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Food Retail Resilience During Unstable Times: A Study of Agricultural Product Retailing

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Master's in Business Administration

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PhD, Henrique José da Rocha O'Neill, Associated Professor with Habilitation
ISCTE – Instituto Universitário de Lisboa

October, 2024

BUSINESS
SCHOOL

Department of Marketing, Operations and General Management

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ACKNOWLEDGMENTS

Firstly, I would like to thank Professor Henrique O'Neill for embarking on this journey with me. His profound knowledge and unconditional support have been instrumental throughout the research process, and his insights and academic thinking have enriched this dissertation immensely. I am truly grateful for his availability and encouragement over the past months, which made all the difference in completing this thesis.

To the interviewees of this dissertation, I extend my gratitude for generously giving up their valuable time to share their insights and experiences. Their openness and expertise have provided valuable perspectives that significantly enriched this research. Without their contribution, this work would not have been possible.

To my parents, for offering me the opportunity to pursue my academic goals, not only the Masters but all throughout my academic journey. They were always willing to help and support me in any way they could, and I am very grateful that I have two amazing role models that always push me to be my best.

To my friends, for being there for me and bringing the best out of me. I am extremely grateful for your presence in my life. Now more than ever I realize life is a journey that is better enjoyed when shared and I am thankful that I get to share my journey with you.

RESUMO

Esta dissertação investiga a resiliência das cadeias de abastecimento no retalho alimentar, com foco específico em produtos agrícolas durante períodos de instabilidade. Utilizando uma abordagem de métodos mistos, integra entrevistas qualitativas com gestores de retalho e questionários quantitativos com consumidores para validar a Estratégia de Cadeia de Abastecimento Resiliente Integrada (IRSC). A estratégia IRSC enfatiza a flexibilidade, a monitorização em tempo real e o planeamento colaborativo para melhorar a estabilidade da cadeia de abastecimento. Os principais resultados sugerem que, embora a flexibilidade e a monitorização em tempo real sejam essenciais para a continuidade, a sua implementação é frequentemente dificultada por elevados custos, especialmente para pequenos retalhistas.

O estudo destaca a importância da diversificação de fornecedores e de tecnologias avançadas de monitorização, embora a viabilidade financeira permaneça um desafio. Além disso, o planeamento colaborativo foi identificado como um componente crucial para alinhar os intervenientes, mas exige um investimento significativo em tecnologia e gestão de relações. A pesquisa conclui que a Estratégia IRSC oferece uma estrutura robusta para melhorar a resiliência da cadeia de abastecimento, mas desafios práticos como custo e integração tecnológica precisam ser superados para uma adoção mais ampla. Esta dissertação contribui para a literatura ao oferecer insights sobre como os retalhistas de produtos agrícolas podem aumentar a sua resiliência e atender às necessidades dos consumidores durante disrupções.

Palavras-chave: resiliência da cadeia de abastecimento; retalho agrícola; distribuição alimentar; perceção do consumidor; flexibilidade; monitorização em tempo real; planeamento colaborativo

Códigos de classificação JEL: Q13 (Agricultural Markets and Marketing; Cooperatives; Agribusiness); M11 (Production Management)

ABSTRACT

This study investigates the resilience of food retail supply chains, focusing specifically on agricultural products during periods of instability. Using a mixed-methods approach, it integrates qualitative interviews with retail managers and quantitative surveys of consumers to validate the proposed Integrated Resilient Supply Chain (IRSC) Strategy framework. The IRSC Strategy framework emphasizes flexibility, real-time monitoring, and collaborative planning to enhance supply chain stability. Key findings suggest that while flexibility and real-time monitoring are essential for maintaining continuity, their implementation is often hindered by high costs, especially for smaller retailers.

The study highlights the importance of diversified sourcing and advanced monitoring technologies, although their financial feasibility remains a concern. Additionally, collaborative planning was identified as a crucial component for aligning stakeholders but requires significant investment in technology and relationship management. The research concludes that the IRSC Strategy framework provides a robust framework for improving supply chain resilience, yet practical challenges like cost and technological integration must be addressed for broader adoption. This study contributes to the literature by offering insights into how agricultural product retailers can enhance their resilience and meet consumer needs during disruptions.

Keywords: supply chain resilience; agricultural retail; food distribution; consumer perception; flexibility; real-time monitoring; collaborative planning

JEL Classification Codes: Q13 (Agricultural Markets and Marketing; Cooperatives; Agribusiness); M11 (Production Management)

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1. INTRODUCTION

1.1. CONTEXTUALIZATION

In the early months of 2020, as the world dealt with the enormous problems of the COVID-19 epidemic, an upsetting reality surfaced throughout global food supply networks. In certain regions, such as the United States and parts of Europe, supermarket shelves, which were typically well-stocked with fresh goods, suddenly appeared empty due to panic buying and logistical challenges (Hobbs, 2020). The complex system of logistics that delivered agricultural products from farms to consumers experienced significant interruptions. News of farmers being forced to waste perishable goods because of distribution delays, along with photographs of long lines at food banks, created a dark image of the vulnerabilities in the food supply networks (Food and Agriculture Organization [FAO], 2020). While this crisis exposed significant systemic issues within the global food distribution industry, it was not universally experienced. For instance, in Portugal, supermarket chains managed to maintain a relatively stable supply, demonstrating resilience in their logistical operations. Natural disasters, such as hurricanes and droughts, have long posed substantial risks to agricultural production, causing fluctuating supply levels and market instability. For example, the 2019 floods in the Midwest United States resulted in severe crop damage and delayed planting seasons, creating ripple effects across the supply chain (English et al., 2021). Furthermore, political conflicts and trade wars have disrupted international trade channels, impacting the availability and cost of essential agricultural products (Lu, 2018). The consequences of these disruptions go far beyond the immediate financial losses. Problems in the supply chain can lead to financial collapse, job losses, and decreased market competitiveness for companies, particularly small-scale farmers and retailers. Companies may struggle to fulfill contractual responsibilities, resulting in conflicts between suppliers and customers. On a social level, these disturbances put at risk food security by making quality food less available and affordable, especially for vulnerable society groups. During the pandemic, the World Food Programme warned that an additional 130 million people could face famine, highlighting the vital relationship between supply chain resilience and global food security (World Food Programme [WFP], 2020).

Environmentally, the impact of supply chain disruptions cannot be ignored. Inefficient supply chains contribute to increased food waste and carbon emissions, aggravating climate change and its consequences. For example, in the United Kingdom, it is projected that supply chain inefficiencies contribute to almost 1.3 billion tons of food waste each year, stressing the need for more sustainable practices (Waste and Resources Action Programme [WRAP], 2023). Given these multifaceted issues, it is critical to explore the resilience of food supply chains, with a particular emphasis on agricultural product retailers, who play a critical role in guaranteeing the consistent availability of food. By understanding these mechanisms, we can develop more robust and adaptable supply chains, capable of withstanding future crises and safeguarding food security for all.

1.2. RESEARCH AIM, OBJECTIVES, AND QUESTIONS

Research Aim:

The proposed research aims to develop, examine, and validate the Integrated Resilient Supply Chain (IRSC) Strategy framework, specifically tailored to address the unique dynamics of the food retail supply chain in unstable environments. Unlike other sectors, such as automotive, electronics, or clothing, the food supply chain is more fragmented, highly sensitive to market fluctuations, and often governed by distinct structural characteristics. These include the influence of global commodity prices on key agricultural products like cereals, coffee, and soybeans, which adds an additional layer of complexity to the supply chain. In contrast to these other industries, food retail must navigate a more competitive landscape, responding quickly to shifts in supply and demand while ensuring product availability and stability, even in the face of disruptions.

This study's primary contribution lies in the development and validation of the IRSC Strategy comprehensive framework that combines flexibility, real-time monitoring, and collaborative planning as core pillars of resilience. Through an examination of how food retailers implement these components, the research assesses the IRSC Strategy's effectiveness in mitigating risks, maintaining operational stability, and enhancing flexibility within the agricultural product supply chain. Furthermore, the study considers the evolving influence of agro-industry players and large distribution chains, alongside emerging alternative sources, to meet rising demand. By evaluating these resilience strategies within the structural and

competitive context of food retail, this research aims to provide both theoretical insights and practical guidance for enhancing resilience in agricultural supply chains.

Research Objectives:

- To identify the specific challenges that agricultural product retailers encounter in maintaining resilience in the food supply chain during periods of instability and disruption.
- To analyze and validate the components of the IRSC Strategy framework—particularly the roles of flexibility, real-time monitoring, and collaborative planning—in enhancing resilience within food retail supply chains.
- To assess the effectiveness of the IRSC Strategy framework in mitigating risks, maintaining stability, and improving responsiveness in the agricultural product supply chain.
- To provide actionable insights for industry stakeholders, aimed at strengthening resilience practices, optimizing logistics, and implementing effective risk mitigation strategies within food retail.
- To explore consumer perceptions and behaviors during times of instability and understand how these factors influence the resilience of the food retail supply chain, thus informing the consumer-responsive component of the IRSC Strategy framework.

Research Questions:

1. What specific challenges impact the resilience of food retail supply chains within the agricultural sector, particularly in maintaining stability during unstable periods?
2. How effectively do food retailers implement the IRSC Strategy framework—focusing on flexibility, real-time monitoring, and collaborative planning—to address disruptions within the agricultural product supply chain?
3. What measurable outcomes does the IRSC Strategy framework achieve in terms of supply chain performance, stability, and resilience for agricultural products?
4. How can food retailers leverage the IRSC Strategy framework to enhance responsiveness and ensure consistent access to agricultural products for consumers during periods of disruption?

5. How do consumer perceptions and behaviors influence the resilience of food retail supply chains, and how can these insights further refine the IRSC Strategy to better address consumer needs during times of instability?

1.3. THESIS STRUCTURE OVERVIEW

As previously mentioned, the primary objective of this thesis is to explore the potential and possibility of the IRSC Strategy framework for enhancing supply chain resilience within the agricultural product retail sector. To achieve this objective, the dissertation will follow a structured approach. Initially, a concise overview of the research theme and its significance will be provided, highlighting the research questions, aim, and objectives. Following that, a comprehensive review of relevant literature on supply chain resilience, customer behavior, and retail management will be conducted to create a theoretical framework for the study. Subsequently, relevant data regarding the state of supply chain resilience and consumer behavior in the agricultural product retail sector, specifically in Portugal, will be presented to provide context and insights into the topic. The methodology used in this study will then be detailed, including the design of both the consumer questionnaire and the interviews, which will specifically target retail managers. Lastly, the findings of the study will be presented and analyzed, along with recommendations for those in the industry on how to maintain and improve supply chain resilience and meet consumer needs effectively.

2. LITERATURE REVIEW

2.1. IMPORTANCE OF THE AGRICULTURAL SECTOR

The agricultural sector is a cornerstone of the global economy, contributing significantly to food security, employment, and sustainable development. While agriculture provides essential food for human survival and acts as a primary income source for millions globally, its impact on economic development extends far beyond this. According to the Food and Agriculture Organization (FAO), approximately 26.7% of the global workforce is employed in agriculture, making it one of the largest employment sectors (FAO, 2021). Furthermore, agriculture's role in food security is vital, with the FAO estimating that global agricultural production must increase by 60% by 2050 to meet the demands of a projected 9.7 billion people (FAO, 2017). However, assessing agriculture's importance solely through its contribution to GDP can be misleading. A high percentage of agriculture in GDP often indicates a reliance on the primary sector, which may suggest a lack of diversification and an underdeveloped economy. For instance, Nigeria had the highest share of GDP from agriculture at 23.7% between 2012 and 2022, while more diversified economies, such as those in the European Union, have a lower average share of GDP from agriculture, around 1.7% (World Bank, 2021). Thus, while agriculture remains crucial, especially in developing regions, its relative economic weight varies significantly across different contexts.

A more comprehensive analysis of the agricultural sector's importance should consider several additional factors. First, examining production indices and the value of agricultural production per capita provides insights into the efficiency and productivity of the agricultural sector in different countries. According to the World Bank (2021), countries with high production values per capita tend to have more advanced agricultural technologies and practices, resulting in higher productivity levels and economic contributions. This approach can highlight countries that, despite having a lower percentage of GDP from agriculture, have highly productive and efficient agricultural sectors contributing significantly to their economies and global food supplies (UNCTAD, 2020). Second, understanding the degree of food autonomy and a country's food balance is crucial. Food autonomy refers to a nation's ability to meet its food needs independently without relying excessively on imports. This measure is critical for assessing a country's vulnerability to global market fluctuations and trade disruptions. For example, countries with high food autonomy are better positioned to withstand

international supply chain disruptions, while those heavily dependent on imports are more susceptible to global crises (FAO, 2019). A country's food balance, which examines the ratio between its food imports and exports, further reflects its capacity to sustain itself and contribute to global food security (IFPRI, 2022). Additionally, the geopolitical aspects of agricultural strategies are increasingly significant. According to Brautigam and Zhang (2013), China's discreet policy of acquiring agricultural land in Africa through land purchases and cooperation projects exemplifies a strategic move to secure long-term food supplies and raw materials for its population. This approach highlights how countries are not only focused on domestic production but are also looking abroad to secure resources, emphasizing the strategic importance of agriculture in international relations and economic planning (Scoones et al., 2016). By adopting a broader analytical approach allows for a deeper examination of the sector's complexities, including its economic, social, and geopolitical dimensions, ultimately offering a more robust framework for understanding agriculture's role in a rapidly changing global landscape.

Despite the numerous challenges and variables that agriculture faces, such as climate change, soil degradation and water scarcity, advancements in technology and infrastructure investment are enabling the sector to maintain its vital role in society. Technological innovations like precision farming, biotechnology, and digital agriculture are revolutionizing agricultural practices. For instance, precision agriculture has the potential to increase crop yields by 10-15% while reducing input costs by 10-20%, according to McKinsey & Company (2020). These advancements help optimize resource use, reduce environmental impact, and enhance resilience to climate change. Additionally, strategic investments in infrastructure and sustainable farming practices are crucial for addressing the projected decline in crop yields due to climate change, as highlighted by the Intergovernmental Panel on Climate Change (IPCC), which estimates a potential 25% decrease in some regions by 2050 (IPCC, 2019). Consequently, through innovation and strategic investment, agriculture continues to uphold its essential role in food security and economic development.

In Portugal, agriculture has been a pillar of the economy, contributing significantly to GDP, employment, and exports. Historically, the sector has been crucial since the mid-20th century, undergoing significant changes due to modernization and European Union (EU) integration. In the 1980s, Portugal's entry into the European Economic Community (EEC) led to increased funding and restructuring efforts, which substantially improved agricultural output and

standards (Reidsma et al., 2018). The 1990s marked further advancements as EU structural subsidies enhanced rural development and infrastructure, thereby increasing the value and competitiveness of Portuguese agriculture. By the early 2000s, agriculture accounted for about 4% of the GDP and employed approximately 11% of the workforce, underscoring its significant socio-economic impact (OECD, 2006).

In recent years, the sector has focused on sustainability and innovation, with advancements in biotechnology and water management programs playing pivotal roles in addressing challenges like climate change and resource shortages. According to Rodrigues et al. (2019), the adoption of these technologies has not only boosted productivity but also ensured the sustainable use of resources. Presently, Portugal's agricultural exports include a range of high-value products such as wine, olive oil, cork, and forestry products like pine wood and eucalyptus pulp. For instance, eucalyptus pulp has become increasingly important due to its high demand in the global paper industry, contributing significantly to Portugal's export revenues (PORDATA, 2022). This diversification into both traditional and non-traditional agricultural products has strengthened the sector's economic contribution. The export of these products has grown substantially, with agri-food and forestry exports reaching €6.8 billion in 2020, reflecting the sector's continued relevance and contribution to the economy (INE, 2021). Despite challenges such as an aging rural population and the adverse effects of climate change, the agricultural sector in Portugal continues to adapt and thrive. This resilience demonstrates its long-term importance to Portugal's economic and social fabric, highlighting the need for continuous innovation and sustainable practices to maintain its competitive edge in global markets.

2.2. SUPPLY CHAIN DISRUPTIONS

Supply chain disruptions represent critical interruptions in the flow of goods and services that challenge the robustness and efficiency of interconnected supply networks. These interruptions highlight the vulnerability of global supply chains, where an unexpected event in one region can have cascading effects worldwide. The complex nature of modern supply chains, with their extensive networks and interdependencies, makes them particularly susceptible to various disruptions. Understanding the sources and impacts of these disruptions is vital for developing effective strategies to enhance supply chain resilience and ensure continuity in the face of unforeseen challenges (Craighead, Blackhurst, Rungtusanatham, & Handfield, 2007).

Natural disasters, such as earthquakes, hurricanes, and floods, are well-known for causing severe disruptions to supply chains. According to Kleindorfer and Saad (2005), various natural disasters have significant impacts on supply chains by causing substantial damage to critical infrastructure and halting production at key manufacturing plants. This highlights the importance of effective contingency planning and infrastructure resilience. A notable example is the 2011 earthquake and tsunami in Japan, which severely disrupted global supply chains, particularly in the automotive and electronics industries, revealing the vulnerability of these networks to natural calamities (Haraguchi & Lall, 2015). Similarly, the 2010 eruption of the Eyjafjallajökull volcano in Iceland disrupted air travel across Europe, affecting the transport of perishable goods and the effectiveness of 'just-in-time' delivery systems, which depend on precise timing to minimize inventory costs and maintain efficiency. More recently, in 2023, production at Volkswagen Autoeuropa (VW-AE) in Portugal was significantly impacted by the flooding of a supplier's facility in Slovenia. This event caused a ripple effect, disrupting the entire supply chain associated with VW-AE, affecting not only direct suppliers but also downstream customers (Volkswagen Group, 2023). Such incidents illustrate the interconnectedness of global supply chains and highlight how disruptions in one area can cascade throughout the entire network, affecting numerous stakeholders. The example of VW-AE further emphasizes the critical need for robust supply chain resilience strategies, including diversified supplier bases and comprehensive risk management frameworks to better withstand unforeseen events.

Geopolitical tensions and trade conflicts also present significant risks to supply chain stability. Handfield et al. (2020) examined the trade war between the United States and China, initiated in 2018, which led to increased tariffs and regulatory barriers. Their research indicated that these geopolitical disruptions forced companies to rethink their supply chain strategies, shifting production to other countries to avoid tariffs. This shift resulted in significant changes to supply chain configurations and increased costs due to the need for new supplier relationships and logistical arrangements.

The COVID-19 pandemic showcased the vulnerability of global supply chains to health crises. Ivanov and Dolgui (2020) emphasized the importance of supply chain resilience, pointing out that the pandemic caused widespread factory shutdowns, transportation restrictions, and labor shortages, severely disrupting the flow of goods worldwide. Their research highlighted the necessity for diversification of suppliers, increased inventory levels,

and investment in digital technologies to effectively monitor and manage supply chain risks. Cyberattacks are another growing threat to supply chain stability, the 'NotPetya' ransomware attack in 2017, as examined by F-Secure (2018), disrupted operations at major companies such as Maersk, Merck, and FedEx, leading to losses estimated at over $10 billion. These incidents indicate the critical need for robust cybersecurity measures and contingency plans to protect supply chain infrastructure and data integrity. Economic fluctuations, including sudden shifts in demand and supply, currency volatility, and financial crises, can also disrupt supply chains. Christopher and Peck (2004) discussed how economic disruptions like financial crises can lead to reduced consumer spending and liquidity shortages, which can force companies to cut back on production and delay investments in supply chain improvements. The global financial crisis of 2008 is a prime example of these dynamics at play.

