusses the role of logistics and supply chain management in enhancing resilience and addressing uncertainties, particularly during crises like the COVID-19 pandemic.

2. METHODOLOGY

The research design employed in this study is a mixed-methods approach (Johnson & Onwuegbuzie,2004) that combines qualitative and quantitative methods to provide a comprehensive analysis of risk and crisis

management strategies in the logistics sector. This approach allows for a deeper understanding of the underlying factors influencing risk management practices while also providing empirical evidence through data-driven analysis.

To begin with, a literature review has been conducted to gather insights into existing risk and crisis management strategies in the logistics industry. Subsequently, qualitative data has been collected through semi-structured interviews with industry experts, logistics practitioners, and risk management professionals. These interviews provide valuable perspectives on the challenges faced by logistics companies, their experiences in handling risks and crises, and the strategies they have found to be effective in mitigating disruptions.

As a result of the interviews, criteria set (strategies) to mitigate the one of the risks (natural disaster) have been determined and weighted by three of the experts. Step by step, AHP applied. As a result of the analysis, four strategies have been ranked based on their importance.

2.1. Expert Interviews

For this study, industry experts working in international logistics companies in Turkey have been selected as key participants for the expert interviews. The selection of these experts has been based on their extensive knowledge, experience, and expertise in risk and crisis management within the logistics sector. Specifically, professionals with roles in logistics operations, supply chain management, risk assessment, and crisis response have been targeted to provide diverse insights.

Once potential industry experts are identified, an invitation was sent to them to participate in the expert interviews. The invitation has included detailed information about the study's objectives, the interview process, and the expected time commitment. Confidentiality and data privacy measures have assured to encourage candid and open responses from the participants.

The expert interviews have been conducted using a semi-structured interview format. This approach allows for flexibility in questioning while ensuring that key themes related to risk and crisis management are Each interview session were audio-recorded, with the consent of the interviewees, to ensure accurate capturing of the insights shared.

During the interviews, participants were asked about their experiences in identifying and addressing risks within the logistics industry, their perspectives on crisis management strategies, and their evaluation of the effectiveness of existing risk mitigation measures. Open-ended questions encouraged experts to share real-world examples, challenges, and success stories related to risk and crisis management in their respective organizations.

The data collected from the expert interviews were transcribed and subjected to thematic analysis to identify recurring patterns, common themes, and novel insights. The findings from the interviews were triangulated with the results from the literature review and other data sources to provide a comprehensive understanding of risk and crisis management strategies employed by international logistics companies in Turkey. The valuable perspectives and practical knowledge shared by the industry experts contribute significantly to informing effective risk management practices within the logistics sector. Table 1 provided information about the interviewees participated in the interviews.

Table 1. Information about Logistics Experts Interviewed

Interviwee #	**Position**	**Experience (Years)**
Interviewee 1	Land Export Manager	12
Interviewee 2	Land Import Supervisor	8
Interviewee 3	Sea Export Specialist	5
Interviewee 4	Sea Export Supervisor	10

Interviewee 4	Istanbul Branch Manager	20

Interview Questions for Industry Experts in International Logistics Companies in Turkey:

1. How do you perceive the potential risks and crises associated with transportation network disruptions caused by natural disasters, such as severe earthquakes, in the logistics industry?
2. Considering the scenario of a transportation network disruption due to a natural disaster, what are the specific challenges and vulnerabilities that logistics companies might face in their operations?
3. In your experience, which risk and crisis management strategies have proven to be effective in mitigating the impact of transportation network disruptions caused by natural disasters? Please provide examples of successful implementations in such scenarios.
4. How do you prioritize risk and crisis management strategies in the context of a transportation network disruption scenario to ensure the allocation of resources effectively?
5. What criteria or factors do you consider when evaluating the feasibility and cost-effectiveness of implementing different risk and crisis management strategies in the face of a transportation network disruption caused by a natural disaster?
6. In light of the scenario presented, how do you assess the long-term sustainability and adaptability of various strategies in managing transportation network disruptions?
7. How do you address the interdependencies and potential conflicts between different risk and crisis management strategies in the context of a transportation network disruption scenario?
8. Are there any innovative approaches or emerging technologies that you believe can significantly enhance logistics companies' ability to handle transportation network disruptions caused by natural disasters?
9. What role do collaborative efforts with stakeholders, such as suppliers, customers, and government agencies, play in effectively managing transportation network disruptions in the aftermath of natural disasters?
10. In your opinion, what are the key takeaways or lessons learned from past experiences of dealing with transportation network disruptions

caused by natural disasters, and how can this knowledge be applied to enhance risk and crisis management strategies in the logistics industry?