In the agri-food supply chain, these disruptions can have particularly severe consequences. Tendall et al. (2015) noted that natural disasters can destroy crops and livestock, leading to shortages and price spikes, while geopolitical tensions can impact the import and export of essential agricultural commodities. The FAO (2020) reported that pandemics can disrupt labor availability, affecting planting and harvesting schedules, and cyberattacks can compromise food safety by targeting critical systems that monitor food quality and safety standards. Economic fluctuations can affect the affordability and accessibility of food, impacting food security. Therefore, building resilience in the agri-food supply chain is crucial for ensuring a stable food supply, maintaining consumer confidence, and safeguarding public health.

2.3. SUPPLY CHAIN RESILIENCE

Supply chain resilience (SCRES) is essential for organizations to endure and recover from disruptions. Resilience involves the ability to anticipate, prepare for, respond to, and recover from significant multi-faceted disruptions, ensuring the continuous flow of goods and services. According to Adobor and McMullen (2018), resilience can be understood through three perspectives: engineering resilience, ecological resilience, and evolutionary resilience. Each dimension plays a vital role in enhancing the robustness and adaptability of supply chains.

One perspective of supply chain resilience focuses on efficiency and rapid recovery following disruptions. This involves optimizing systems and processes to quickly return to normal operations after an interruption. Key strategies include contingency planning, business continuity planning, and designing agile supply chains. For instance, maintaining safety stocks and diversifying supply sources are common practices that enhance this form of resilience.

These strategies are particularly relevant for supply chains where disruptions can lead to significant losses due to the perishable nature of products. Adobor and McMullen (2018) emphasize that implementing robust resilience measures helps minimize downtime and ensures a quick recovery, thereby maintaining the flow of goods to the market.

A complementary approach is understanding resilience as the system's ability to absorb impacts and adapt without losing functionality. This form of resilience, characterized by redundancy, flexibility, and self-organization, ensures that supply chains can continue functioning under stress. Redundancy, for instance, involves maintaining spare capacity and multiple supply sources to sustain operations during disruptions. Flexibility allows rapid reconfiguration of supply chains in response to changing conditions, as highlighted by Ivanov (2017), who emphasizes the role of flexibility in transportation and logistics to mitigate regional disruptions and maintain continuous product delivery.

The conceptual framework shown in Figure 2.1 (Pettit et al., 2010) aligns with these perspectives by illustrating how resilience arises from a balance between vulnerabilities (V) and capabilities (C). In this model, achieving resilience depends on matching capabilities to the specific vulnerabilities faced by the supply chain. If vulnerabilities are high but capabilities are low, resilience is compromised, resulting in excessive risk (Path A). Conversely, when capabilities exceed vulnerabilities (Path B), performance is enhanced, enabling the supply chain to manage disruptions effectively. Optimal resilience is achieved when a balanced portfolio of capabilities matches the vulnerabilities encountered (Path C), leading to improved overall performance. This balance is essential to ensure that the supply chain can withstand disruptions without over-investing in unnecessary redundancy or flexibility.

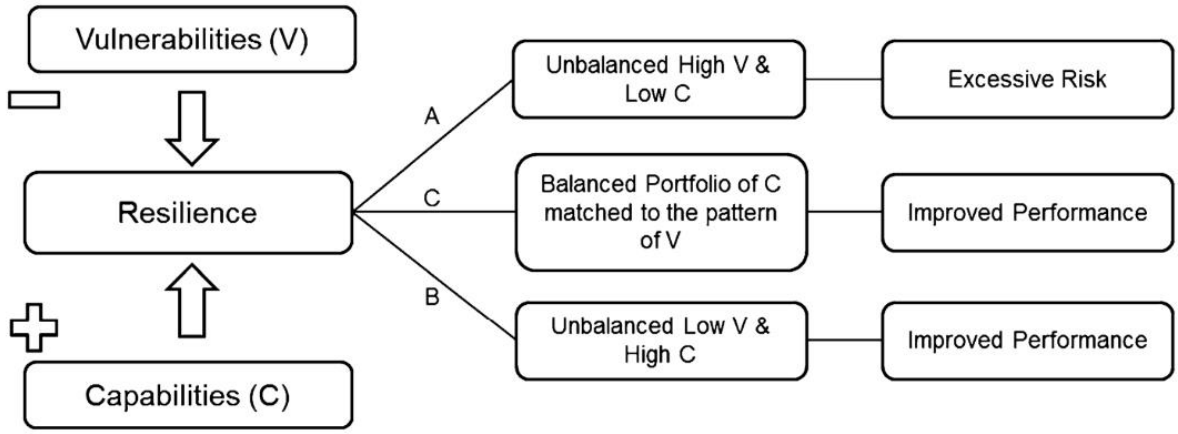

Figure 2.1 - Conceptual Framework for Resilience, (Pettit et al., 2010)

The capacity for transformation and growth following disruptions represents another crucial dimension of supply chain resilience. This forward-looking resilience involves adaptive management, continuous learning, and the development of new capabilities to enhance supply chain performance post-disruption. As Adobor and McMullen (2018) suggest, this approach is key for long-term sustainability, enabling supply chains to evolve in response to changing environments and emerging threats. For instance, adopting new technologies, such as precision agriculture, can improve resilience and productivity. Ivanov (2017) underscores that aligning resilience with sustainability practices—like efficient resource use and reducing carbon footprints—strengthens supply chains by supporting both environmental and social goals.

Ivanov's (2017) viable supply chain model further integrates agility, resilience, and sustainability, creating a robust system capable of withstanding various disruptions. Agility, defined as the ability to respond quickly to changes, is crucial for managing unforeseen disruptions. Resilience ensures a swift recovery, while sustainability focuses on long-term viability. These elements interlink, as agile supply chains are better positioned to manage supply-demand variability, resilient chains recover quickly from disruptions, and sustainable practices support the longevity of operations.

The interconnected nature of supply chain components calls for a collaborative approach to resilience. Zhao et al. (2018) emphasize that collaboration among supply chain partners, through joint decision-making and regular communication, enhances resilience by ensuring that all stakeholders are aligned in their strategies. Supply chain visibility and traceability are also vital, with transparency allowing for quick identification and mitigation of disruptions. This traceability is particularly valuable in high-risk scenarios, such as contamination, where pinpointing the issue source promptly is critical. Zhao et al. (2022) further highlights that fostering a risk-aware culture within agri-food supply chains, supported by regular training and leadership, is instrumental in building resilience and proactive risk management.

2.4. ESTABLISHED THEORIES AND METHODS

In this thesis, results will be obtained through interviews with supply chain managers of agri-food supply chains. To facilitate meaningful discussions, three highly specific supply chain theories/methods/hypotheses that increase resilience will be analysed according to several different parameters. These theories are the Adaptive Supply Chain Resilience model, the Digital Twin technology, and Collaborative Planning, Forecasting, and Replenishment (CPFR).

Each of these has been chosen for its relevance and potential to enhance resilience in agri-food supply chains.

2.4.1. ADAPTIVE SUPPLY CHAIN RESILIENCE MODEL

Backstory and Specifications

The Adaptive Supply Chain Resilience model, introduced by Pettit et al. (2019), emphasizes the ability of supply chains to adapt to changing conditions through a combination of flexibility, redundancy, and agility. This model integrates real-time data analytics, scenario planning, and a deep understanding of supply chain interdependencies to prepare for and respond to disruptions effectively. Key components include:

- *Flexibility:* The ability to change processes and strategies in response to disruptions. This includes flexible sourcing, manufacturing processes, and logistics networks.
- *Redundancy:* Maintaining excess capacity, alternative routes, and backup suppliers to ensure continuity in case of disruptions.
- *Agility:* The speed at which a supply chain can respond to changes. This involves rapid decision-making processes, streamlined communication channels, and quick implementation of changes.

Applications in Agri-Food Supply Chains

In the context of agri-food supply chains, flexibility can be achieved by having multiple sourcing options for critical inputs such as seeds, fertilizers, and other agricultural inputs. For instance, having a network of local and international suppliers can mitigate risks associated with regional disruptions. Redundancy in agri-food supply chains might involve maintaining buffer stocks of non-perishable items and developing relationships with alternative logistics providers to ensure timely delivery. Agility is crucial for perishable goods, where rapid response to changes in demand or supply is necessary to prevent spoilage and loss. Real-time data analytics can monitor weather conditions, crop health, and market demand, allowing for quick adjustments in harvesting, processing, and distribution plans.

2.4.2. DIGITAL TWIN TECHNOLOGY

Backstory and Specifications

Digital Twin technology, as discussed by Tao et al. (2019), involves creating a virtual replica of the physical supply chain. This technology allows for real-time monitoring, simulation, and optimization of supply chain operations. Key components of Digital Twin technology include:

- *Real-Time Monitoring:* Continuously collecting data from various points in the supply chain, such as production facilities, warehouses, and transportation networks.
- *Simulation:* Creating detailed simulations of supply chain operations to predict outcomes of different scenarios and disruptions.
- *Optimization:* Using advanced analytics and machine learning to optimize supply chain processes, reduce inefficiencies, and improve overall performance.

Applications in Agri-Food Supply Chains

For agri-food supply chains, Digital Twin technology can significantly enhance resilience by providing a detailed, real-time view of the entire supply chain. Real-time monitoring can track the status of crops, inventory levels, and transportation conditions, allowing for immediate responses to potential issues. For example, sensors in fields can provide data on soil moisture, weather conditions, and crop health, which can be integrated into the Digital Twin to predict yields and identify potential risks. Simulation capabilities enable supply chain managers to test various disruption scenarios, such as extreme weather events or supply shortages, and develop contingency plans accordingly. Optimization tools can help improve the efficiency of planting schedules, harvest times, and distribution routes, ensuring that agricultural products reach markets in the best condition possible.

2.4.3. COLLABORATIVE PLANNING, FORECASTING AND REPLENISHMENT (CPFR)

Backstory and Specifications

Collaborative Planning, Forecasting, and Replenishment (CPFR) is a business practice that combines the intelligence of multiple trading partners in the planning and fulfillment of customer demand. Initially introduced by the Voluntary Interindustry Commerce Standards

(VICS) Association in the late 1990s, CPFR aims to enhance supply chain integration by supporting and assisting joint practices.

- *Collaborative Planning:* Partners jointly develop business plans and determine the best approach to fulfill demand.
- *Forecasting:* Shared forecasting processes to align production and procurement plans.
- *Replenishment:* Coordinated replenishment strategies to ensure optimal inventory levels across the supply chain.

Applications in Agri-Food Supply Chains

In agri-food supply chains, CPFR can be used to improve coordination between farmers, processors, distributors, and retailers. Collaborative planning ensures that all parties are aligned on production schedules and market demand. Shared forecasting processes allow for more accurate predictions of crop yields and market needs, reducing the risk of overproduction or shortages. Coordinated replenishment strategies ensure that fresh produce is available at the right place and at the right time, minimizing waste and improving overall efficiency. CPFR enhances visibility across the supply chain, allowing for better anticipation of disruptions and more effective mitigation strategies.

Table 2.1 - Synthesizing the Three Supply Chain Resilience Strategies

Aspect	**Adaptive Supply Chain Resilience Model**	**Digital Twin Technology**	**Collaborative Planning, Forecasting, and Replenishment (CPFR)**
Explored By	Pettit et al. (2019)	Tao et al. (2019)	VICS Association (1990s)
Key Attributes	Flexibility, Redundancy, Agility	Real-time monitoring, Simulation, Optimization	Collaborative planning, Shared forecasting, Coordinated replenishment

Focus	Adapting to changing conditions, real-time analytics	Creating virtual replicas, proactive management	Enhancing supply chain integration, aligning demand and supply
Improves Resilience By	Promoting flexibility and agility, real-time response	Providing detailed, real-time supply chain views	Improving coordination, reducing risk of overproduction or shortages
Application in Agri-Food	Multiple sourcing options, buffer stocks, quick response to demand changes	Monitoring crop health, simulating disruption scenarios, optimizing distribution routes	Joint business plans, aligned production schedules, accurate crop yield predictions

Source: Author's Elaboration

3. METHODOLOGY

3.1. RESEARCH DESIGN

This study employs a mixed methods approach, combining qualitative and quantitative methodologies to gain a comprehensive understanding of the potential and feasibility of the newly synthesized "Integrated Resilient Supply Chain Strategy" (IRSC Strategy framework) for enhancing supply chain resilience in the agricultural product retail sector. The integration of these methods aims to enrich the depth of the study's findings, allowing for a thorough examination of the research theme and testing specific hypotheses related to supply chain resilience.

To guide the research, three specific hypotheses have been formulated, each focusing on a different aspect of the IRSC Strategy framework:

H1: The implementation of real-time monitoring through Digital Twin technology, as proposed in the IRSC Strategy framework, will significantly enhance the ability of agricultural product retailers to quickly respond to supply chain disruptions, thereby reducing the frequency and severity of stockouts and delays.

H2: Flexibility in sourcing and logistics, as emphasized in the IRSC Strategy framework, will lead to greater resilience in the agricultural supply chain by enabling retailers to better adapt to changing market conditions and disruptions, thereby maintaining consistent product availability and reducing waste.

H3: The collaborative planning and forecasting practices included in the IRSC Strategy framework will improve the alignment between supply chain partners (farmers, processors, distributors, and retailers), resulting in more accurate demand forecasting, optimized inventory levels, and enhanced overall supply chain efficiency.

The qualitative component of this study involves semi-structured interviews with retail managers in the agricultural product retail sector. These interviews will provide insights into the experiences, perspectives, and strategies of retail managers regarding the proposed IRSC Strategy framework and its potential to support supply chain resilience. Utilizing qualitative data allows for an in-depth exploration of the complexities and challenges of implementing the

IRSC Strategy framework, as well as the perceived effectiveness of the strategy's components, aligning with the hypotheses set forth.

Complementing the qualitative approach, a quantitative method is employed through a structured questionnaire distributed to consumers. The questionnaire is designed to gather quantitative data on consumer perceptions, behaviors, and preferences related to the IRSC Strategy framework and its ability to enhance supply chain resilience in response to disruptions in the agricultural product retail sector. This quantitative data will facilitate statistical analysis to identify patterns, correlations, and trends among consumer responses, providing empirical evidence to support or refute the formulated hypotheses. By triangulating data from interviews with retail managers and survey responses from consumers, this study aims to provide a comprehensive analysis of the feasibility, potential impact, and practical effectiveness of the IRSC Strategy framework in the agricultural product retail sector. This mixed-methods approach, guided by the principles of mixed methods research (Creswell & Plano Clark, 2018), ensures that the findings are robust, well-rounded, and applicable to real-world scenarios.

3.2. DATA COLLECTION

3.2.1. INTERVIEW DEVELOPMENT

During the interview phase, a purposeful sampling method was employed to select retail managers with diverse experiences in supply chain management within the targeted sector. The primary objective of these interviews was to explore strategies, challenges, and perceptions regarding the proposed IRSC Strategy framework for supply chain resilience, focusing on its specific components as outlined in the hypotheses.

Each interview was conducted using a semi-structured format guide, allowing for flexibility in discussing relevant topics while maintaining consistency across interviews (Annex A). Key themes explored included the potential impact of the IRSC Strategy framework on supply chain operations, strategies employed to mitigate risks, adaptations required during unstable times, and recommendations for implementing and improving the strategy. The interviews specifically aimed to gather managerial insights on the core elements of the IRSC Strategy framework — real-time monitoring, flexibility in sourcing and logistics, and collaborative planning—to validate the hypotheses. Interviews were transcribed and included as an annex in the dissertation (Annex B). Following the interviews, thematic analysis was conducted to identify recurring patterns, insights, and recommendations that align with or challenge the formulated hypotheses.

3.2.2. QUESTIONNAIRE DEVELOPMENT

The questionnaire, titled "Consumer Perceptions of Resilience in the Agricultural Supply Chain," employs a quantitative approach to gather insights into consumer perceptions of the "Integrated Resilient Supply Chain Strategy" (IRSC Strategy framework) and its potential impact on the agricultural product retail sector during periods of instability. It was distributed online via email and social media platforms, specifically targeting a diverse demographic within the Portuguese population. The survey was designed to include closed-ended questions for clarity and ease of response, utilizing branching logic to direct participants to different follow-up questions based on their initial answers. This approach allowed for a nuanced understanding of consumer experiences, preferences, and perceived effectiveness of the IRSC Strategy framework. Additionally, an open-ended section was included to invite further comments, providing deeper qualitative insights into the strategy's potential impact. This mixed-method approach, integrating structured quantitative data with qualitative feedback, aims to complement findings from interviews with retail managers, offering a comprehensive analysis of the IRSC Strategy framework 's effectiveness and applicability in enhancing supply chain resilience within the agricultural sector.

The questionnaire (Annex C) is organized into six sections, each designed to capture different aspects of consumer perceptions and experiences:

1. **Participant Demographics:** This section gathers essential socio-demographic information, including age, gender, education level, and the type of food distribution facilities frequented by respondents. Additionally, it captures the size of the respondent's household, allowing for a more nuanced segmentation of consumer perspectives. By understanding the demographic characteristics, this study aims to contextualize consumer attitudes towards supply chain resilience, as perceptions may vary across different age groups, education levels, and shopping habits.
2. **Perceived Importance of Shopping Attributes:** In this section, respondents are asked to rate the importance of various factors—such as price, quality, flexibility, sustainability, and availability—when purchasing food products. This aims to capture the baseline priorities of consumers, which serve as a foundation for analyzing their expectations regarding resilience strategies. Knowing which attributes consumers prioritize provides insight into the values that resilience strategies must align with to meet consumer demands effectively.

3. **Experiences with Supply Chain Disruptions:** This section delves into consumers' personal experiences with supply chain disruptions, specifically in the context of agricultural products. Respondents are asked whether they have observed any changes in product availability, quality, or pricing due to disruptions like the COVID-19 pandemic, economic instability, or other global events. This section assesses the awareness level of consumers regarding disruptions and helps establish a link between personal experience and the perceived need for resilient supply chains.
4. **Impact of Disruptions on Consumer Behavior:** Building on their experiences, this section seeks to understand the specific ways in which supply chain disruptions have influenced consumer behavior. Respondents indicate the challenges they have faced—such as higher prices, product shortages, or longer delivery times—and their behavioral responses, if any. This section aims to explore how disruptions affect consumer loyalty, purchasing patterns, and preferences, which is crucial for designing resilience strategies that align with consumer behavior during crises.
5. **Evaluation of Resilience Strategies:** Here, respondents evaluate the significance of various resilience strategies within supply chains, such as strategic alliances, supplier diversification, and the use of advanced technology for demand forecasting. By rating these strategies on a scale of importance, consumers provide feedback on which elements they perceive as most effective for ensuring resilience. This data is essential for determining the alignment between consumer expectations and the IRSC Strategy framework's proposed resilience measures, guiding the development of strategies that resonate with consumer needs.
6. **Consumer Perceptions of the IRSC Strategy Framework and Future Intentions:** In this final section, respondents are introduced to the IRSC Strategy framework, which focuses on flexibility, real-time monitoring, and collaborative planning. They are then asked about their likelihood of continued engagement with retailers implementing these resilience-focused strategies. Additionally, respondents can provide open-ended feedback, suggesting potential improvements to resilience strategies in the agricultural retail sector. This section assesses the overall reception of the IRSC Strategy framework and its perceived impact on retailer competitiveness, offering insights into consumer loyalty and support for resilience measures.