Summary of the Interview Answers

The interviews conducted with industry experts yielded valuable insights into effectively managing transportation network disruptions caused by natural disasters in the logistics sector. Participants emphasized the significance of proactive risk assessment and contingency planning to mitigate the impact of such crises. They highlighted the challenges posed by disruptions on supply chain efficiency, transportation delays, and increased operational costs. In response to the scenario, the experts proposed a range of strategies aimed at bolstering resilience and responsiveness. These included the establishment of redundant supply chains to diversify sourcing options, the implementation of flexible transportation networks to accommodate disruptions, and the adoption of real-time monitoring technologies for early warning and swift decision-making. Moreover, collaborative partnerships with suppliers, customers, and government agencies were considered crucial for sharing information and resources during crisis situations. The experts underscored the importance of learning from past experiences to continuously improve risk and crisis management strategies, ensuring the industry's adaptability and long-term sustainability. Overall, the interviews provided comprehensive insights into a proactive and collaborative approach to crisis management, equipping logistics companies with effective strategies to navigate transportation network disruptions caused by natural disasters successfully.

2.2.The Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP), introduced by Thomas L. Saaty in the 1970s, is a fundamental decision-making approach widely utilized to select the most accurate and optimal choice among multiple alternatives. AHP involves comparing alternatives based on various criteria and aims to simplify

complex decision problems by breaking them down into pairwise comparison matrices, ultimately leading to a solution.

AHP holds a significant position among decision-making techniques due to its ability to structure people's thought processes hierarchically. It facilitates the comparison of similar pairs based on shared attributes, enabling individuals to assess the relative importance of one factor over another (Saaty& Hu, 1998).

While the Analytic Hierarchy Process (AHP) offers valuable insights into decision-making, it is not without its disadvantages. AHP can be susceptible to biases and subjectivity, as the process heavily relies on the judgments of decision-makers during pairwise comparisons. The complexity of creating and managing pairwise comparison matrices for larger and more intricate decision problems can also lead to increased time and resource requirements, potentially impeding its practicality for extensive or time-sensitive analyses. Moreover, the calculation of consistency ratios and eigenvalues can be intricate, and improper handling of these calculations may introduce inaccuracies into the final results.

The Analytic Hierarchy Process (AHP) holds distinct advantages over the Analytic Network Process (ANP) in various scenarios. AHP's simplicity and ease of use make it accessible for decision-makers, involving straightforward pairwise comparisons. Its transparency and intuitive hierarchy structure allow for clear visualization of relationships among criteria and alternatives. AHP also includes a built-in consistency check to ensure coherent judgments. Additionally, AHP's stability and applicability to smaller problems make it efficient for decision-making, especially in cases with limited data or simpler decision contexts (Asadabadi, Chang & Saberi, 2019).

Distinguished by its inclusion of both numerical and subjective factors, AHP surpasses other decision-making methods by embracing a broader spectrum of considerations within the system.

The application of the AHP method follows a systematic framework, making the attainment of solutions relatively straightforward. The procedure comprises the following steps (Saaty and Hu, 1998):

Step 1: Problem Definition and Goal Setting

The initial step involves defining the problem to be addressed and evaluating its suitability for AHP. The desired goal of the solution is established, along with the criteria that will lead to its achievement. The identification of alternative options, whose criteria will be compared, completes this step.

Step 2: Hierarchy Construction

The AHP framework comprises a 3-level hierarchy. The top level signifies the target to be reached, the third level encompasses the alternatives for achieving the target, and the second level encompasses the criteria used to compare the alternatives.

Step 3: Pairwise Criterion Comparison

This step entails comparing the predetermined criteria in pairs, evaluating their relative importance. The comparison utilizes Saaty's developed comparison scale, which aids in assessing the significance of one criterion over another.

In essence, the Analytic Hierarchy Process offers a structured approach to decision-making, allowing for the systematic evaluation of alternatives based on multiple criteria. Its hierarchical structure, pairwise comparisons, and consideration of subjective factors render it a powerful tool for complex problem-solving and decision-making processes.

Table 2. Pair-wise comparison scale for AHP preferences

Numerical Rating	**Verbal Judgements of Preferences**
9	Extremely preferred
8	Very strongly to extremely
7	Very strongly preferred

6	Strongly to very strongly
5	Strongly preferred
4	Moderately to strongly
3	Moderatey preferred
2	Equally to moderately

Source: Saaty, T. L. (1990). An exposition of the AHP in reply to the paper "remarks on the analytic hierarchy process". Management science, 36(3), 259-268.

How important is which of the two criteria over the other? By answering the question, a pairwise comparison matrix is created.

Step 4: Normalizing the Pairwise Comparison Matrix

The process of normalizing the matrix involves summing each column individually and subsequently dividing each row's values by the sum of the respective column, thereby achieving normalization.

Step 5: Calculation of Criterion Weights

The calculation of criterion weights is accomplished by computing the average of each row within the normalized matrix. This process concludes the weighting procedure, determining the importance of each criterion.

Step 6: Calculating Consistency

Following the preceding steps, an assessment of the matrix's consistency is undertaken to gauge the consistency of decision-makers' behavior. For a matrix to be deemed consistent, the consistency value should fall below 10%. The evaluation of consistency involves the following steps:

1. The pairwise comparison matrix is multiplied by the weighted eigenvector matrix. Subsequently, each value is divided by the corresponding eigenvector component.

2. The mean of the values obtained in the first row is calculated, yielding the maximum eigenvalue, denoted as λmax.
3. The consistency ratio calculation comprises two stages. Initially, the consistency index (CI) is computed.

$$CI = (\lambda\_max - n) / (n - 1).$$

4. After calculating the consistency index, the Random Consistency Index (RI) is calculated.

Table 3. Average Random Consistency

Size of Matrix	1	2	3	4	5	6	7	8	9	10
Random consistency	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Source: Saaty, T. L. (1990). An exposition of the AHP in reply to the paper "remarks on the analytic hierarchy process". Management science, 36(3), 259-268.

Consistency rate is calculated with below formula;

$$CR : CI/RI$$

The result is expected to be less than 0.1. If it is lower than this rate, the result is considered consistent, if it is higher, the result is considered inconsistent.

Diagram below summarizes the steps in the analysis.

Diagram 1. Steps of the Analysis in the Study

3.FINDINGS OF THE ANALYSIS

In this study, AHP has been utilized to address the critical challenge faced by logistics companies – the management of risks and crises. Specifically, the study has focused on the scenario of a disruption in the transportation network due to a natural disaster, such as a severe earthquake, which could significantly impact the logistics operations.

To apply AHP, a hierarchical structure has been constructed that comprises the main objective and criteria. The main objective has been to identify the most effective crisis management strategy in the logistics industry to address the disruption caused by the natural disaster such as a severe earthquake, that disrupts the transportation network in a region where it operates. This disruption could lead to delays in shipments, damage to infrastructure, and challenges in accessing critical supply chain routes.

As a result of the Iiterature review and expert interviews, below strategies have been identified and will be used in the analysis as the criteria.

Table 4. Criteria Set used in the AHP Analysis

Criteria no#	Criteria	References
1	Diversification of Transportation Routes	Ndambuki & Al Hitmi, (2021)
2	Real-time Tracking and Visibility	Özcan & Özlem (2021)
3	Business Continuity Planning	Adıgüzel (2022).
4	Collaboration with Suppliers and Customers	Eygü & Karabacak. (2017)

Once the criteria were established, three interviewees were engaged to perform pairwise comparisons using Saaty's 1-9 scale, aligning with their individual expertise and experiences. By calculating geometric averages from the participants' responses, pairwise comparison matrices were derived. These matrices serve as a representation of expert consensus.

Table 5. Pairwise Comparisons of The Strategies

	C1	C2	C3	C4
S1	1	3	4	2
S2	1/3	1	2	1
S3	1/4	1/2	1	1/3
S4	1/2	1	3	1

Then we normalize the pairwise comparison matrix by dividing each element by its corresponding weight:

Table 6. Normalization of the Criteria Comparison Matrix

	C1	**C2**	**C3**	**C4**
S1	1/0.35	(3/0.87)	(4/1.63)	(2/0.64)
S2	(1/3)	1/0.87	(2/1.63)	(1/0.64)
S3	(1/4)	(1/2)	1/1	(1/0.64)
S4	(1/2)	1/0.87	(3/1.63)	1/0.64

The practical implementation involved constructing a four-level Analytic Hierarchy Process (AHP) model. After determining the importance levels of the criteria, the consistency of the evaluations was gauged using indicators of randomness. The subsequent table presents the significance levels, consistency assessments of the study's criteria, and the ultimate ranking of these criteria.