4. INTEGRATED RESILIENT SUPPLY CHAIN STRATEGY FRAMEWORK (IRSC Strategy framework)

4.1. STRATEGY CREATION

Current strategies for supply chain resilience, such as the Adaptive Supply Chain Resilience model, Digital Twin technology, and Collaborative Planning, Forecasting, and Replenishment (CPFR), each offer unique strengths but often fail to comprehensively address all critical components required for a robust and adaptable supply chain. These existing methods tend to focus on specific aspects—such as flexibility, technological integration, or collaborative forecasting—without providing a comprehensive approach that considers the full range of necessary resilience parameters. To bridge this gap, this research proposes a new, integrated approach: the Integrated Resilient Supply Chain (IRSC) Strategy framework. The IRSC Strategy framework is conceived as a comprehensive framework that combines the most effective elements of these established models to create a unified approach capable of enhancing resilience across the entire agri-food supply chain. The decision to develop this strategy stems from the recognition that supply chains face complex and interconnected challenges that require a multi-dimensional response. By synthesizing the strengths of each model, the IRSC Strategy framework seeks to provide a balanced solution that incorporates flexibility, real-time monitoring, redundancy, optimization, collaborative planning, forecasting, and replenishment.

The development of the IRSC Strategy framework involves carefully selecting and integrating parameters from the Adaptive Supply Chain Resilience model, Digital Twin technology, and CPFR. This process is guided by the principle of avoiding internal contradictions within the strategy. For instance, while automation and efficiency are critical in some models, they may contradict the need for agility and flexibility emphasized in others. Thus, the IRSC Strategy framework is deliberately crafted to ensure cohesion, taking advantage of the most appropriate features from each existing strategy without compromising the overall goal of comprehensive resilience. By proposing this combined strategy, we aim to fill the gaps identified in current approaches and offer a more adaptable and robust framework for managing supply chain disruptions in the agri-food sector. This strategy will then be presented to retail managers for evaluation and feedback, providing valuable insights into its practical applicability and potential impact on enhancing supply chain resilience.

4.2. STRATEGY CHARACTERIZATION

The Integrated Resilient Supply Chain (IRSC) Strategy framework is designed to provide a robust framework that enhances resilience across the agri-food supply chain by integrating critical parameters from established resilience models. These parameters include flexibility, real-time monitoring, redundancy, simulation and scenario planning, optimization, collaborative planning, forecasting, and replenishment. Each parameter is carefully selected to ensure a cohesive and comprehensive approach to supply chain resilience.

Flexibility:

Flexibility is a core component of the IRSC Strategy framework, drawn from the Adaptive Supply Chain Resilience model. It focuses on the ability to adapt processes and strategies in response to disruptions. In agri-food supply chains, this flexibility can be achieved by diversifying sourcing options and having adaptable logistics networks, which help mitigate risks associated with regional disruptions. By being able to pivot quickly, the supply chain can maintain continuity and minimize potential losses during unforeseen events.

Real-Time Monitoring:

Real-time monitoring is facilitated by Digital Twin technology, which is integrated into the IRSC Strategy framework to provide continuous data collection from various points in the supply chain. This is particularly crucial for tracking perishable goods in the agri-food sector, where timely responses to potential issues can prevent spoilage and maintain product quality. This continuous oversight helps in maintaining operational efficiency and ensuring product safety from farm to market.

Redundancy:

Redundancy is incorporated in the IRSC Strategy framework to ensure supply chain continuity during disruptions by maintaining excess capacity, alternative routes, and backup suppliers. This approach, derived from the Adaptive Supply Chain Resilience model, is essential for managing risks such as crop failures or transportation delays. Redundancy provides a safety net that helps maintain steady supply chain operations, even under challenging conditions.

Simulation and Scenario Planning:

The IRSC Strategy framework employs Digital Twin technology to enable advanced simulation and scenario planning, allowing for proactive risk management. By simulating various

disruption scenarios, such as extreme weather events or supply shortages, supply chain managers can develop effective contingency plans. This preparedness helps in minimizing the impact of disruptions, ensuring a quicker recovery and maintaining supply chain stability.

Optimization:

Optimization is achieved through Digital Twin technology within the IRSC Strategy framework, which utilizes advanced analytics to enhance supply chain processes. This parameter focuses on improving efficiencies in planting schedules, harvest times, and distribution routes. Optimizing these processes helps reduce costs, minimize waste, and ensure that products reach markets in optimal condition, thereby supporting the overall resilience of the supply chain.

Collaborative Planning:

Collaborative planning is a key element of the IRSC Strategy framework, derived from the principles of Collaborative Planning, Forecasting, and Replenishment (CPFR). It emphasizes cooperation among stakeholders, including farmers, processors, and retailers, to align their production schedules and market strategies. This joint planning effort enhances coordination, reduces inefficiencies, and helps in quickly adapting to changes in market demand or supply conditions.

Forecasting:

Forecasting in the IRSC Strategy framework is supported by CPFR to enable accurate predictions of supply and demand. Shared forecasting processes help in aligning production and procurement plans, reducing the risks associated with overproduction or shortages. This collaborative approach to forecasting ensures that all stakeholders are prepared for market fluctuations, enhancing the overall resilience of the supply chain.

Replenishment:

Replenishment is managed within the IRSC Strategy framework using the CPFR framework to maintain optimal inventory levels across the supply chain. By coordinating replenishment strategies, the strategy ensures that fresh produce is consistently available to meet consumer demand, minimizing waste and maximizing efficiency. This coordination is crucial for maintaining supply chain fluidity and adapting to changing market conditions.

By integrating these eight parameters, the IRSC Strategy framework offers a comprehensive approach to enhancing supply chain resilience in the agri-food sector. Each parameter contributes to a different aspect of resilience, ensuring that the supply chain is well-equipped to handle a wide range of disruptions and challenges.

4.3. STRATEGY VALIDATION

The final step in developing the IRSC Strategy framework is its validation through feedback from industry experts and consumers, particularly retail managers within the agri-food supply chain. The purpose of this validation is to assess the practical applicability of the IRSC Strategy framework in real-world scenarios and to refine it based on expert insights. Retail managers, who operate at the front lines of supply chain management, are well positioned to evaluate the strategy's strengths and potential weaknesses. By conducting interviews and gathering feedback from these professionals, we aim to validate the effectiveness of the IRSC Strategy framework in enhancing resilience within the agri-food supply chain. This process will provide critical insights into the strategy's feasibility, adaptability, and overall value in ensuring supply chain continuity and resilience in the face of disruptions.

5. EMPIRICAL FINDINGS

5.1. QUALITATIVE DATA: INTERVIEWS WITH RETAIL MANAGERS

5.1.1. INTRODUCTION OF INTERVIWEES

The interviewees for this research were selected based on their extensive experience and knowledge in supply chain management within the food and agricultural retail sector. Each interviewee holds a managerial or leadership role and has firsthand experience with strategies related to supply chain resilience in food and agricultural retail, making them well-suited to provide insights into the viability and potential impact of the Integrated Resilient Supply Chain (IRSC) strategy. The selection process for the interviewees involved contacting potential candidates via email and LinkedIn, and the interviews were conducted virtually through Microsoft Teams or Google Meet. Full transcripts of each interview are provided in Annex B at the end of this dissertation.

Interviewee A has over 20 years of experience in supply chain management, with a focus on procurement, logistics, and operations. Currently serving as a Supply Chain Manager, this professional also teaches Supply Chain, Innovation, and Operations Management at university level, combining both practical and academic expertise. Notably, Interviewee A has held several senior positions in supply chain and procurement management, overseeing international logistics and warehouse operations. Experience at SONAE MC, where responsibilities included managing reverse logistics and implementing supply chain processes, is particularly relevant to this research. Furthermore, Interviewee A has expertise in supply chain flexibility, real-time monitoring, and contingency planning provides valuable insights for evaluating resilient supply chain strategies in the food and agricultural retail sector.

Interviewee B has over 14 years of experience in retail management, with a focus on leadership and operations in various retail chains. Currently serving as a Store Manager in the agricultural retail sector, this professional has previously managed stores across different retail segments, overseeing day-to-day operations and team management. Experience in managing supply chains at the store level provides practical insights into the challenges of ensuring supply continuity and adaptability, which are relevant to the evaluation of resilience strategies in the agricultural retail supply chain.

Interviewee C has over 20 years of experience in supply chain management, retail operations, and strategic leadership. With a long tenure in the retail sector, this professional has held roles such as Senior Category Manager and Retail Senior Project Manager, with expertise in managing global procurement, driving category growth, and improving operational efficiency. His experience spans food categories, including frozen food, fish seafood, delicatessen and meat, as well as leadership in international sourcing. Interviewee C's expertise in leading cross-functional teams and implementing data-driven strategies aligns with key areas of focus in supply chain resilience, particularly in sourcing flexibility, collaborative planning, and optimization.

Interviewee D has more than 23 years of experience at Sonae MC, holding key leadership roles in supply chain management and transformation. Currently serving as Support Service Director, this individual leads critical functions such as e-commerce supply chain, consumables purchasing, and master data management across multiple business units within Sonae. Previous positions include Process Expert Director, where they were responsible for defining and implementing supply chain processes across various business areas, and Head of Supply Chain in Fresh Products, leading a team that managed fresh product procurement strategies. His extensive expertise in strategic supply chain transformation, data management, and team leadership directly supports key themes such as flexibility, collaborative planning, and real-time monitoring in the research context.

5.1.2. THEMATIC ANALYSIS OF INTERVIEWS

5.1.2.1. Strategies for Supply Chain Resilience

During the interviews, multiple strategies for building supply chain resilience emerged. One recurring theme was the prioritization of stock optimization as a critical factor in maintaining smooth operations during disruptions. Interviewee A emphasized that optimizing stock levels, especially with the aid of automation, was pivotal in freeing up human resources and minimizing errors in inventory management. The process of transitioning from manual stock orders to fully automated systems, as described by this interviewee, significantly improved efficiency and reduced stockouts. Interviewee B also highlighted the importance of stock management but provided a different perspective, noting that manual intervention was necessary when automation systems failed. According to this interviewee, the reliance on automated systems needed to be supplemented with robust manual processes to ensure that stockouts were avoided, especially during system downtimes. Beyond stock management, flexibility in logistics was another key strategy that retail managers identified as essential for

resilience. Interviewee D discussed the need for flexibility within their structured systems, mentioning how important it was to integrate safety stocks and adaptable risk management layers within their operations. This allowed them to adjust when faced with demand surges or unforeseen supply chain issues. Such flexibility, as the interviewees suggested, could make the difference between operational success and failure during a crisis. This aligns directly with the principles outlined in H2 (Hypothesis 2) of the IRSC Strategy detailed in the Methodology chapter, which suggests that flexibility in sourcing and logistics enhances resilience.

Risk management and contingency planning were also highlighted as fundamental strategies for resilience. Interviewee C pointed out that managing supplier relationships and diversifying supply sources was a crucial way to mitigate risks associated with supply disruptions. This interviewee explained that having multiple suppliers allowed him to maintain supply continuity even when one supplier faced issues, reinforcing the need for strategic supplier management. In contrast, Interviewee B touched on a slightly different approach, focusing on how local suppliers were sometimes leveraged to fill gaps when national suppliers could not meet demand. This practice of incorporating local suppliers as a form of contingency planning proved to be an effective risk mitigation strategy, especially in the context of unpredictable disruptions such as natural disasters or sudden market shifts. Additionally, Interviewee A emphasized the significance of collaborative planning between different stakeholders within the supply chain. This interviewee detailed how their company integrated commercial management, logistics, and operations to ensure a synchronized approach to supply chain management. Collaborative efforts helped reduce costs and enhance margins, which is strongly aligned with the hypotheses surrounding the importance of collaborative planning (Hypothesis 3).

5.1.2.2. Flexibility in Sourcing and Logistics

Throughout the interviews, flexibility in sourcing and logistics emerged as a fundamental element of supply chain resilience. Interviewee D shared an insightful experience regarding their time as a supply chain manager for fresh products. They recounted a period of market volatility when they faced severe disruptions from their primary supplier of perishable goods. To adapt, they relied on a diversified supplier network, including both local and international partners, which provided the necessary flexibility to switch sources without impacting product availability. This diversification was a crucial part of their contingency strategy, allowing them to maintain continuity during unexpected supply disruptions. On a similar note, Interviewee B discussed the role of flexibility in logistics when dealing with disruptions caused by transport

strikes. They described how their company quickly adapted by negotiating with local logistics providers to maintain delivery schedules. According to Interviewee B, this ability to swiftly pivot logistics operations by contracting smaller, regional carriers was essential for ensuring that stores remained stocked, particularly in remote regions. This experience highlights the importance of flexibility in logistics networks as a safeguard against unpredictable disruptions, reinforcing the principles of the IRSC Strategy related to logistics flexibility.

Interviewee C emphasized that while flexibility is critical, it also comes with significant challenges, particularly regarding cost implications. They noted that increasing flexibility, whether by maintaining alternative suppliers or having a diversified logistics network, often leads to higher operational costs. For example, during a supply shortage, Interviewee C was forced to switch to a more expensive supplier to avoid stockouts. This not only impacted short-term profitability but also required careful consideration of long-term supplier relationships. The cost of flexibility, according to Interviewee C, must be carefully weighed against its benefits in risk mitigation. On the other hand, Interviewee A provided a contrasting view by discussing how their company had invested heavily in real-time data and analytics to enhance flexibility in sourcing. By leveraging data to predict demand fluctuations, they were able to proactively adjust orders from suppliers, thereby reducing the impact of supply chain disruptions. This proactive approach to flexibility, enabled by technology, allowed Interviewee A's company to minimize the need for last-minute, costly adjustments while still maintaining a high level of resilience. In discussing supplier relationships, Interviewee D also mentioned the importance of having alternative suppliers readily available. During their tenure managing the supply chain for perishable goods, they established a practice of continuously reviewing and onboarding potential new suppliers. This allowed them to rapidly switch sources when primary suppliers faced issues, such as crop failures or shipping delays. According to Interviewee D, building a network of alternative suppliers is one of the most effective ways to enhance flexibility, ensuring that the company can respond swiftly to both minor and major disruptions.

However, Interviewee B pointed out the challenges of supplier flexibility in more specialized product categories. They explained that when dealing with very specific product types, it becomes difficult to find alternative suppliers who meet the company's quality standards. In one instance, when a primary supplier faced logistical issues, Interviewee B struggled to find a suitable alternative, illustrating how flexibility can be limited by product specificity and quality requirements. Overall, the interviews demonstrated a strong consensus on the importance of flexibility in sourcing and logistics for enhancing supply chain resilience.

While Interviewee D and Interviewee B focused on the practical aspects of logistics flexibility and local supplier relationships, Interviewee C raised important concerns about the cost of maintaining this flexibility. Interviewee A provided an additional layer of insight, emphasizing how technology and real-time data can optimize flexibility without significantly increasing costs.

5.1.2.3. Role of Real Time Monitoring and Technology

Interviewee A was particularly keen on the use of Digital Twin technology and real-time monitoring systems to track supply chain operations, especially for perishable products. They explained that, by having continuous, real-time insights into stock levels, product location, and even environmental conditions (such as temperature for refrigerated goods), their company was able to reduce both stockouts and overstock situations. This led to more efficient inventory management and a reduction in waste, aligning with the core components of the IRSC Strategy. Expanding on this point, Interviewee C shared how real-time monitoring has allowed proactive disruption management. By monitoring key performance indicators (KPIs) in real-time, they could quickly detect delays in shipments or issues at distribution centers. In one instance, when a crucial shipment was delayed due to port congestion, the company was able to immediately reroute goods using alternative logistics solutions, thus avoiding potential shortages in stores. For Interviewee C, the immediate visibility provided by real-time monitoring was vital for maintaining uninterrupted supply chain operations, particularly during high-demand periods.

Interviewee D also emphasized the importance of real-time data in ensuring operational continuity. In their experience managing a large-scale retail operation, real-time monitoring of supply routes helped mitigate the risks associated with long shipping lead times. It was pointed out that before implementing these technologies, they often faced challenges in coordinating product flow from international suppliers. However, with the adoption of real-time tracking and monitoring, they could optimize their logistics, reduce delays, and increase overall supply chain transparency. This improved visibility significantly enhanced the ability to react quickly to unforeseen disruptions. However, not all interviewees viewed real-time monitoring purely in a positive light. Interviewee B raised concerns about the costs associated with implementing these advanced monitoring technologies. While acknowledging the benefits of having real-time data, particularly in high-volume retail environments, it was pointed out that the upfront costs of integrating such systems (both in terms of financial investment and the resources required to maintain them) could be prohibitive for smaller retailers. Interviewee B noted that while their

company had started to implement some basic real-time monitoring tools, they were hesitant to fully commit to more advanced systems like Digital Twin due to these cost considerations.

Similarly, Interviewee C mentioned that although real-time monitoring systems provide valuable data, the integration and training required to utilize these tools effectively could be a barrier. They observed that in their experience, some employees struggled to interpret the data generated by these systems, which led to inefficiencies in decision-making. For them, the key challenge was not just acquiring the technology but also ensuring that the workforce was adequately trained to make the most out of it. In terms of real-time monitoring's impact on decision-making, Interviewee A highlighted how their company used real-time analytics to enhance demand forecasting and adjust procurement accordingly. By tracking consumer buying patterns in real-time, it’s possible to anticipate demand fluctuations and adjust stock levels dynamically. This not only improved product availability but also allowed the company to optimize its inventory, reducing excess stock and minimizing the risk of product spoilage. On a related note, Interviewee D pointed out that real-time monitoring had become an integral part of their company's contingency planning. In one particular instance, during a supply chain disruption caused by extreme weather conditions, real-time monitoring allowed them to assess which routes were still operational and redirect their shipments accordingly. This capability to adapt in real-time helped prevent a potential supply shortage, demonstrating the practical benefits of this technology in mitigating risks.

5.1.2.4. Collaborative Planning and Forecasting

Collaborative planning and forecasting were highlighted by all interviewees as critical to maintaining resilience, though experiences varied in terms of success and implementation challenges. Interviewee A noted that the ability to align with suppliers on production schedules was essential for mitigating disruptions. For example, during high-demand periods, Interviewee A's company would work closely with their main suppliers to ensure production schedules aligned with real-time demand forecasts. This approach helped avoid stock shortages and optimized inventory levels, particularly in the case of perishable goods, where accurate forecasting is essential to prevent waste. Supporting this view, Interviewee C shared that collaborative planning was integral to streamlining operations across different regions. Specifically, Interviewee C mentioned that working closely with international suppliers allowed for the alignment of demand forecasts, which was crucial for managing seasonal products. By developing collaborative forecasting models, Interviewee C's company could adjust inventory levels based on real-time sales data, thus avoiding both overstocking and understocking, which

would otherwise create inefficiencies in the supply chain. This collaboration also extended to logistics planning, helping the company avoid bottlenecks during peak seasons by planning transportation routes in advance.

However, Interviewee B raised concerns about the difficulty of implementing collaborative planning, particularly with smaller suppliers. Interviewee B mentioned that while their company had made efforts to improve collaboration, some suppliers lacked the necessary technology and resources to fully engage in the process. As a result, there were delays and inefficiencies in aligning forecasts and supply schedules, which led to occasional supply shortages. Interviewee B emphasized that the additional effort required to manage collaboration with less technologically advanced suppliers could sometimes limit the benefits of such initiatives, especially when compared to larger suppliers who had more sophisticated forecasting systems in place. Contrasting Interviewee B's concerns, Interviewee D provided an example where their company had successfully collaborated with both small and large suppliers by sharing real-time sales data. This open exchange of information allowed Interviewee D's team to adjust procurement strategies based on immediate feedback from suppliers, who could then ramp up or slow down production in line with actual market conditions. For Interviewee D, the key to successful collaboration was ensuring transparency across all supply chain partners, which helped avoid misalignments and contributed to smoother operations. This level of transparency, according to Interviewee D, was particularly important during supply chain disruptions, where being able to quickly realign schedules with suppliers helped mitigate delays and shortages.