Table 5: Final Ranking of the Criteria

Criteria no#	**Criteria**	**Weights**
1	Diversification of Transportation Routes	0.491
2	Collaboration with Suppliers and Customers:	0.257
3	Real-time Tracking and Visibility	0.250
4	Business Continuity Planning	0.101

Consistency rate is 0,01269409 which is below 0.1. It suggests that the result is consistent.

The analysis shows that the strategy "Diversification of Transportation Routes" is considered the most effective in managing the risk of transportation network disruptions due to natural disasters in the logistics industry. The other strategies are also important and should be considered in the overall risk and crisis management plan of the logistics company.

The findings of the study indicate that the logistics industry faces various risks and potential crises that can significantly impact their operations. Through a comprehensive analysis of risk and crisis management strategies in the logistics sector, several key observations were made:

Common Risks and Crises: The study identified a range of common risks and crises faced by logistics companies, including supply chain disruptions, transportation delays, natural disasters, economic fluctuations, and regulatory compliance challenges. These risks can lead to operational inefficiencies, financial losses, and reputational damage.

Proposed Strategies: Industry experts proposed a set of effective risk and crisis management strategies to address the identified challenges. These strategies encompassed various aspects such as supply chain diversification, collaboration with stakeholders, technology utilization for risk prediction, regular testing of crisis plans, robust crisis communication, proactive risk identification, business continuity planning, resilient supply chain networks, employee training, and regulatory compliance measures.

Prioritization of Strategies: One of the risks identified was natural disaster. It was the chosen scenario for the study. Four strategies were identified to overcome. They are; Diversification of Transportation Routes, Collaboration with Suppliers and Customers, Real-time Tracking and Visibility, Business Continuity Planning. The application of the Analytic Hierarchy Process (AHP) method allowed to prioritize the proposed strategies based on their relative importance in managing risks and crises. Through

expert interviews and pairwise comparisons, the most critical strategy was identified which is "Diversification of Transportation Routes, (0.491)", "Collaboration with Suppliers and Customers (0.257)", "Real-time Tracking and Visibility (0.250)", "Business Continuity Planning **(**0.101)"**.**

In conclusion, the study's findings underscore the importance of proactive risk and crisis management in the logistics sector. By implementing the prioritized strategies, logistics companies can enhance their resilience, maintain business continuity, and effectively navigate the dynamic challenges prevalent in the industry. The comprehensive analysis and prioritization provided by the AHP method offer valuable guidance to logistics decision-makers, enabling them to make informed and strategic choices to safeguard their operations and reputation.

4.DISCUSSION

The findings of the analysis presented in this study align closely with the information gleaned from the literature review, reinforcing the significance of effective risk and crisis management strategies within the logistics industry. The synthesis of the analysis results with the insights from the literature provides an understanding of the challenges faced by logistics companies and the strategies employed to mitigate these challenges.

The literature review revealed common risks and crises that logistics companies encounter, including supply chain disruptions, transportation delays, natural disasters, economic fluctuations, and regulatory compliance issues. These challenges were corroborated by the analysis, which identified the risk of transportation network disruptions due to natural disasters as a focal point. This alignment underscores the importance of considering both common and specific risks when developing comprehensive risk management strategies.

The proposed risk and crisis management strategies identified in the literature resonated well with the strategies highlighted in the analysis. Both sources emphasize the significance of supply chain diversification, collaboration with stakeholders, technology utilization, crisis communication, proactive risk identification, business continuity planning,

and resilient supply chain networks. This correspondence reinforces the notion that these strategies are not just theoretical concepts but practical approaches endorsed by both industry experts and empirical analysis.

Furthermore, the prioritization of strategies using the Analytic Hierarchy Process (AHP) method in the analysis offers a quantifiable dimension to the insights gathered from the literature. The literature may discuss various strategies in detail, but the analysis adds value by assigning relative importance to these strategies based on specific risk scenarios. The prioritization, with "Diversification of Transportation Routes" emerging as the most critical strategy, serves as a benchmark for logistics decision-makers looking to allocate resources effectively.

It is noteworthy that the alignment between the literature and analysis highlights the dynamic nature of the logistics industry's risks and crises. The evolving landscape demands a proactive and multifaceted approach to risk and crisis management. The literature, through its broad exploration of challenges, and the analysis, through its focused examination of a specific risk scenario, together provide a holistic view of the complexities involved.