Both Interviewee C and Interviewee A agreed on the importance of trust in collaborative planning, pointing out that relationships built over time made it easier to engage in open discussions about production needs and forecasts. Interviewee C provided an example where long-term partnerships with key suppliers allowed their company to react quickly to unexpected disruptions. In one instance, during a period of unanticipated demand, Interviewee C's company was able to collaborate effectively with suppliers to increase production and avoid stockouts, demonstrating the importance of established relationships in ensuring resilience. In contrast, Interviewee B argued that achieving this level of collaboration required significant investment in technology and resources, which was not always feasible for smaller players. This created a disparity between suppliers, where larger, more technologically advanced partners could engage fully in collaborative planning, while smaller suppliers struggled to keep up. Interviewee B noted that while collaborative planning had clear benefits, it was important to

acknowledge these practical limitations when implementing such strategies across diverse supply chain networks.

5.1.2.5. Contingency Planning and Risk Mitigation

Contingency planning and risk mitigation were frequently mentioned by interviewees as essential elements in managing supply chain disruptions. Interviewee C emphasized the importance of having alternative suppliers in place, particularly in the case of perishable goods. They provided an example from their experience managing disruptions caused by extreme weather conditions. By having multiple suppliers for key products, Interviewee C's company was able to shift orders quickly when one supplier faced difficulties, ensuring a continued flow of goods to their stores. This ability to switch between suppliers without disrupting the supply chain proved invaluable, particularly during peak demand periods.

Similarly, Interviewee A shared how their company had developed detailed contingency plans that incorporated alternative logistics routes and backup suppliers. In one instance, when a major logistics provider experienced delays due to port congestion, the company was able to reroute shipments using an alternative transport network, minimizing the impact on stock levels in stores. Interviewee A stressed that such contingency plans were regularly tested through simulations, which allowed the company to identify potential weak points in their supply chain and address them proactively before a real disruption occurred. These simulations also enabled the company to improve communication and coordination between different departments during crises. Expanding on this point, Interviewee D highlighted how risk mitigation strategies went beyond just having alternative suppliers. In their experience, risk management also included working closely with logistics partners to ensure flexibility in transportation. Interviewee D mentioned that during a particularly challenging period caused by supply chain disruptions in international markets, their company had to rapidly diversify its logistics providers to reduce reliance on any single partner. By doing so, it was possible to maintain a steady flow of goods despite the disruptions, demonstrating the importance of logistics diversification as a key component of risk mitigation. Interviewee B raised a point regarding the balance between cost and risk when developing contingency plans. While acknowledging the importance of risk mitigation highlighted the financial constraints that smaller retailers face when trying to implement comprehensive contingency strategies. For Interviewee B, the challenge was in finding the right balance between investing in backup suppliers and alternative logistics networks while maintaining profitability. Interviewee B explained that while larger companies may have the resources to maintain relationships with multiple suppliers and test

different logistics routes, smaller retailers often struggle to justify the costs associated with such measures. As a result, his company relied more heavily on long-standing supplier relationships and tried to build flexibility into those partnerships rather than diversifying extensively.

Both Interviewee C and Interviewee A agreed that regular testing and review of contingency plans were essential to ensure their effectiveness. Interviewee C mentioned that their company conducted frequent "stress tests" on their supply chain, simulating various disruption scenarios to evaluate how well their contingency plans would hold up under pressure. This proactive approach allowed them to refine their strategies and prepare for potential future disruptions more effectively. Conversely, Interviewee D focused more on the role of technology in contingency planning. They pointed out that real-time monitoring tools, which were discussed in a previous section, played a significant role in their risk mitigation efforts. By continuously tracking shipment locations and delivery times, Interviewee D's company was able to anticipate delays and activate contingency plans more quickly, thereby reducing the overall impact of disruptions. For Interviewee D, integrating technology into risk management processes was a critical factor in maintaining supply chain resilience.

5.1.3. SYNTHESIS OF QUALITATIVE FINDINGS

5.1.3.1. General Trends and Insights

In synthesizing the qualitative data from interviews, several key themes emerged that align with established literature on supply chain resilience, particularly in the context of the agri-food sector. One recurring trend was the importance of flexibility in both sourcing and logistics, a core component emphasized in the IRSC Strategy and widely supported by research. According to Pettit et al. (2019), flexibility allows supply chains to adapt swiftly to changing conditions, a point expressed by Interviewees A, B, and C, who consistently mentioned the need for adaptable processes in managing disruptions. This focus on flexibility as a resilience mechanism also parallels the insights from Christopher and Peck (2004), who highlighted flexibility as essential for handling supply chain volatility, particularly in perishable goods.

Another significant insight from the interviews was the emphasis on real-time monitoring technologies, such as Digital Twin technology, which has transformed the ability of supply chains to respond quickly to disruptions. This is consistent with the literature, where authors like Ivanov (2017) argue that real-time data enables supply chains to identify potential risks earlier, improving decision-making speed and accuracy. Interviewees A and D strongly advocated for the use of such technology, highlighting its ability to enhance both operational

efficiency and disruption management, an observation also supported by Tao et al. (2019) in their discussions of Digital Twin's role in optimization.

Collaborative planning emerged as another dominant theme, particularly in enhancing communication and coordination between supply chain partners, such as farmers, distributors, and retailers. This finding is consistent with the Collaborative Planning, Forecasting, and Replenishment (CPFR) framework introduced by the VICS Association (1990s), which highlights the role of joint planning and shared forecasting in improving supply chain integration. Interviewee C, in particular, emphasized the challenges and benefits of maintaining ongoing communication with supply chain partners, reinforcing the need for coordinated strategies, as detailed in both the literature and the IRSC Strategy. At the same time, the interviews revealed some concerns, notably around the high costs of implementing advanced monitoring systems. Interviewee B, for example, raised doubts about the financial feasibility of such technologies, particularly for smaller-scale operations. This concern is aligned with Adobor and McMullen's (2018) discussion on the trade-offs between investing in resilience-enhancing technologies and managing the associated costs.

Finally, the interviews also reflected the broader trend of incorporating contingency planning into everyday operations, which literature identifies as essential for resilience. For instance, Kleindorfer and Saad (2005) highlight the importance of having alternative suppliers and logistics plans in place, a point raised by all interviewees as a necessary measure for handling disruptions.

5.1.3.2. Cross-Comparison with the IRSC Strategy

In comparing the strategies discussed by the interviewees with the elements of the Integrated Resilient Supply Chain (IRSC) Strategy, there is considerable overlap, particularly in the areas of flexibility, real-time monitoring, and collaborative planning, which form the backbone of the IRSC Strategy.

Firstly, flexibility in sourcing and logistics, a critical aspect of the IRSC Strategy, was frequently mentioned by the interviewees as an essential element for enhancing supply chain resilience. Interviewees A and C specifically emphasized the need for flexible logistics networks and diversified suppliers to mitigate risks. This reflects the IRSC Strategy's approach, where flexibility is viewed as a core resilience enabler, as discussed in Pettit et al. (2019), and is supported by real-world strategies employed by managers. The literature, particularly works by Christopher and Peck (2004), also strongly advocates for such flexibility, suggesting that

agile and adaptable supply chains are better positioned to cope with disruptions. However, a gap identified in the interviews, particularly by Interviewee B, was the cost challenge associated with implementing such flexibility, which may be prohibitive for smaller retailers. This presents a practical limitation to the broad application of the IRSC Strategy's flexibility component, as also discussed by Adobor and McMullen (2018).

Secondly, real-time monitoring was another area where the interviewees' experiences aligned closely with the IRSC Strategy. Interviewees A and D described real-time data monitoring as transformative in enhancing operational visibility and disruption response capabilities, mirroring the IRSC Strategy's emphasis on Digital Twin technology. The literature, including works by Ivanov (2017) and Tao et al. (2019), points out how real-time data can streamline decision-making and prevent stockouts or overstocking, thus minimizing wastage and maintaining product flow. The adoption of real-time monitoring technologies, particularly in the food retail sector where perishable goods are involved, was highlighted as crucial for maintaining product quality and availability, consistent with the strategy's intent. However, as noted by Interviewee B, the high initial cost and resource requirements of these technologies may limit their implementation, especially for companies with limited budgets, an issue also discussed by Kleindorfer and Saad (2005) in the context of balancing costs and resilience.

Finally, collaborative planning was a major component of both the IRSC Strategy and the interview responses. Interviewees A and C specifically highlighted the need for better coordination between different supply chain partners—echoing the CPFR model referenced in the IRSC Strategy. Collaborative planning, as outlined in the literature by Sodhi and Tang (2012), helps synchronize supply chain activities and reduces inefficiencies caused by misaligned production schedules or inaccurate forecasting. However, despite the clear advantages, interviewees pointed out the difficulty in implementing truly collaborative approaches across all stages of the supply chain, particularly when working with a diverse set of partners. Interviewee C, for example, noted the challenges of maintaining real-time communication with suppliers located in different regions, adding a layer of complexity to the strategy's execution. This gap highlights a potential area for further refinement within the IRSC Strategy, where a more nuanced approach to managing communication channels between diverse stakeholders could be beneficial.

In summary, while the core components of the IRSC Strategy—flexibility, real-time monitoring, and collaborative planning—were strongly supported by the insights from the

interviews, there are practical challenges, particularly around cost and implementation, that suggest areas for further refinement. These findings indicate that while the strategy is robust, its practical application may require adjustments to suit specific contexts, particularly for smaller retailers or more complex supply chains.

5.1.3.3. Insights on Hypotheses

This section provides an evaluation of the qualitative findings from the interviews in relation to the three main hypotheses of the study. As a reminder, the hypotheses being tested in this research are as follows:

- H1: The implementation of real-time monitoring through Digital Twin technology, as proposed in the IRSC Strategy, will significantly enhance the ability of agricultural product retailers to quickly respond to supply chain disruptions, thereby reducing the frequency and severity of stockouts and delays.
- H2: Flexibility in sourcing and logistics, as emphasized in the IRSC Strategy, will lead to greater resilience in the agricultural supply chain by enabling retailers to better adapt to changing market conditions and disruptions, thereby maintaining consistent product availability and reducing waste.
- H3: The collaborative planning and forecasting practices included in the IRSC Strategy will improve the alignment between supply chain partners (farmers, processors, distributors, and retailers), resulting in more accurate demand forecasting, optimized inventory levels, and enhanced overall supply chain efficiency.

H1: Real-Time Monitoring and Digital Twin Technology

The interviews provided substantial support for H1, indicating that the implementation of real-time monitoring, particularly through advanced technologies like Digital Twin, has a significant positive impact on supply chain resilience. Interviewees A and D, in particular, demonstrated how the use of real-time data for tracking stock levels, shipment statuses, and environmental factors like temperature had improved their ability to react quickly to disruptions.

Additionally, the evidence from Interviewee C, who successfully rerouted shipments during a port delay, reinforces the hypothesis that real-time monitoring systems help in reducing the frequency and severity of disruptions. This supports the core argument of H1, suggesting that real-time technology directly contributes to supply chain resilience by providing actionable, data-driven insights that allow for swift corrective measures. However, the concerns raised by

Interviewee B about the costs associated with implementing such systems provide an important objection to this hypothesis. While the benefits of real-time monitoring are clear, the financial and resource challenges, particularly for smaller companies, must be taken into account. This echoes the findings of Kleindorfer and Saad (2005), who note that balancing the costs of advanced technologies with their benefits is a key challenge for many retailers. Thus, while H1 is largely validated by the interview data, the practical limitations regarding cost need to be considered when applying this hypothesis in different retail environments.

H2: Flexibility in Sourcing and Logistics

The interview findings strongly support H2, confirming that flexibility in sourcing and logistics is crucial for enhancing supply chain resilience. Interviewees A and C both emphasized the importance of having alternative suppliers and flexible logistics solutions to mitigate risks, particularly in times of disruption. This is consistent with the literature, where flexibility is identified as a fundamental factor in resilient supply chains, particularly in the face of unpredictable disruptions (e.g., Christopher and Peck, 2004).

For instance, Interviewee A described how flexibility in logistics allowed the company to adapt to transportation issues, while Interviewee C highlighted the importance of flexible sourcing strategies in ensuring consistent product availability despite market fluctuations. These real-world examples validate the IRSC Strategy's emphasis on flexibility as a key driver of resilience, supporting the most important premise of H2. However, as with H1, there are challenges related to the cost and complexity of implementing such flexibility, especially for smaller organizations. Interviewee B noted that while flexibility is desirable, maintaining multiple suppliers and logistics routes can introduce higher costs and complexity. This trade-off between flexibility and cost aligns with concerns raised in the literature, particularly by Adobor and McMullen (2018), who suggest that while flexibility is critical, its implementation requires careful management to avoid unnecessary cost increases.

H3: Collaborative Planning and Forecasting

The support for H3, which postulates that collaborative planning and forecasting improve supply chain alignment and efficiency, is also evident in the interviews. Interviewees A and C both highlighted the importance of coordination between supply chain partners, especially in aligning production schedules with market demand. This supports the CPFR model emphasized in the IRSC Strategy and is backed by the literature, with authors like Sodhi and Tang (2012) acknowledging the role of collaboration in reducing inefficiencies and enhancing resilience.

However, several interviewees pointed out that while collaboration is beneficial, it is often challenging to implement effectively, particularly when dealing with partners in different regions or those with varying capabilities. Interviewee C noted that maintaining consistent communication across the supply chain was a significant hurdle, especially when working with international partners. This aligns with the literature's discussions on the complexities of maintaining collaborative relationships across geographically dispersed supply chains (Simchi-Levi et al., 2015). Therefore, while H3 is largely validated, the practical challenges of achieving seamless collaboration must be acknowledged.

In conclusion, the qualitative data from the interviews provide strong support for all three hypotheses, validating the core tenets of the IRSC Strategy. However, the practical limitations related to cost, implementation complexity, and workforce training present areas that require further consideration when applying the strategy in different retail contexts. These findings contribute significantly to the overall research objectives, reinforcing the importance of flexibility, real-time monitoring, and collaboration in building resilient supply chains.

5.2. QUANTATIVE DATA: QUESTIONNAIRE RESULTS FROM CONSUMERS

5.2.1. OVERVIEW OF RESPONDENT DEMOGRAPHICS

The demographic breakdown of the respondents is essential to contextualize the findings of this research, as consumer perceptions and preferences may vary significantly depending on factors like age, gender, education level, and shopping habits (Annex C). The total number of respondents was 241.

Table 5.1 - Demographic Description of Respondants

	N	% Total
Total	241	100%
Gender		
Female	135	56%
Male	105	44%
Other	1	0,4%
Age Group		
18–24	94	39%
25–34	41	17%
35–44	50	21%
45–54	26	11%
55–65	21	9%
65+	9	4%
Education Level		
Primary Education	14	6%
Secondary Education	62	26%
Bachelor's Degree	100	41%
Master's Degree	55	23%
Doctorate	10	4%
Type of Prefered Retailer		
Supermarkets	205	67%
Local Groceries	38	12%
Farmer's Markets	19	6%
Online Food Retailers	41	13%
Other	2	1%
Household Size		
Only for me	94	39%
For me and one more person	58	24%
For me and two to three people	69	29%
For me and four or more people	20	8%

- Gender: The gender distribution was relatively balanced, with 56% of the respondents identifying as female and 44% as male. Only a small portion, less than 1%, selected the "Other" option (Table 5.1). This equilibrium in gender representation allows for a more comprehensive view of consumer perspectives across genders.
- Age: The majority of respondents fell into the younger demographic groups. 39% were aged between 18 and 24 years, followed by 17% aged 25 to 34, and 21% aged 35 to 44. The older age groups were less represented, with 11% aged 45 to 54, 9% between 55 and 65, and only 4% over 65 years. This younger skew in the sample might influence

certain preferences, such as the perceived importance of sustainability and the use of technology (Table 5.1).

- Education: In terms of educational background, a significant portion of respondents were highly educated. 41% had completed a bachelor's degree, 23% held a master's degree, and 4% had a doctorate. In contrast, 26% had only completed secondary education, while 6% had only primary education. The higher level of education among participants suggests that they may have more nuanced opinions on supply chain practices and resilience strategies (Table 5.1).

- Preferred Retailer Type: Most respondents preferred to shop at supermarkets (85%), followed by online food retailers (17%), local groceries (16%), and farmer's markets (8%). A small percentage of respondents (1%) selected "Other" (Table 5.1). These preferences can reflect the convenience and availability of products at larger retail chains, as well as an increasing tendency towards online shopping.

- Household Size: In terms of household size, the largest group was respondents who purchased food products solely for themselves (39%). Meanwhile, 29% bought for two to three people, 24% bought for one other person, and 8% bought for four or more people. These figures indicate a variety of household dynamics that may influence purchasing decisions, such as larger households potentially being more concerned with price and product availability (Table 5.1).

5.2.2. ANALYSIS OF CONSUMER RESPONSES

This section presents a detailed analysis of consumer responses to the questionnaire, focusing on their perceptions of supply chain resilience and their views on the Integrated Resilient Supply Chain (IRSC) Strategy. By breaking down the data gathered from the 241 participants, we can identify trends, preferences, and areas of concern for consumers regarding flexibility, real-time monitoring, and collaborative planning in the food supply chain.

When analyzing the importance of key aspects of their shopping experience, participants were asked to evaluate factors like price, quality, flexibility, sustainability, and availability (Question 7). Price emerged as the most critical factor, receiving an average score of 4.8, with 215 participants rating it as 4 or 5 on a scale from 1 (not important) to 5 (very important). Similarly, quality was also highly valued, with an average score of 4.6 and 188 participants giving it a high importance rating. In contrast, flexibility scored lower with an average of 3.9, suggesting that while consumers do care about product variety, it is not as crucial as price or

quality. Sustainability received a relatively high average score of 4.2, indicating increasing awareness and concern for environmental practices, while availability scored 3.8 on average, showing that consumers have moderate concerns about finding products on shelves (Figure 5.1).

The impact of recent global disruptions, such as the COVID-19 pandemic and other geopolitical or economic challenges, was assessed in Question 8. A significant majority (76%) of respondents (183 participants)—reported experiencing disruptions in the availability or purchase of agricultural products. This high percentage highlights widespread awareness among consumers of the potential impacts of global events on supply chains (Figure 5.2).

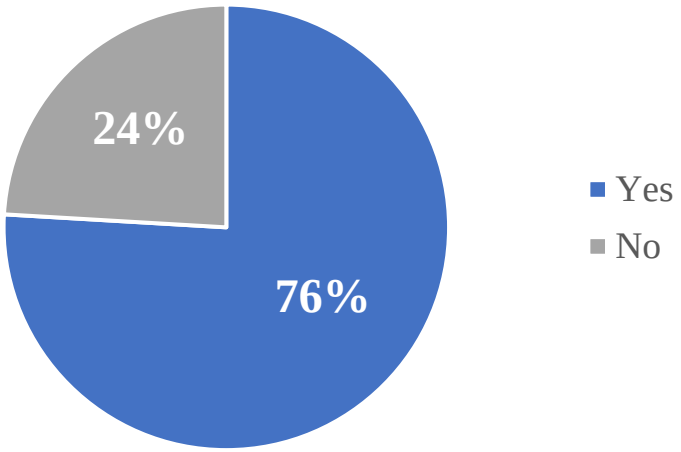

Figure 5.2 - Experience with Disruptions while Purchasing

For those who experienced disruptions (Question 9), 92% (168 respondents) reported facing higher prices as the main consequence. This was by far the most common effect, reflecting the immediate sensitivity of consumers to price fluctuations during supply chain disruptions. Product shortages were the second most common issue, with 11% of respondents (approximately 20 people) reporting difficulties in finding specific items, while 14% (about 26 respondents) observed a decrease in product quality. Only 4% of participants (around 7 people) mentioned delays in product delivery, suggesting that logistical delays were not as prevalent as other issues (Figure 5.3).

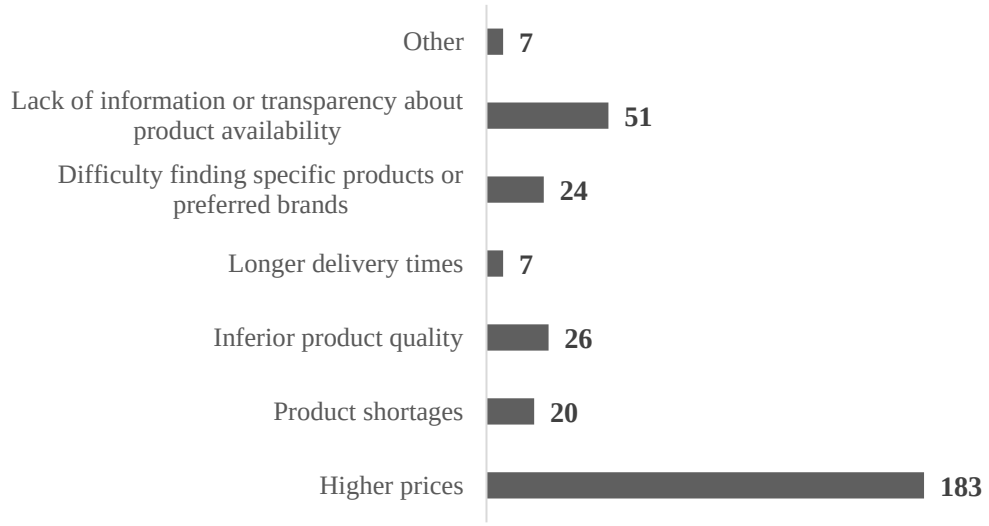

Figure 5.3 - Effects of Supply Chain Disruptions

In terms of resilience strategies (Question 11), consumers were asked to rate various strategies for improving supply chain resilience. The creation of strategic alliances with other supply chain partners was seen as the most important strategy, with an average score of 4.8, and 208 respondents rating it highly. Diversifying suppliers to reduce dependency on a single source was similarly regarded as critical, receiving a score of 4.7. The use of advanced technology for precise demand and stock forecasting also received strong support, with a 4.5 average score. On the other hand, strategies like partial automation of administrative tasks were seen as less significant, scoring only 2.8, indicating that consumers prioritize high-impact, external-facing strategies over internal operational adjustments (Figure 5.4).

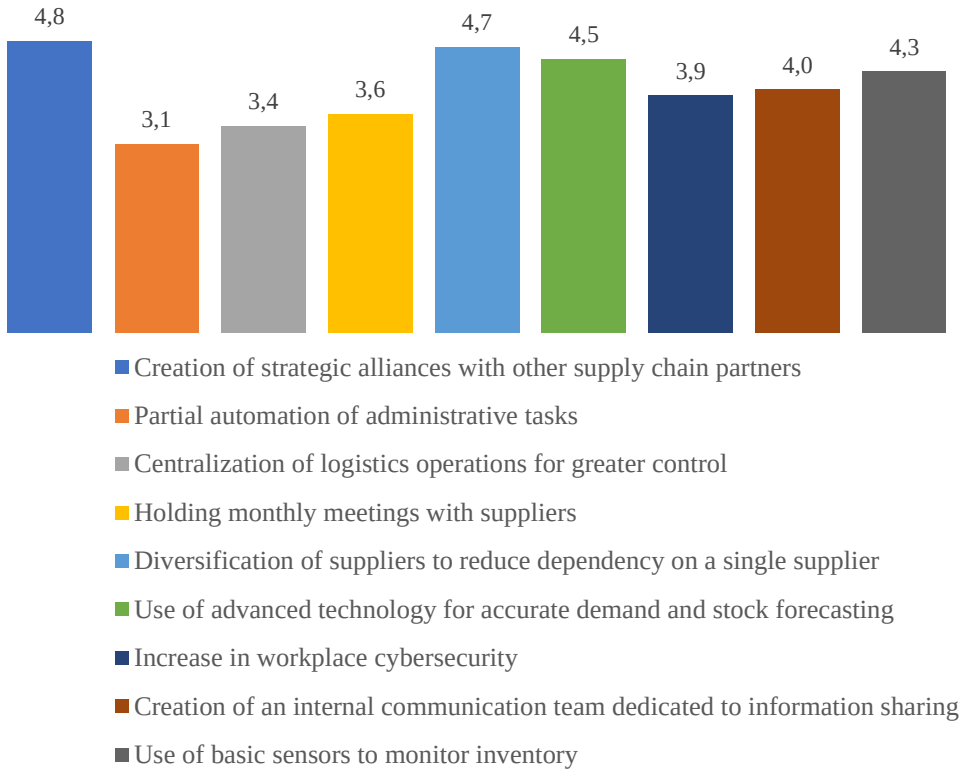

Figure 5.4 - Importance of Resilience Strategies

When asked if retailers that invest in resilience strategies would become more competitive (Question 12), 81% of participants (about 195 respondents) agreed or strongly agreed, suggesting broad consumer support for the IRSC Strategy's objectives and a belief that resilience strategies offer long-term benefits for both consumers and the industry (Figure 5.5). Additionally, those who were supportive of this idea were further asked about their views on the long-term benefits of such competitiveness (Question 13). Among them, 42% strongly agreed, and 17% agreed that this competitiveness would bring benefits not only to consumers but also to the industry as a whole. This shows that a significant portion of consumers believe that investing in supply chain resilience can have a positive ripple effect across the sector (Figure 5.6).

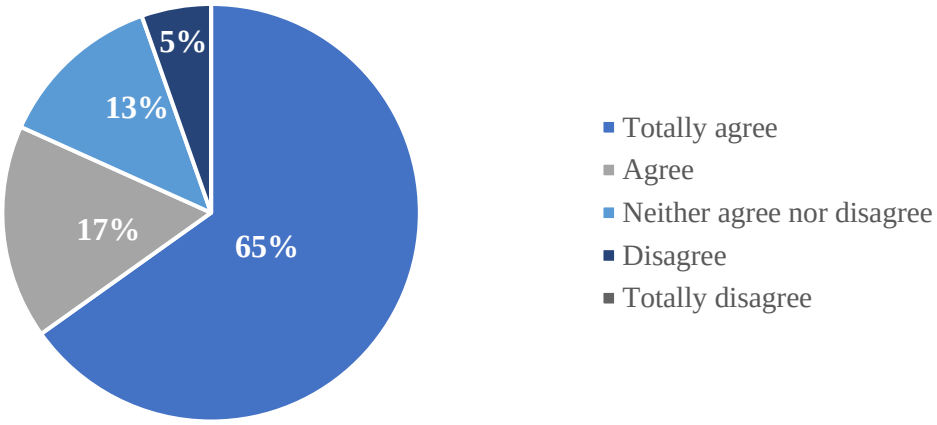

Figure 5.5 - Opinions on Supply Chain Optimization and Competitiveness

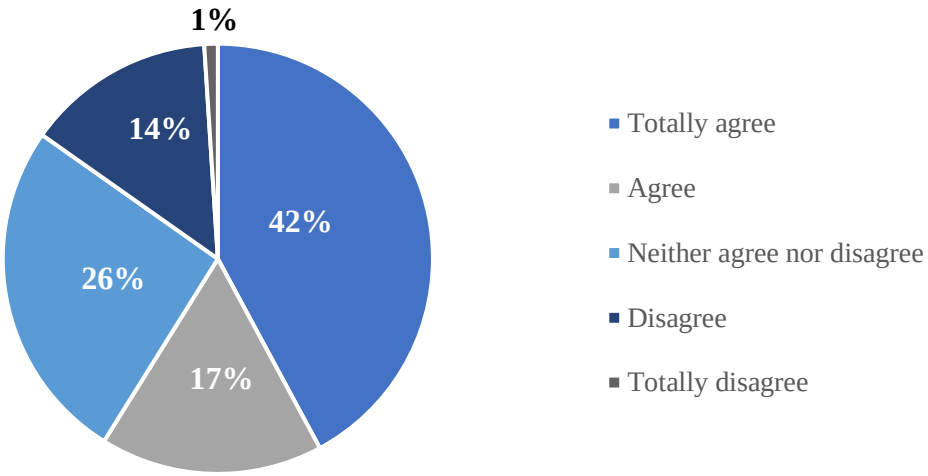

Figure 5.6 - Opinions on the Effect Competitiveness has in the Future of the Industry

Additionally, 58% of respondents (about 140 people) indicated that they would be more likely to continue purchasing from retailers who implement strategies focusing on flexibility, real-time monitoring, and collaborative planning (Question 14). This response highlights consumers' awareness and preference for resilience strategies that improve product availability and mitigate disruptions (Figure 5.7).

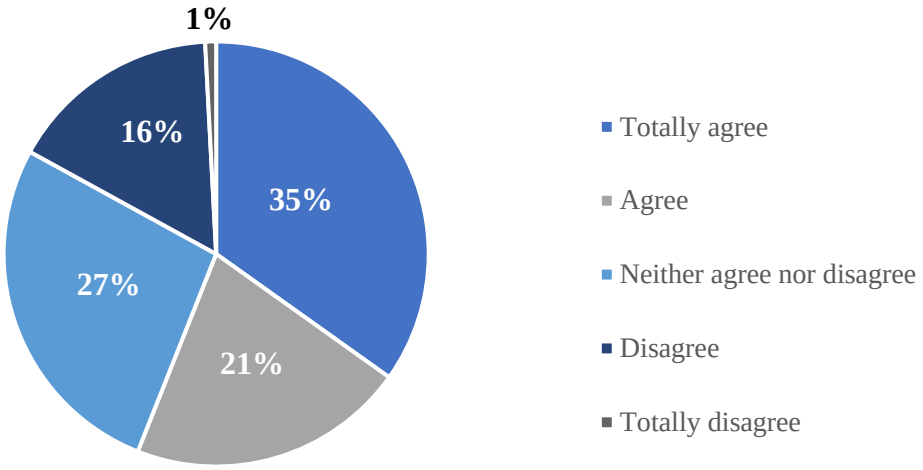

Figure 5.7 - Likelihood of Purchasing from Retailers Using the IRSC Strategy

These findings demonstrate that while consumers are most concerned about immediate factors like price and quality, they are also receptive to strategies that enhance supply chain resilience. The strong support for strategies that advocate for partnership building and supplier diversification aligns with the principles of the IRSC Strategy.

5.2.3. STATISTICAL VALIDATION OF KEY THEMES

This section examines consumer responses in detail, focusing on three core themes that align with the hypotheses of this study: real-time monitoring, flexibility in sourcing, and collaborative planning. By analyzing these themes through statistical validation, the study aims to assess how consumer perceptions and preferences support the principles of the Integrated Resilient Supply Chain (IRSC) Strategy.

5.2.3.1. Real-Time Monitoring

Real-time monitoring, a central component of the IRSC Strategy, is hypothesized to improve retailers' ability to manage disruptions (H1). To validate this hypothesis, the questionnaire explored consumer views on the importance of real-time monitoring in ensuring product availability and reducing disruptions.

In Question 11, respondents rated the importance of various measures for improving supply chain resilience, including the "use of advanced technology for accurate demand and stock forecasting." This measure, closely aligned with real-time monitoring, received a high average rating of 4.5, indicating strong consumer support for its role in enhancing supply chain performance. A total of 189 respondents rated it as either "important" or "very important", emphasizing the value consumers place on technological tools that offer visibility and responsiveness in the supply chain (Figure 5.4). This preference for technological solutions was further reflected in Question 12, where 81% of respondents indicated that they believed retailers

who invest in optimizing their supply chains through such strategies could achieve greater competitiveness. This suggests that consumers recognize the long-term benefits of real-time monitoring, not only for maintaining product availability but also for improving overall service quality during times of disruption.

Additionally, the responses from Question 8, where 76% of consumers reported experiencing disruptions during recent global events, suggest a context in which real-time monitoring could have mitigated negative impacts, such as stock shortages or delays. The emphasis on technology's role in anticipating and adjusting to supply chain challenges aligns with the IRSC Strategy's focus on leveraging real-time data to support more agile decision-making and minimize disruption impacts.

5.2.3.2. Flexibility in Sourcing

Flexibility in sourcing and logistics is another key element of the IRSC Strategy, supporting H2, which suggests that increased flexibility can enhance resilience by allowing retailers to adapt to changing market conditions. Consumers' views on this aspect were explored through their responses regarding the diversification of suppliers and the importance of maintaining consistent availability.

In Question 11, the factor "diversification of suppliers to reduce reliance on a single supplier" received a high average rating of 4.7. A significant majority (over 200 respondents) rated this aspect as "important" or "very important," highlighting consumers' awareness of the risks associated with supply chain dependencies and their preference for strategies that mitigate these risks (Figure 5.4). This finding strongly supports the emphasis on flexibility in sourcing as a means of ensuring product availability during disruptions. Further, the analysis of Question 9, where 13% of respondents indicated difficulties in finding specific products or preferred brands during supply chain disruptions, pointing out the importance of flexibility from a consumer perspective. This suggests that consumers value the ability of retailers to source from multiple suppliers to maintain product consistency on shelves, especially during times of instability. The consumer responses imply that having access to a broader range of suppliers allows retailers to adapt quickly to shifts in availability, reinforcing the importance of sourcing flexibility as posited by H2.

Additionally, the consumer endorsement of strategies like supplier diversification reflects an understanding that flexibility in sourcing can directly benefit them by ensuring a stable

supply of goods. This aligns with the IRSC Strategy's approach to enhancing resilience through adaptable sourcing practices, reinforcing the relevance of H2 to the real-world context.

5.2.3.3. Collaborative Planning

Collaborative planning between supply chain partners is central to H3, which hypothesizes that such cooperation improves demand forecasting and inventory optimization, ultimately contributing to greater resilience. To understand consumer perspectives on this theme, the questionnaire addressed the importance of strategic partnerships and communication within the supply chain.

In Question 11, "creation of strategic alliances with other supply chain partners" emerged as the highest-rated factor, with an average score of 4.8. This result reflects that 208 respondents regarded such alliances as critical to building a resilient supply chain capable of withstanding disruptions (Figure 5.4). The strong consumer emphasis on collaboration highlights a recognition that coordination between retailers, suppliers, and other stakeholders is essential for maintaining a steady flow of products during uncertain times. Furthermore, the responses from Question 12 show that 81% of participants believed that retailers focusing on collaborative strategies would gain a competitive edge. This supports the notion that consumers see value in efforts to align operations and share information across the supply chain, ensuring that demand can be met even when external challenges arise. However, in Question 13, which examined the long-term benefits of such strategic investments, 42% of the respondents who supported these initiatives strongly believed that collaborative efforts could provide broader advantages to the industry, while 17% simply agreed. This suggests that although most consumers see immediate benefits in collaborative planning, a substantial proportion also recognizes its potential for fostering long-term stability and growth within the sector.

These insights align with the principles of the IRSC Strategy, which emphasizes collaborative forecasting and planning as critical to improving overall supply chain efficiency. The consumer support for strategic alliances underlines the practical applicability of H3, suggesting that collaboration is not only feasible but also desirable from a consumer perspective, as it promises to ensure product availability and reliability during times of disruption.

5.2.3.4. Additional Statistical Findings

While the focus of this analysis has been on the core themes of real-time monitoring, flexibility in sourcing, and collaborative planning, several additional findings from the survey provide further insights into consumer attitudes towards supply chain resilience.

For instance, in Question 7, despite the emphasis on price and quality as top factors influencing purchasing decisions, the relatively high score given to sustainability (4.2) indicates that consumers are also increasingly aware of and concerned about the environmental impact of their purchasing choices (Figure 5.2). This suggests a potential area where supply chain strategies could be adapted to incorporate more sustainable practices, aligning with consumer preferences. Additionally, Question 9 revealed that while price increases were the most observed consequence of disruptions, a notable 28% of respondents indicated a lack of transparency regarding product availability as a significant issue during disruptions (Figure 5.4). This highlights the need for improved communication from retailers to consumers, possibly through enhanced digital channels or transparency initiatives. Such measures could complement the IRSC Strategy's emphasis on communication and real-time data sharing, offering a more comprehensive approach to managing consumer expectations during disruptions.

These insights, while not directly related to the core hypotheses, enrich the understanding of consumer expectations and concerns regarding supply chain resilience. They suggest that while consumers prioritize strategies that ensure availability and affordability, there is also an appreciation for efforts that improve transparency and sustainability in the supply chain.

5.3. CROSS-COMPARISON OF QUALITATIVE AND QUANTATIVE DATA

This section integrates findings from the qualitative interviews with retail managers and the quantitative questionnaire responses from consumers, providing a comprehensive view of perceptions around supply chain resilience and the IRSC Strategy. By analyzing common themes and areas of divergence between managerial insights and consumer perspectives, we can gain a deeper understanding of how the strategies discussed align with the expectations and experiences of both managers and end consumers.

Integration of Real-Time Monitoring Insights

Real-time monitoring and technology emerged as crucial themes in both the interviews with retail managers and the consumer survey. From the interviews, managers such as Interviewee A and Interviewee D highlighted the value of technologies like Digital Twin and real-time data analytics in providing operational visibility and reducing the impact of disruptions. These tools enabled faster decision-making, optimized logistics, and improved coordination between supply chain nodes. However, both Interviewees B and C raised concerns about the costs and training challenges associated with implementing such technologies, particularly for smaller retailers.

The consumer survey data aligns with the managers' emphasis on real-time monitoring but adds another layer of perspective. According to Question 11, 189 respondents rated the use of advanced technology for precise demand and stock forecasting as important or very important (Figure 5.4). Additionally, 81% of respondents (around 195 participants) agreed that retailers investing in such strategies could gain a competitive advantage (Figure 5.5). This broad consumer support suggests a high level of awareness of the benefits of real-time monitoring, mirroring the emphasis managers placed on these tools in their strategies. However, the quantitative data also reflects some divergence between consumer expectations and managerial realities. While consumers strongly supported the use of advanced technology, the concerns raised by Interviewee B regarding the costs of implementation indicate a gap between consumer support for such initiatives and the financial feasibility of deploying them, especially for smaller companies. This contrast highlights the need for strategies that balance technological investment with cost efficiency, an aspect that was less visible to consumers but central to the considerations of retail managers.

Analysis of Flexibility in Sourcing

Flexibility in sourcing, a critical component of the IRSC Strategy, was highlighted by both managers and consumers as essential for maintaining resilience during supply chain disruptions. Interviewees D and C particularly emphasized the importance of having diversified supplier networks, allowing them to quickly switch between sources in response to unexpected supply disruptions. This ability to pivot was identified as crucial for maintaining stock levels during disruptions like weather events or transport delays.