In conclusion, the congruence between the literature review and analysis results emphasizes the robustness of the findings. It underscores the importance of evidence-based decision-making, where theoretical insights from existing literature are validated and enriched by empirical analysis. By weaving together theoretical concepts and practical applications, this study equips logistics professionals with a well-rounded understanding of risk and crisis management, empowering them to tackle challenges head-on and foster resilience within the dynamic logistics landscape.

CONCLUSION

In this study, some risks and crisis management strategies in the logistics sector were presented, aiming to prioritize the most effective approaches for enhancing strategic resilience. The scenario presented involved a logistics company facing a sudden disruption in its supply chain due to a natural disaster, causing significant delays and inventory shortages. Each of the four strategies presented in the study—Diversification of

Transportation Routes, Collaboration with Suppliers and Customers, Real-time Tracking and Visibility, and Business Continuity Planning—plays a distinct role in mitigating and managing potential disruptions caused by a sudden supply chain disruption due to a natural disaster. These strategies can have different effects on the overall outcome and result of the logistics company's response to the crisis scenario.

As a result of the AHP analysis, the strategies were ranked based on their importance and effectiveness. “Diversification of Transportation Routes” at the time of a natural disaster was found to be most effective based on the AHP method thus, experts views. This strategy involves establishing alternative and varied pathways for transportation during times of natural disasters. Natural disasters, such as earthquakes, floods, hurricanes, and wildfires, can severely disrupt the regular transportation infrastructure, including roads, highways, railways, and airports. This disruption can lead to supply chain interruptions, delays in delivering essential goods, and difficulties in evacuating affected areas. Implementing the diversification of transportation routes strategy involves several key principles (Ndambuki & Al Hitmi, 2021);

- Redundancy: This strategy emphasizes creating redundant routes, meaning having multiple options for transporting goods and people. These alternative routes may involve different modes of transportation or routes that circumvent disaster-prone areas.
- Multi-Modal Approach: Utilizing multiple modes of transportation, such as road, rail, air, and sea, diversifies options and provides flexibility in case one mode becomes inoperable.
- Geographical Variation: Establishing transportation routes that take different geographical paths reduces the risk of all routes being affected by a single disaster event.
- Supply Chain Resilience: By having diversified transportation options, supply chains can continue to function even if some routes are impacted. This maintains the flow of goods and services, reducing disruptions to businesses and communities.
- Emergency Evacuation: Diversification of routes is crucial for efficient evacuation during disasters. Having multiple escape routes

ensures that people can move away from danger zones quickly and safely.

- Investment in Infrastructure: Governments and organizations should invest in creating and maintaining alternative transportation infrastructure to support the strategy. This may involve building new roads, bridges, and transportation hubs.
- Technological Integration: The use of technology, such as GPS, real-time traffic monitoring, and communication systems, enhances the effectiveness of diversification strategies by providing up-to-date information on route availability.

Overall, the diversification of transportation routes strategy aims to enhance resilience and minimize the impact of natural disasters on transportation networks. By creating redundancy and flexibility in transportation options, this approach can significantly improve disaster response, mitigate disruptions, and ensure the continuous flow of goods and services even in the face of unforeseen events.

While this study offers valuable insights into risk and crisis management in the logistics industry, it is essential to acknowledge its limitations. The findings and prioritized strategies are context-specific to the Turkish logistics sector and may not be fully applicable to other regions or industries. Moreover, the study's reliance on expert interviews may introduce subjective biases in the selection and evaluation of strategies. To address these limitations, future research could expand the scope of analysis to encompass a broader range of logistics companies in different countries and industries. Additionally, employing a combination of qualitative and quantitative methods could provide a more comprehensive understanding of risk and crisis management strategies.

In future studies, researchers can delve into various aspects to deepen our understanding of risk and crisis management in the logistics sector. Exploring comparative analyses across different regions, investigating the impact of emerging technologies, and conducting case studies of successful risk management strategies can provide valuable insights. Additionally, studying long-term resilience strategies, considering the human factor, and examining

sustainability integration can enhance the sector's preparedness. Evaluating the effectiveness of collaborations, assessing economic and policy implications, and exploring supply chain sustainability will further contribute to advancing risk and crisis management practices in logistics. By pursuing these avenues, future research can empower the industry to navigate challenges effectively and ensure its continued growth and success in a dynamic and ever-evolving landscape.

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