Consumers echoed this sentiment in their responses to Question 11, where the diversification of suppliers was rated with a high average score of 4.7 (Figure 5.4). Over 200

respondents recognized the value of reducing dependency on a single supplier, indicating a shared understanding with managers about the importance of maintaining flexible sourcing strategies. This commonality supports H2, which posits that flexibility in sourcing enhances supply chain resilience by allowing retailers to adapt to changing conditions. However, some differences in perspective emerged. Interviewee C mentioned the cost implications of maintaining such flexibility, as shifting to alternative suppliers often involves higher costs, a nuance that was not as apparent in the consumer responses. While consumers appreciate the end result of flexibility which is consistent product availability, they may not fully understand the financial and logistical trade-offs that managers must navigate to achieve this. This gap between consumer expectations and managerial realities highlights a potential area where more transparent communication from retailers could bridge understanding, particularly around why certain products might experience price fluctuations during supply chain disruptions.

Perspectives on Collaborative Planning

Collaborative planning between supply chain partners, another pillar of the IRSC Strategy, was strongly endorsed by both managers and consumers. From the interviews, managers like Interviewees A and D emphasized the critical role of collaboration with suppliers in aligning forecasts and ensuring that production schedules match market demand. These managers highlighted examples of successful coordination, such as real-time data sharing with suppliers to adjust procurement strategies during periods of high demand. This theme of collaboration agreed with consumers as well. In Question 11, "creating strategic alliances with other supply chain partners" received the highest average rating of 4.8, with 208 respondents considering it important or very important (Figure 5.4). Furthermore, 58% of respondents indicated that they would prefer to continue purchasing from retailers that engage in collaborative planning, reinforcing the perceived value of such strategies in maintaining product availability during disruptions (Figure 5.7).

In contrast, the interviews revealed practical challenges in implementing collaborative planning that consumers might not be fully aware of. For example, Interviewee B highlighted difficulties in achieving effective collaboration with smaller suppliers who may lack the necessary technological infrastructure. This challenge was not directly addressed by the survey respondents, suggesting a disconnect between the perceived benefits of collaboration and the operational challenges that managers encounter when attempting to execute these strategies.

Addressing this gap may involve more proactive communication from retailers about the complexities of managing diverse supplier relationships, particularly in times of crisis.

Consumer Awareness Versus Managerial Challenges

The comparison between the qualitative and quantitative data also reveals an interesting dynamic between consumer awareness of supply chain disruptions and the strategic priorities identified by managers. The survey results showed that 76% of respondents experienced disruptions during recent global events and were highly attuned to changes in product pricing and availability (Figure 5.2). This suggests a heightened consumer awareness of the impact of external events on supply chains, which aligns with the managers' experiences of navigating such disruptions.

However, while consumers were quick to recognize the consequences of disruption such as increased prices or reduced availability, the interviews provided a deeper understanding of the strategic considerations behind the scenes. For instance, Interviewee C emphasized the role of contingency planning and maintaining alternative logistics routes, which are crucial in preventing stockouts during disruptions. These behind-the-scenes strategies are often not visible to consumers, despite directly impacting their shopping experience. This contrast highlights the value of integrating consumer feedback into strategic planning while also ensuring that consumers are informed about the complexities involved in supply chain management. Bridging this understanding could strengthen consumer trust, particularly during periods of disruption when transparency is crucial.

Holistic Insights into the IRSC Strategy

Overall, the cross-comparison between the interview insights and survey results provides a more nuanced understanding of the IRSC Strategy's applicability. While both managers and consumers recognize the importance of flexibility, real-time monitoring, and collaborative planning, their perspectives differ on the challenges associated with implementing these strategies. Managers, drawing on their practical experiences, highlighted cost constraints, the need for training, and the complexities of managing diverse supplier networks as critical considerations. In contrast, consumers expressed strong support for resilience strategies, focusing on the outcomes like product availability and price stability.

These differences underscore the importance of aligning strategic priorities with consumer expectations while remaining realistic about the limitations of implementation. A more

integrated approach that incorporates both perspectives could help refine the IRSC Strategy, making it more adaptable to the needs of retailers while still meeting the demands of consumers. This cross-comparison reveals that the core components of the IRSC Strategy are broadly supported by both managers and consumers, though practical challenges require careful consideration. The alignment on the importance of collaboration and technology suggests a shared vision for a more resilient supply chain. However, achieving this vision will require continuous communication, investment, and strategic adjustments to navigate the complexities of the modern food and agricultural supply chain.

6. CONCLUSION, IMPLICATIONS, LIMITATIONS AND RECOMMENDATIONS

6.1. CONCLUSIONS

The purpose of this study was to evaluate the effectiveness of the Integrated Resilient Supply Chain (IRSC) Strategy in enhancing the resilience of supply chains, particularly within the food and agricultural retail sector. This research aimed to test three key hypotheses: (H1) that real-time monitoring, including the use of Digital Twin technology, enhances retailers' ability to respond swiftly to disruptions; (H2) that flexibility in sourcing and logistics contributes to greater resilience by allowing better adaptation to changing conditions; and (H3) that collaborative planning among supply chain partners improves alignment and operational efficiency.

The analysis of the qualitative data from interviews with retail managers and the quantitative data from consumer surveys revealed several insights. Managers frequently emphasized the importance of real-time monitoring and flexibility, which aligns with consumer recognition of the value of these strategies. However, the challenges of implementing these strategies, especially related to costs and technology integration, were a key concern for managers but less visible to consumers. The results demonstrated that while consumers appreciate the outcomes of these resilience strategies, such as consistent product availability, they may not fully grasp the complexities that retailers face in implementing them. From the consumer perspective, the data showed a strong awareness of disruptions and a preference for retailers who invest in strategies that enhance resilience. A significant portion of respondents believed that such investments lead to competitive advantages, with many expressing a willingness to remain loyal to retailers who prioritize flexibility and real-time adjustments. This highlights an alignment between consumer expectations and the strategic goals of the IRSC framework, particularly in terms of maintaining product availability during periods of instability.

The interviews with retail managers reinforced the hypothesis that real-time monitoring plays a crucial role in managing disruptions effectively. This was particularly evident in discussions of how digital tools provide timely data, enabling swift adjustments in logistics and inventory levels. The ability to preempt disruptions through data-driven insights was highlighted as a major advantage of these technologies. However, concerns about the cost of

implementing these technologies, especially for smaller-scale operations, indicate that while the strategy has merits, practical considerations need to be addressed.

Regarding flexibility in sourcing and logistics, both managers and consumers acknowledged its importance. Managers frequently discussed the benefits of maintaining a network of alternative suppliers and diversified logistics routes, which proved invaluable during unforeseen disruptions. This was echoed in consumer responses, where many highlighted the importance of supplier diversification as a strategy for ensuring product availability. The findings support the hypothesis that flexibility enhances supply chain resilience, though the operational costs and complexities must be considered. Collaboration with supply chain partners was another critical theme that emerged from the study. Managers emphasized the need for strong partnerships and shared planning to synchronize supply chain activities. This aligns with consumer perspectives, as many respondents indicated that strategic alliances and better communication between supply chain entities are essential for maintaining stability. However, the interviews also revealed challenges in achieving effective collaboration, particularly with smaller or less technologically equipped partners, which may limit the practical application of these strategies.

In conclusion, the findings from this study suggest that the IRSC Strategy is a viable approach for enhancing supply chain resilience, but its implementation requires a complex understanding of both strategic and operational challenges. Real-time monitoring, flexibility, and collaborative planning all contribute to resilience, as evidenced by both qualitative and quantitative data. However, addressing cost considerations and ensuring broader technological adoption are crucial for realizing the full potential of the IRSC Strategy in diverse retail environments.

6.2. THEORETICAL AND PRATICAL IMPLICATIONS

Theoretical Implications

The study contributes to the existing body of knowledge on supply chain resilience by reinforcing and expanding upon several core concepts. A primary theoretical contribution is the validation of real-time monitoring, particularly Digital Twin technology, as a critical tool for enhancing supply chain responsiveness. While previous research by Ivanov (2017) and Tao et al. (2019) highlighted the potential of such technologies, this study provides empirical evidence from the food and agricultural retail sector, demonstrating how real-time data can preemptively address disruptions, thus minimizing stockouts and delays. By directly linking real-world

managerial experiences to these theoretical frameworks, the study enriches our understanding of how technological tools can be applied to practical resilience challenges.

The emphasis on flexibility in sourcing and logistics, a theme consistently highlighted in the interviews, further supports the theories posited by Christopher and Peck (2004) and Pettit et al. (2019). This study shows that maintaining a diverse network of suppliers and adaptable logistics routes enables companies to respond to market volatility effectively, confirming flexibility as a cornerstone of resilient supply chains. Additionally, the study extends this theoretical framework by discussing the challenges and trade-offs associated with implementing flexibility, such as increased operational costs and complexities. This adds a nuanced perspective to the literature, suggesting that while flexibility is beneficial, it must be balanced with considerations of resource allocation.

The study also contributes to the discourse on Collaborative Planning, Forecasting, and Replenishment (CPFR) by illustrating the practical challenges and benefits of collaboration in supply chain management. While existing literature, such as Sodhi and Tang (2012), has emphasized the role of collaboration in achieving better alignment and efficiency, this study provides empirical insights into the difficulties of maintaining real-time communication and shared planning with partners of varying technological capabilities. By highlighting these challenges, the study offers a more comprehensive view of collaboration's role in resilience, suggesting that theoretical models must account for these practical barriers to be more broadly applicable.

Practical Implications

The study's findings have several practical implications for retail managers and supply chain practitioners. First, the positive reception of real-time monitoring and technology-based solutions by consumers suggests that retailers should prioritize investments in digital tools, such as real-time analytics and Digital Twin technology. These technologies not only improve visibility and operational efficiency but also align with consumer expectations for transparency and responsiveness. Retailers that effectively implement such technologies can differentiate themselves in the marketplace, potentially attracting more loyal customers who value stability in product availability. For practical application, managers must consider the scale of their operations when adopting real-time monitoring solutions. While larger retail chains may find it easier to absorb the costs associated with advanced technologies, smaller companies might need to explore more cost-effective alternatives. This study suggests that a phased approach starting

with basic monitoring tools and progressively incorporating more advanced system could be a viable strategy for smaller retailers. This allows for a balance between the immediate benefits of visibility and the longer-term investment in advanced digital capabilities.

The emphasis on flexibility in sourcing and logistics also carries important practical recommendations. Retailers should develop strategies that include a diversified base of suppliers and flexible logistics networks. This is particularly crucial for companies dealing with perishable goods, where delays or disruptions can lead to significant losses. The findings suggest that creating a network of both local and international suppliers can help companies adapt to sudden changes in supply availability. Managers should also explore partnerships with smaller, regional logistics providers as a way to quickly adjust routes and maintain service levels during disruptions. These practices align closely with the IRSC Strategy's focus on adaptable sourcing and logistics solutions.

Collaborative planning emerged as another practical focus area. The study indicates that strong partnerships with suppliers can enhance forecasting accuracy and inventory management. However, achieving effective collaboration requires investment in communication tools and shared planning platforms that can bridge the gap between technologically advanced partners and those less equipped. For managers, this means that establishing clear communication protocols and regularly updating shared forecasts can improve alignment across the supply chain. It also emphasizes the importance of long-term relationship-building with key suppliers, which can enhance trust and facilitate more effective coordination during periods of instability.

The study’s findings also highlight the importance of balancing resilience with cost considerations. For many companies, particularly those with limited resources, the challenge lies in implementing resilience-enhancing measures without compromising profitability. Retail managers should consider a targeted approach, focusing investments on the most critical areas of vulnerability. For instance, rather than adopting a fully diversified supplier base, companies could identify a few key alternative suppliers for high-risk products. Similarly, rather than comprehensive automation, partial automation in key processes can offer a middle ground that balances efficiency with manageable costs.

6.3. LIMITATIONS AND RECOMMENDATIONS

This study offers meaningful insights into the resilience of supply chains in the context of the food and agricultural retail sector, especially through the lens of the Integrated Resilient Supply Chain (IRSC) Strategy. However, certain limitations need to be considered, as they shape the interpretation of the results and highlight areas for future research and practical improvements.

One key limitation lies in the technical nature of the subject matter, which can be difficult to communicate effectively to a broad consumer audience. Concepts such as "real-time monitoring" and "collaborative planning" are inherently complex and may be unfamiliar to many respondents. This could have influenced their understanding of the questions and the strategies discussed, potentially affecting their responses. Simplifying these concepts without losing their essence is a challenge that future studies should address, perhaps by using more accessible language or offering brief explanations in surveys to ensure clarity.

Another notable limitation concerns the consumer questionnaire's focus on experiences with supply chain disruptions. The design of the survey may have unintentionally skewed the results, particularly regarding the high percentage of respondents who reported having experienced disruptions. Since "higher prices" was listed as a consequence of supply chain disruptions, many participants may have identified with this option, even though price increases can result from various factors beyond supply chain issues, such as inflation or changes in demand. This could have led to an overestimation of the extent to which consumers perceive themselves as directly impacted by disruptions. Future studies should consider refining the questionnaire to distinguish more clearly between general economic changes and specific supply chain disruptions to obtain a more accurate picture of consumer experiences.

Additionally, while the study included a robust qualitative phase involving interviews with experienced supply chain managers, the relatively small number of interviewees limits the generalizability of the findings. The insights gathered provide in-depth perspectives but may not capture the full diversity of challenges faced by different retailers, especially those operating in varying regional markets or under different economic conditions. Expanding the pool of interview participants in future research could help ensure that a broader range of perspectives is considered, leading to a more comprehensive understanding of how different retail environments influence supply chain resilience.

Despite these limitations, the findings of this study point to practical areas for improvement. One recommendation is for retailers to consider investing in consumer education when

implementing advanced supply chain strategies. By making consumers more aware of the efforts to enhance resilience, such as through transparency about stock levels or real-time monitoring practices, retailers can potentially improve customer satisfaction and trust. Additionally, there is a clear opportunity for companies to refine their communication strategies during times of disruption, ensuring that consumers understand the steps being taken to maintain product availability and manage price fluctuations.

Additionally, future research could explore the application of the IRSC Strategy in different retail contexts, particularly smaller-scale or niche markets that may face unique constraints and opportunities compared to larger chains. Testing the strategy's elements, such as real-time monitoring or collaborative planning, across various market conditions could provide a better understanding of their effectiveness and offer tailored recommendations for different types of retailers. Addressing these areas would enhance the strategy’s adaptability and practical application, ultimately contributing to more resilient supply chains.

Another recommendation emerging from this study is the potential benefit of looking beyond the food retail sector to identify successful resilience strategies from other industries. While food and agricultural retail hold a critical place in the strategies of major retailers, exploring resilience approaches from diverse industries could provide valuable insights. Examining how sectors outside of food retail have navigated supply chain disruptions may reveal unique strategies or alternative perspectives that could be adapted effectively to the specific challenges of the food retail environment. Such cross-industry analysis could offer innovative ideas, potentially helping food retailers to adopt more adaptive, flexible, or efficient practices, ultimately strengthening their resilience against future disruptions.

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ANNEXES

ANNEX A – INTERVIEW SCRIPT

Supply Chain Resilience Interview Guide

These 8 questions are part of a research project for a Master's thesis in Business Management. The purpose of the study is to analyze the feasibility and impact of certain methods and strategies that, in theory, provide resilience to a food supply chain (specifically in the agricultural sector). The profile of the interviewees was selected with the aim of gathering information that reflects the perspective of professionals with experience in the food supply chain industry.

Questions

1. How many years have you worked in the food retail industry? Please specify the specific sector and describe the role you held/hold.
2. During your experience, have you followed or implemented any specific strategies that prioritize resilience?
    - **If yes**: Which ones? (Examples: Prioritizing stock management, downstream logistics efficiency, managing according to customer demand, automation, etc.)
    - **If no:** Why? What is your opinion on adopting specific strategies?
3. Flexibility is a common element in theories that support supply chain resilience. In your experience, is this flexibility truly effective and worth implementing?
    - **If yes:** Can you provide an example of a time when supply chain flexibility was crucial to its functioning?
    - **If no:** Why not? If possible, mention 1 or 2 factors that lead to the disregard for supply chain flexibility.
4. Another factor that theoretically strengthens resilience is real-time monitoring, i.e., continuous data collection at different points of the supply chain (such as transport management systems and machine learning with recurring data). In practice, do you

believe that the investment in real-time monitoring technologies is worth the costs and resources required?

- **If yes:** In which area do you think this technology has the greatest impact? (Inventory management, communication between supply chain nodes, goal management, etc.)
- **If no:** Why?

5. Regarding contingency plans and well-defined alternative options (alternative suppliers, alternative logistics routes, etc.), how important is it to have a viable option to rely on in case of disruption?
   - **If yes**: Do you believe that these plans should be tested or simulated to assess their viability?
   - **If no:** Why not?
6. Certain resilience strategies place great emphasis on collaborative planning between supply chain partners/nodes. However, do you think that this collaboration is always feasible between the various elements of the chain? Is the coordination effort worthwhile?
   - **If yes:** In your opinion, is there a part of the supply chain where communication plays a more important role than in others?
   - **If no:** Why not?
7. Shared forecasts to align production and supply plans might seem ideal. However, in your experience, are shared forecasts effective in practice?
   - **If yes:** Do you believe that the results justify the additional coordination effort?
   - **If no:** Do you prefer another type of metric to align the focus of all supply chain members?
8. Considering the resilience parameters discussed in the questions above, do you think that a possible theoretical strategy whose three main pillars are flexibility, real-time monitoring, and collaborative planning could be considered an appropriate strategy for managing an agricultural product supply chain?

9. Based on your experience, is there any factor or characteristic that a resilient supply chain should have, but which has not been discussed in the questions above?

ANNEX B – INTERVIEW TRANSCRIPTIONS

Interview A

Interviewer: So, let's get to it. First of all, thank you for taking the time. As I briefly summarized in my request to Célia, I am working on a thesis about the resilience of supply chains, particularly in the food sector during times of instability. From what I could see on LinkedIn, Célia is currently working at Janssen, which I noticed deals with a variety of photovoltaic plants. While this isn't exactly the topic I'm studying, she has significant experience in the area relevant to my research, which I believe is a great asset.

Interviewee A: Very good. Thank you very much. I'm here to help with anything you need. Thank you.

Interviewer: So, what I have here are about seven or eight questions for Célia. Some are more introductory, and the others will delve into certain characteristics or factors that some supply chains follow. I would like to know Célia's opinion on the viability of each one. Basically, it's about whether they are worth it or not. The truth is that most resilience strategies are theoretically viable for increasing resilience, but sometimes putting them into practice isn't always the easiest, as Célia must know.

Interviewer: So, I'll start by asking how many years you have worked or are working in the food retail industry, and if you could give a brief idea of what your specific role was and the branch of the area you were involved in?

Interviewee A: I worked for 23 years in the retail sector, and throughout these 23 years, I dealt with various product categories, with food always being a constant.

Interviewee A: Why? Because my main function over 23 years was to optimize the supply chain and all the provisioning to the store. That is, I was very, very focused on the downstream area of the supply chain, not the upstream. But everything was connected, so we coordinated with the upstream team, essentially communicating with suppliers. We initiated the entire process with suppliers, designing the supply chain, understanding the needs in the downstream area, that is, in the store, and then working our way up to the supplier. My role was essentially in optimization, starting from the '90s with the automation of provisioning.

Interviewee A: This led to the complete release of human resources in executing and obtaining the needs for store supply. Everything became automatic, which brought extraordinary gains for the company because it freed up resources that spent 50% of their time doing a manual ordering process with many errors. We first used a model without stock information, which is still viable today for provisioning without stock information, called Sales Based Order, and we used it for three years.

Interviewee A: It then moved to Oracle, and we optimized the entire process, this time with algorithms for sales forecasts, etc., and once again, everything was automated. Additionally, we further optimized by implementing radio frequency terminals to swiftly collect all the information in the store and warehouse, and these data were processed centrally by the respective algorithms.

Interviewee A: I was part of a small, central team that handled everything, from identifying all the needs, pinpointing the algorithms, and optimizing them to fit reality. We implemented the entire process, from defining requirements to overseeing development, testing, training the teams, and implementation.

Interviewee A: And why am I saying this before mentioning the areas of activity? Because SONAE had a principle that always started in the food sector, which was the core business of the group. Then, what we did was implement it in all other areas, namely light bazaar, which includes everything like tools, plates, dishes, butcher shops, charcuterie, all the fresh produce, and also Worten—everything related to appliances, software, etc.

Interviewee A: Before it became Worten, a brand and a business, this process remained apart from the food sector.

Interviewer: But if I may ask a question, since I'm almost more interested now, why did you say that the food sector was always the priority? Was it because SONAE recognized that it was the sector that needed the most logistical support and everything new had to go there?

Interviewee A: The main reason was the gains achieved. Retail in the late '90s was changing, with centralization of goods in warehouses starting in '93. Before that, the supplier delivered directly to the store. The food sector was always the first to adopt these innovations because it was the core business. We gained significant advantages by implementing these process improvements in food, and then the rest followed. But since other sectors had much lower business volume, it was about implementing procedures in a way that was...

Interviewee A: ...global and comprehensive. What did these teams enable? I was pleased to be a part of them. Every time we moved from one business sector to another, we almost had to start from scratch because the businesses were extraordinarily different. In the food sector, we tested the robustness of the design. Once validated, we moved forward with minimal risk to the other sectors. We always did pilot tests, live with the stores open. It couldn't go wrong.

Interviewee A: Sometimes I find it very curious when I see implementations that go wrong because pilot tests are crucial.

Interviewer: You conducted live pilot tests?

Interviewee A: Yes, everything was tested live. We always worked in multidisciplinary teams. There was a small team of three people, each covering a different area: one in the north, one in the center, and another in the south, and we implemented it across the entire region.

Interviewee A: We always used the same working base, which was a recipe for success. We gathered all the internal stakeholders, designed the process, and identified the key requirements. We brought in commercial management, logistics, finance, operations, and the store's operational teams, including receiving and operational store areas.

Interviewee A: We would put together a large group of people who committed to having a representative for each area. This representative would clear any doubts. These individuals were tasked with validating documentation, running tests, approving training materials, and then training their teams, acting as our ambassadors.

Interviewer: So, Célia's team, although small, had the authority to engage with all necessary experts in the company. That's interesting and seems very efficient.

Interviewee A: Yes, all projects had a sponsor from the administration. Project management was handled very well, with directors representing each area in regular follow-up meetings. Depending on the project's progress, these meetings happened more or less frequently, and we were responsible for driving the entire project engine, coordinating all the teams involved.

Interviewer: Célia touched on several points I wanted to discuss, which is excellent. I wanted to focus on food.

Interviewee A: Exactly, food was always the focus. For about 8 to 10 years, I worked in this area. Then I spent around 4 years implementing reverse logistics in the company. That project was solely mine, and I managed the entire process with an information systems team, ensuring business assessments and gathering requirements.

Interviewee A: After implementing reverse logistics, we started with gaming, software, and computers, where we had the most obsolete stock, and then moved on to food, which was the only project where we started in reverse.

Interviewee A: We even won a European award for implementing a workflow system in an operational logistics process, which was generally used for expenses. This workflow started with the return request and mapped the entire path back to the store. After that, we saw huge gains in returns.

Interviewee A: Later, I was invited to join a wholesale channel project and to support ecommerce for four brands: Modalfa, Zippy, Sport Zone, and Worten. I spent my final years in international logistics, working on the Angola project and Sport Zone's franchising projects.

Interviewee A: We had a lot of import know-how but none in export, and my team was responsible for designing the export process. I supported various sectors, working with very small teams that acted as bridges between downstream customers and logistics operations.

Interviewer: That's interesting! You mentioned the food sector being the priority, but other sectors also had people optimizing supply chains, right? Did their work ever stop?

Interviewee A: At SONAE, innovation is continuous. I had the privilege of being part of what I call the "fifth wave of innovation," from the '90s to 2020. Now we're in the sixth wave, expected to last around 15 to 20 years. SONAE was very good at keeping up with innovation. We always sought out best practices, collaborating closely with companies like Tesco in the UK.

Interviewee A: SONAE reduced stock by 50%, focusing on optimizing logistics to cut costs. We worked with suppliers on a "Picking by Line" system, ensuring stock arrived within 24 hours of identifying store needs. The system reduced errors and was a model for others to follow.

Interviewer: This Picking by Line sounds fascinating. The goal was to reduce storage costs and physical space, right?

Interviewee A: Yes, absolutely. It drastically reduced costs and was incredibly efficient.

Interviewer: Moving on, I'd like your opinion on contingency plans. Did you have any supplier-related plan Bs, logistical backups, and did you conduct simulations?

Interviewee A: Risk wasn't a major focus until the turn of the century, but after experiencing a significant strike in France, we started taking it seriously. We identified critical functions, ensured redundancy, and had contingency plans for suppliers. We continuously evaluated suppliers for quality and service levels, with strict monitoring to avoid stockouts, especially for key products like milk, water, and olive oil.

Interviewee A: Nowadays, private labels have helped mitigate this risk, as companies now have more control over their production chains.

Interviewer: How did you manage lost sales due to stockouts?

Interviewee A: We estimated sales losses, but in the future, AI will make it much easier to analyze lost sales by tracking customer behavior patterns.

Interviewer: That will be valuable.

Interviewee A: Yes, it will. We also had very strict quality monitoring systems, particularly in non-food sectors where 80 to 90% of products were imported.

Interviewer: Did you have similar monitoring in the food sector?

Interviewee A: The food sector had a much lower percentage of imports, around 20 to 30%, mostly for products like milk and pineapple. Proximity to suppliers was key for managing stock efficiently.

Interviewer: Célia mentioned earlier about service levels and reducing stock to have direct supply from the supplier. Could you elaborate?

Interviewee A: Yes, reducing stockouts relies on having excellent service levels from suppliers. Without a buffer, we're dependent on them delivering on time, otherwise, we risk stockouts.

Interviewer: How did communication with suppliers work? Did they accept feedback?

Interviewee A: Yes, we collaborated closely with suppliers, especially when we implemented VMI (Vendor Managed Inventory) systems. We planned promotions together and coordinated stock levels to avoid disruptions. Everyone benefited from this collaboration, even competitors.

Interviewee A: The goal was always to reduce internal costs, improve processes, and increase margins. This open communication with suppliers and partners allowed us to optimize the supply chain.

Interviewer: That's fascinating. I didn't realize there was such openness between competitors in retail.

Interviewee A: Yes, and it's becoming more common. Retailers are realizing that by collaborating, they can avoid unnecessary costs and improve efficiency.

Interviewee A: Yes, they're realizing that they are hurting themselves. For example, if a SONAE truck goes to pick up half a truckload of yogurt, and Pingo Doce from Jerónimo Martins picks up the other half, why not agree to use just one truck and make one route?

Interviewer: Exactly.

Interviewee A: When companies understand the benefits of looking at the supply chain as a whole, everyone wins.

Interviewer: For example, don't you think that competitiveness, like with Lidl emerging in recent years, could be beneficial for a new player but less so for established companies like SONAE and Jerónimo Martins, who might take a more collaborative stance?

Interviewee A: Yes, exactly. In essence, brands like Lidl or Mercadona have completely different business models. They invest more heavily in their own brands and have maybe one or two other brands because they know they need to attract customers. For example, Mercadona has their own toothpaste brand, but they also stock Colgate because they know they can't afford to lose a customer over a missing product.

Interviewer: Right.

Interviewee A: So, these players compete with different philosophies, and they probably won't collaborate with each other. But other businesses can. Those working in the supply chain need to sit down with various partners and look at the bigger picture.

Interviewee A: In the past, people said "secrecy is the soul of the business." That's no longer true.

Interviewer: Right, it's not.

Interviewee A: Exactly. Today, we can't operate with that mentality. We need to sit down with colleagues, even those from other sectors, and share ideas. When I left SONAE and joined another company, for example, I spent two years optimizing their operations. Then I moved to MCA, an infrastructure company in the construction sector. And let me tell you, logistics in the construction sector is practically nonexistent.

Interviewer: Really? That's surprising.

Interviewee A: Yes, zero. It's incredible. And when I arrived, they told me, "This isn't selling rice." There was a total lack of understanding about logistics.

Interviewer: Wow, I didn't realize the construction sector was so different.

Interviewee A: Exactly. And for me, the real richness is hiring people from outside the sector. I always preferred recruiting someone from a different background because they bring fresh perspectives.

Interviewer: Yes, I agree.

Interviewee A: Everything we do today may be correct, but there's always room for improvement. That's why companies like IKEA are so innovative. They let customers pick up their products themselves in the warehouse, and suddenly, shopping becomes fun and efficient.

Interviewee A: So, there's always value in embracing new ideas. Nothing we do today is perfect—it's just one possible approach.

Interview B

Interviewer: So, basically, I have here eight questions for Diogo, following up on my research, which is to analyze the viability and impact of certain resilience strategies in food retail supply chains, especially in the agricultural sector. I found Diogo's profile while looking for Agriloja collaborators and people with management positions in Agriloja, and I

noticed your experience at Auchan supermarkets and Mini Preço as well. I thought it would be great to ask you some questions.

Interviewer: To start, the first question would be how many years have you worked or are currently working in the food retail industry, and could you specify the specific branch or detail the role you play or have played, and more or less summarize your career?

Interviewee B: So, I started working at ICAO. I entered as a trainee in 2009, in early 2009.

Interviewer: On the day, right?

Interviewee B: Exactly, on the day. I've always worked in distribution. I started with Grupo Dia as a trainee, then I became responsible for a store in the center of Lisbon, and later I had the opportunity to move to Auchan as a market manager, and I accepted the challenge and went abroad.

Interviewer: Are you from Lisbon, Diogo?

Interviewee B: No, I'm from Aveiro.

Interviewer: Oh, from Aveiro, okay. I actually thought you were from Évora based on recent history.

Interviewee B: I studied in Porto Alegre. I did a Strategic Management course, still under the Bologna system, which lasted four and a half years. That's where I met my wife, my current wife, my girlfriend at the time, and then I went to Lisbon, Porto Alegre, and so on.

Interviewee B: I started working in Lisbon after finishing the course. I started at Mini Preço as a trainee, then I moved to Auchan. We went to Faro, I spent six months in Alfragide as an intern, and then I went to Faro to the Saturday store. At Auchan, I worked in the DP department, and in this case, it was DPH, which was perfumes and personal care products.

Interviewer: Then?

Interviewee B: Later, when Auchan went through an update, they eliminated the area managers. There used to be a director, then the area managers, and finally, the market managers.

Interviewee B: So, the area managers were eliminated, and the market managers started taking on that role. We handled everything, and I was part of the PGC, which stands for "Large Consumer Goods." I'm not sure if you're familiar with these terms.

Interviewer: Yes, yes, but I can always ask for clarification if needed.

Interviewee B: PGC stands for "Large Consumer Goods," which includes packaged foods, groceries, liquids, fruits and vegetables, the butcher, the bakery, perfumes, and personal care products. After that, I also began to oversee all these areas alongside my colleague from the liquids department. We were both responsible for the market and for all these areas before the director.

Interviewee B: Then my son was born, and I needed to slow down a bit, as the pace was incredibly hectic.

Interviewer: I can imagine.

Interviewee B: I believe things are different now, but back then, it was quite chaotic. Then, the opportunity came for me to work at Acquipa Evo. My wife works from home; she's a visual artist, and our child was only 9 months old, so we decided to move to Évora.

Interviewee B: It was another adventure. We had gone abroad before, and then I came to Acquipa. After working there for some time, I had an offer from a company called Juan Merlão. There was supposed to be a restructuring of middle management, which meant I would have to work in Almada.

Interviewee B: I would have had to commute, but at that point, I wasn't interested in leaving Évora, so I declined the offer. I thanked them and decided not to stay with the company, as I found the process very transparent.

Interviewee B: I then became the manager of a store called Casa, which was a passion of mine, not related to food retail at all. So, I started in the food sector, then moved into DIY, then the home sector, and now I'm back in agriculture.

Interviewer: So, you returned to the agricultural sector, exactly.

Interviewee B: Yes, now I'm in the agricultural area. I didn't have much knowledge of agriculture when I started, but I had more experience with DIY, heating systems—things I'd dealt with before. The agricultural and livestock sectors were not my fields, but I've been here for almost two years now. It's different, but I still have a lot to learn. When I arrived, these weren't areas I was comfortable with.

Interviewee B: I wasn't comfortable at all, but I've started to enjoy it.

Interviewer: Out of curiosity, was this something you found rewarding?

Interviewee B: Exactly. I never liked home decor, yet I was managing a home decor store. I had never done much DIY, but I learned. The commercial area is still the commercial area. We

have to know our field and understand the difficulties of our business, but the fundamentals of commerce remain the same.

Interviewee B: Everything else, you can learn. But some things can't be learned. UNICEF, for example, is always open to new experiences. I started as a store manager, then became a section manager, department head, back to store manager, and now I'm a store director.
Sometimes the terms don't always make sense.

Interviewer: Right, and now that you're in a position where you can make decisions, you're the Store Manager or market manager. Have you implemented any specific strategies, like prioritizing customer demand or stock management? Any guiding star that you followed?

Interviewee B: When I joined the team, my focus wasn't on creating but on rebuilding the team and adjusting the store's operations in Évora. The next priority that emerged naturally was stock management.

Interviewee B: We had some problems with stock rotation. We had a lot of products sitting idle, and the breakages were higher than they should have been. So that was my main focus when I started, alongside managing the team.

Interviewer: Did you implement any type of automation for stock management? Could you briefly explain how your system works, if you use sensors?

Interviewee B: The stock system is centralized, not automatic. However, we had an issue last year. At the beginning of the year, we lost access to automation, and we had to go back to doing everything manually.

Interviewee B: Coincidentally, this month, the automatic systems returned, and now we are relearning how to work with them.

Interviewer: So, you were without automation for quite a while, right?

Interviewee B: Yes, for about a year, a year and a bit. We had some IT issues, and it took a while to make sure things would work correctly to avoid overstocking or stockouts and to ensure that the algorithm was functioning properly.

Interviewer: Do you think that once it's up and running properly, automation is worth it and saves a lot of labor?

Interviewee B: Absolutely, automation always frees up more time to focus on customers.

Interviewer: Right.

Interviewee B: It allows us to focus on other tasks. For instance, we used to spend a couple of hours placing orders manually, which the system could easily handle.

Interviewee B: Of course, we always need to make adjustments and keep an eye on things.
For example, if there's an extraordinary sale of a particular product, we have to be careful that it doesn't mess up the history, even though there are some restrictions in place. But the algorithm isn't perfect, so we still need to be cautious.

Interviewee B: If we want to replenish for a customer, we must manually adjust, but overall, it frees up a lot of time for sales.

Interviewer: Right. Now, regarding products, at Agriloja, as a large company, does Diogo have any say in how the product arrives, where it comes from, and what logistics are used?
Or do you only handle what comes into the warehouse?

Interviewee B: Well, at Agriloja, we order from centralized suppliers, and deliveries are made on a fixed schedule. But there are other suppliers who deliver directly to the store. Before it reaches our store, we have little autonomy.

Interviewer: So, you have little decision-making power, right?

Interviewee B: Exactly. The only thing we can do is, if I need a product urgently and the supplier can't deliver within a week, I'll call them and arrange for expedited shipping via Santos Ival, DHL, CTT, or something similar.

Interviewee B: I'll make the request, handle the urgent shipping, and we cover the cost. Or, if we need to transfer stock from another store and it's not urgent, we wait for the next scheduled delivery.

Interviewee B: For example, our delivery is on Thursdays. If the other store also delivers on Thursdays, it takes at least a week for the product to arrive here.

Interviewer: Got it.

Interviewee B: If it's urgent – and clients always want things urgently – we have to make the special request ourselves.

Interviewer: Right, a special order.

Interviewee B: Exactly, and we handle that process ourselves. We work a lot with Samos and Val, NMAL, etc.

Interviewer: Regarding contingency plans, for example, if your supplier has low stock for the coming months, does Agriloja have a plan to switch suppliers quickly? And are those plans tested?

Interviewee B: Usually, our product managers get this information in advance, but if something happens unexpectedly, like a factory closing, we have to act fast.

Interviewer: Exactly, I mean those kinds of disruptions that are hard to predict, like seasonal shortages or external disruptions like wildfires.

Interviewee B: Yes, the product team deals with those issues. Sometimes, we can also rely on local suppliers. For instance, if there's a national shortage of corn, but we know of a local supplier, we can arrange deliveries to the Évora store and other nearby locations.

Interviewee B: When national suppliers can't fulfill orders, we turn to local suppliers. The product team works with the area managers and store managers. There's a team for each area, made up of a product manager, an area manager, store managers, and specialists.

Interviewee B: They come together to find solutions. If a store knows of a local supplier that could be beneficial, they have the autonomy to suggest it and negotiate.

Interviewer: Got it. You were mentioning the suppliers you deal with directly. Is there always communication with them? Do you personally handle communication with local suppliers?

Interviewee B: Local suppliers are more centralized, so I don't deal with them directly.

Interviewer: Ok, I see.

Interviewee B: Franchises tend to use local suppliers more often.

Interviewer: Franchises? I didn't know that.

Interviewee B: Yes, in Agriloja, there are company-owned stores and franchised stores.

Interviewer: Ah, I didn't realize.

Interviewee B: Franchised stores have a slightly different product range and use local suppliers more often. Here, for example, we sell locally sourced melons and potatoes. We make contact, get approval from the business area, and the supplier delivers to our store.

Interviewer: Do you find that proximity to suppliers is an advantage?

Interviewee B: Absolutely. It's the same with dried fruits, walnuts, for instance. Since they're local, customers accept them more. We've even sold local olive oil and wine.

Interviewee B: We always have a few local products. Some of these suppliers eventually expand nationally if their product is interesting and they have distribution capacity.

Interviewer: That depends on higher management, right?

Interviewee B: Yes, it depends on whether the supplier is accepted. But it's beneficial for Agriloja because customers appreciate these products.

Interviewee B: We also get better purchasing conditions when buying in bulk.

Interviewer: Right. Now, one last question. I think I've covered all the questions I wanted to ask. Is there any factor or characteristic of Agriloja's supply chain that was new to you when you started? Something you didn't see at Auchan?

Interviewer: For example, Auchan is a "logistics machine," right? I assume Agriloja is similar, but is there anything different?

Interviewee B: Yes, Auchan is... Well, Agriloja is still growing and experiencing growing pains, as they say. But we already have centralized and optimized processes. There's still a lot of work to do, but one thing I noticed is the more personalized customer service.

Interviewee B: In Auchan, customer service is more automated. When you sell services like fish or meat, it's more mechanical. But here, customers enjoy coming to the store. We sell

tractors, small machines, and even large items like pools worth 6,000 to 7,000 euros. So the service is more personalized.

Interviewer: Exactly, the service has to be more hands-on.

Interviewee B: Yes, it's a different approach. In the food retail sector, customers help themselves. Here, we need to attend to the customer. It's a different type of interaction, which I also saw in the home decor sector, where personalized service is key.

Interviewee B: You need to know the technical aspects of the products. It's more specialized.

Interviewer: Yes, specialized. Diogo, you've also specialized, right? You started in a large chain like Auchan, which is impersonal, and now you're in a field where customer service is more important.

Interviewee B: Exactly. Here, on a good day, we attend to around 400 customers.

Interviewer: That's quite a lot.

Interviewee B: Yes, it's still a lot. But at Auchan in Faro, for example, we would attend to 13,000 or 14,000 customers a day.

Interviewer: That's a huge difference.

Interviewee B: Yes, and you can't really engage with those customers. Here, it's a more personal business. Despite having grown considerably, customers come looking for specific people by name – António, José, or Ricardo.

Interviewer: You already know who they are.

Interviewee B: Exactly. That builds trust. What sets us apart from the competition isn't the price because prices are similar, but it's the technical knowledge and the personalized service.

Interviewee B: That's crucial. Of course, if there's a big price difference, customers buying in bulk will go for the cheaper option. But often, it's the customer service that makes the difference.

Interviewer: Right. How was it dealing with the difference in terms of technology? Agriloja doesn't have the same tech facilities as Auchan or Leroy Merlin. Was it easy to adapt?

Interviewee B: It was different. At Auchan, I had more autonomy over my budget and had to justify profitability down to the last detail. Here, there's less autonomy. At Auchan, as a store manager, I was more of a well-paid salesperson, opening and closing the store, hiring staff, and managing the team. Here, I have more responsibilities.

Interviewee B: At Agriloja, I have autonomy over the store's budget, I negotiate with external suppliers, and I manage the budget. Globally, I have to justify it to higher management, but it's different.

Interviewer: So, your superior at the moment is the area manager?

Interviewee B: Yes, we call them area managers. Then there's the executive director.

Interviewer: Right, from the Agriloja Group.

Interviewee B: Yes, from Agriloja. There are other associated groups with many companies – it seems endless.

Interviewer: I understand. And there are area managers, typically overseeing 8 or 9 stores.

Interviewee B: Exactly. Then there are store managers, section managers, sales staff, and so on.

Interviewer: The section manager is below you, right?

Interviewee B: Yes, exactly.

Interview C

Interviewer: Very well, it's already recording. Okay, let's get started. This quick interview will focus on some questions that will follow one after the other. This is already the sixth interview I've done, so I already know that I don't necessarily need to ask all the questions because a lot comes out naturally during the conversation.

But what I explained here is that, basically, we're evaluating, or rather, I'm evaluating the resilience of certain strategies that are imposed by supply chain managers. My first question here for Pedro would be: how many years have you worked or are you currently working in the food industry? And if you could specify your field and role.

Interviewee C: Very well. So, I've worked for the last 15 years in supply chain, sometimes as a negotiator or a buyer. Then, over the last year and a half to two years, I've been focusing more on supply chain projects, so I haven't been as directly involved in the business itself.

Throughout these years, I've dealt with completely different types of businesses. Some were more local sourcing, others involved global sourcing, while some were limited to Europe. The key factor influencing the sourcing of products often depends on whether the businesses involve cold chains or not, which significantly changes the dynamics.

For example, 99% of the articles we source are imported from all over the world, and a frozen product container can circulate between any part of the world. However, if we're talking about products that are more specific to a national market, whether due to consumer tastes or the type of product, the supply chain is much more limited in scope.

Interviewee C: Consumer preferences and tastes are one aspect, but product conservation methods and the validity periods of products are also critical. Shorter validity periods force the supply chain to be much closer, while longer validity periods significantly broaden the ability to source. For instance, it's much easier to transport frozen food globally than it is to transport fresh food, mainly due to the complexity of transporting fresh products.

Interviewer: So, for those 15 years, you've been dealing with the supply chain?

Interviewee C: Yes, for 15 years, I've been working primarily with frozen food products, mainly within Europe. There are various brands involved, and it's important to understand that the responsibility for sourcing and supply chain management in branded businesses often lies with the supplier. However, in businesses where the distribution brand is involved, such as private labels, the responsibility falls on the buyer or the importer who commercializes the product.

Interviewee C: In the frozen food industry, I've worked extensively with vegetables, meals, frozen fish, frozen seafood, charcuterie, and even tail meats.

Interviewer: So, in these cases, would you say you were the one setting up the operations, or did you just work with the manufacturers to make the connections?

Interviewee C: I'll give you an example. Imagine nowadays when you go to a supermarket and buy a "Dourada" or "Robalo" (types of fish) which are aquaculture products. You might be buying from the national market, which has limited smoking capacity, or from industries in Spain, Greece, or today, Turkey, which has become a prominent player.

Interviewee C: All these logistics chains guarantee the distribution capacity of products across different markets. For instance, a customer may have a DDP business, meaning they handle everything, including the commercial relationship with someone a thousand kilometers away. But essentially, it's the same as buying from a supplier just down the street because the supplier takes care of everything, from transportation to customs, duties, and taxes.

Interviewee C: It's a multi-transport operation involving land, sea, and other logistics. This is the famous DDP (Delivered Duty Paid) model.

Interviewer: Right, and when does the retailer take on the role of the importer?

Interviewee C: That happens in cases where the retailer assumes responsibility for importing. All logistical aspects, including customs, are now the retailer's responsibility. They need to ensure product quality, meet specifications, and oversee every step once the product is delivered to the factory door.

In an X-Works model, for instance, the price the seller gives is based on the product being delivered to their warehouse door. After that, everything—quality control, transportation, customs, and final delivery—becomes the buyer's responsibility. So, I'm giving you two extreme examples: one where the supplier manages everything, and another where the retailer takes over after the product leaves the factory.

Interviewer: I wanted to ask about that because, in previous interviews, I've spoken with someone from the Continent (SONAE) supply chain. We talked about how Continent minimizes supply chain risks by producing its own brand products. Does Continent do this internationally as well, or is it mostly at a national level?

Interviewee C: SONAE's strategy is a bit different compared to, say, Jerónimo Martins. If you speak to someone from Jerónimo Martins, you'll find that they tend to have more involvement in production, possibly even taking ownership stakes or committing to future production agreements.

Jerónimo Martins has businesses where they own part or all of the capital, like in animal farming, for example. They have partnerships and a higher level of vertical integration than SONAE. While SONAE does have some vertical projects, historically speaking, Jerónimo Martins has been more involved in this type of verticalization because their background is more deeply rooted in food production, given their historical connection with Unilever.

Interviewee C: Jerónimo Martins has a long-standing partnership with Unilever, which used to make margarines and ice creams, among other products. So, they have a history of expertise in the food industry. SONAE, on the other hand, began in different sectors before specializing in distribution, so their industrial involvement came later as a result of their growth in distribution.

Interviewee C: What I'm saying is that these companies have taken different paths. From my understanding, there's increasing openness to vertical integration because of the risks in the supply chain, but there's a lot of risk involved. If a retailer has ample supply options and multiple suppliers at their disposal, there's less incentive to take on the risks of vertical integration.

Interviewee C: On the other hand, if supply is unpredictable or limited, the retailer might take a more active role, leveraging their financial capacity and market presence to secure the supply chain. But when we move beyond the Iberian Peninsula, for example, Portuguese retailers are relatively small players compared to companies like Lidl, Aldi, Tesco, or Walmart, which have much more purchasing power.

Interviewee C: Portuguese retailers can sometimes make an effort toward vertical integration, but in a global market, bigger players often have the upper hand. Retailers like Lidl and Aldi have stronger supply chain control because they operate on a much larger scale.

Interviewer: Yes, and retailers, in general, are tough customers for the food industry, right? They demand small margins, negotiate tough contracts, and often don't make long-term commitments.

Interviewee C: Exactly. Retailers are very demanding clients. They want to pay as little as possible while getting the highest quality and best specifications. Producers, on the other hand, need to ensure they can continuously supply a certain portion of their production to their large retail clients.

Interviewee C: Retailers don't want to commit to long-term contracts because they want flexibility. This can sometimes lead to tension between retailers and producers, especially when retailers are competing with the food industry for the same products.

Interviewer: Right, and earlier, you mentioned Lidl. I've noticed that in Portugal, Lidl has a lot of private label products. They seem to offer just one or two branded products, but the rest are their own. Do you know how that works? Do they source from their German or European operations and bring products to Portugal?

Interviewee C: Yes, that's exactly how it works. Going back a bit, when Lidl first entered the market as a pure discounter, they didn't even have brands like Colgate. Over time, they realized that Portuguese customers, for example, might stop shopping at Lidl if they couldn't find

familiar brands like Delta Coffee or Colgate, which they could easily get at Pingo Doce or Continente.

Interviewee C: But Lidl's power lies in their central purchasing operations. The sheer volume of products they buy in Europe is so large that they can negotiate unbeatable prices. A buyer at Lidl Portugal may not even know the cost price of the toothpaste they're selling because the negotiations happen at a much higher, central level, where massive quantities are purchased for all of Europe.

Interviewee C: Lidl's supply chain works through central negotiations, where a huge amount of product is bought and then distributed across different countries.

Interviewer: That's interesting. And what you mentioned earlier about vertical integration being a trend—how does that play into risk mitigation in the national context?

Interviewee C: Vertical integration has become almost fashionable, but it's important to understand that running an industrial operation is very different from running a retail operation. The skill sets required are completely different. In my experience, companies that succeed with vertical integration are those that bring professionalism to an underdeveloped area of the industry. However, when the industry is already professionalized, the advantages of verticalization can be limited.

Interviewee C: Vertical integration can provide more control over supply and reduce risks related to disruptions, but it can also limit innovation and flexibility. If a retailer becomes too vertically integrated, they lose the ability to respond quickly to changes in the market. For example, innovation is critical for marketing, but from an industrial perspective, production efficiency is often prioritized over innovation.

Interviewer: So, the trade-off is between control over supply and the ability to stay flexible and innovative?

Interviewee C: Exactly. Retailers need to balance the need for control with the need for flexibility. If you're too focused on one supplier or too vertically integrated, you might miss out on innovations or shifts in the market.

Interviewer: In terms of contingency plans, how did you handle disruptions? Did you always have a plan B in place?

Interviewee C: There's no one-size-fits-all recipe for contingency planning. It depends on the business and the product. For example, if you rely on one supplier for a specific product, you're placing all your risk in that supplier's hands. But having multiple suppliers can reduce your risk, although it might increase complexity.

Interviewee C: Risk management requires a cautious approach because the cost of not serving the market is enormous. It involves making decisions based on historical data, governance, and strategic planning. These decisions often involve millions of euros and need to be carefully managed.

Interviewer: And how did you handle forecasts for future supply needs when entering new markets, like Chile, for example?

Interviewee C: It depends on the business. Some businesses have a steady sales distribution throughout the year, while others are highly seasonal. For example, when I went to Chile to buy fish, the demand was fairly uniform throughout the year, so the risk management strategy was different than for a seasonal business like seafood at Christmas, where 80% of the sales happen over a few days.

Interviewee C: For seasonal businesses, we start preparing months in advance. Managing the risk and ensuring supply is critical, especially when dealing with short timeframes and high demand.

Interviewer: It sounds like forecasting and risk management are essential, but they also vary greatly depending on the type of business.

Interviewee C: Absolutely. Forecasting and risk management depend on the specific business and the supply chain involved. The key is to balance supply and demand while maintaining flexibility and competitiveness.

Interviewer: That makes sense. Thank you so much for all this information. It's been incredibly insightful.

Interviewee C: You're welcome. I'm happy to help, and if you need anything else as you progress with your research, feel free to reach out.

Interview D

Interviewer: Let's start. Basically, my research is relatively simple, but intense, as I'm researching and analyzing the viability of certain resilience strategies in agricultural retail chains. More specifically, I'm focusing on food and agriculture. I have a series of questions for Tiago that naturally lead into one another as they often arise in conversation. We'll start by talking a bit about Tiago's experience, and then I'll move on to the questions related to my research. I've already conducted some interviews with others, and I think Tiago will understand the direction I'm going in and provide some valuable answers.

Interviewer: So, to start, my first question is: how many years have you been working in the food industry, and what is your specific field or function? I noticed that Tiago has been with Sonae for many years.

Interviewee D: Yes, 22 years at least with Sonae, but I started even earlier, so...

Interviewer: Really? And who were the others, just out of curiosity?

Interviewee D: It was Pedro Leitão.

Interviewer: Pedro Leitão, yes, I've worked with him. He's a commercial guy.

Interviewee D: Exactly. And Célia... I can't remember her last name... Fialho. Célia Fialho.

Interviewer: I think I'll leave it here. There are a few others. But Célia doesn't work there anymore, right?

Interviewee D: I don’t know. I think she still works there, in the commercial area.

Interviewer: Let’s leave that aside. I know that Sonae is a logistics giant.

Interviewee D: Yes, it’s huge.

Interviewer: A lot of people.

Interviewee D: Definitely. There are so many people that I may not know everyone, like Célia Pedro.

Interviewer: She worked at the end of the 90s, beginning of the 2000s, right?

Interviewee D: Ah, I started in 2001, so we might not have crossed paths.

Interviewer: Very well. Let’s dive in. What questions do you have?

Interviewer: My first question is about Tiago’s specific field of work and his experience with food.

Interviewee D: Well, I’ve been in the food industry for around 26 years—22 of those with Sonae. My focus has mainly been on fresh food, but always in the food area.

Interviewer: Tiago is in a management position where you coordinate food chains, right? Has there always been a sort of "North Star" guiding your approach in terms of prioritizing client needs, logistical efficiency, or innovation? Have there been phases where your priorities have shifted over time?

Interviewee D: It’s like this: in companies, there’s that saying, “the customer is always right,” and although they’re not always right, the focus is always on the customer. A company exists for its customers. Unless it's a non-profit organization, its focus is the customer.

Interviewee D: The base is always the customer. The customer wants something, and we have to adapt every process—whether it’s logistics, commercial, or communication—to meet their needs. If we don't, we're out of business, and we disappear. That’s why the customer is always at the center. Of course, there are other priorities.

Interviewee D: A company is also about making a profit. So, while we meet the customer’s needs, we also have to minimize costs, optimize the entire chain to gain as much as possible, while always following the rules—never breaking rules related to food quality, food safety, and so on.

Interviewer: Flexibility is a key topic these days, especially when discussing the resilience of supply chains. How important is flexibility in your daily operations, and can you provide examples where this flexibility has really made a difference in maintaining or enhancing the supply chain?

Interviewee D: In large companies, systems and processes are typically structured to be efficient, but as companies grow, things can become more complex. There’s always this tendency to overhaul systems and make everything procedural and rigid to ensure that processes don’t lose efficiency due to staff turnover or other factors.

Interviewee D: This has its advantages—ensuring consistent processes regardless of personnel—but it can limit flexibility, which is crucial for resilience. A rigid system might prevent quick adaptations, whereas a more flexible system, like one that uses Excel databases, offers more room for maneuvering and parallel analyses.

Interviewee D: What we've done over the years is integrate the old, more flexible systems into more structured ones while ensuring we have certain levers to maintain flexibility at various stages. For instance, in our forecasting system for restocking, if we only followed the sales trend from last year, we'd lose the flexibility to adapt for other factors like demand surges or stock shortages.

Interviewee D: We've created additional layers like safety stock or risk factors to provide room for flexibility, allowing us to adapt when necessary. It's crucial to capture the thought process of people managing these systems, so we're not completely reliant on rigid structures.

Interviewee D: Another key issue is knowledge loss. When someone with 20 years of experience leaves, we often find ourselves needing to replace them with three or four people because much of the know-how isn't documented. That's why we focus on optimizing processes through technology while retaining flexibility.

Interviewee D: This is particularly important in our supply chains because we have multiple types: short chains, long chains, and ultra-fresh chains, like those dealing with lettuce, which have a very short shelf life. Each of these chains requires a different approach.

Interviewee D: Then there's the complexity of distribution. It's not just about delivering from one factory to another. Each store has different needs, and different types of products— like lettuce with shorter shelf life—require different supply chains. We also have a central team that manages master data to ensure that parameters are standardized, but also flexible enough to accommodate these different needs.

Interviewer: There are so many parameters to manage. Which ones guide your decisionmaking? Do you see artificial intelligence playing a role in managing these complexities?

Interviewee D: Yes, AI is definitely going to play a big role. It can help connect and analyze a vast amount of variables much faster than a human brain, and it will enable us to optimize decision-making in ways we haven't even fully tapped into yet.

Interviewee D: For instance, AI could account for factors like weather conditions or unexpected events that aren't currently part of the system. AI can analyze millions of variables simultaneously, something the human brain just can't do at that scale.

Interviewee D: With AI, we'll be able to make more informed decisions and ensure that our processes remain flexible. It can act like a DJ mixing board—adjusting different levers to maintain balance, but also predicting when to push back and warn, "Wait, this adjustment doesn't make sense because of X, Y, and Z." I see a lot of potential for AI in helping us manage our supply chains more effectively.

Interviewer: Speaking of forecasting, do you think AI will be particularly helpful in improving the accuracy of forecasts? **Interviewee D:** Yes, but forecasting will never be 100% accurate. It's inherently fallible. That's why we always need human input to adjust for unforeseen variables. No forecast will ever be perfect, but AI can help us get closer by considering more data points.

Interviewee D: But it's important to remember that AI is only as good as the data it's based on. If we're looking at aggregate data, like the performance of all stores in a week versus individual stores on a specific day, the granularity matters. The more specific the data, the more useful the forecast.

Interviewer: Let's talk about SONAE's private label products. Does SONAE own the entire supply chain, or do they work closely with their suppliers?

Interviewee D: We don't typically capitalize suppliers, like buying them out. That's more common in other groups like Jerónimo Martins. We work with a producer's club, helping suppliers grow by guaranteeing purchases and providing support, but we don't own their operations.

Interviewee D: This allows us to remain flexible and adapt to new suppliers when necessary. If, for example, a cheaper or more efficient producer comes along, we can switch without being tied down. Vertical integration can limit competitiveness because it reduces flexibility.

Interviewer: How does SONAE manage risk mitigation? Are there contingency plans in place, especially given recent disruptions like COVID or the war in Ukraine?

Interviewee D: Yes, we always have risk mitigation plans, though some risks are unpredictable, like COVID. But when we anticipate disruptions, we prepare. For example, when there were transport strikes, we had alternative solutions in place, and after such events, we always do debriefings to learn and improve.

Interviewee D: We also work closely with third-party logistics providers and suppliers to ensure continuity. For example, when a supplier's factory burned down, we offered them one of our own unused spaces to keep production going.

Interviewee D: Situations like the Suez Canal blockage are rare but have a huge impact. In such cases, we work with our logistics partners to find alternative routes, although they might be longer and more expensive.

Interviewer: It sounds like you've developed comprehensive mitigation strategies over time. How did COVID specifically affect your operations?

Interviewee D: At first, supermarkets didn't suffer much because we were considered essential. But then we started seeing the effects when suppliers were hit with COVID outbreaks and had to shut down. We implemented strict safety measures—distancing, masks, restricted access—to keep our operations running, but it was a learning process.

Interviewee D: Flexibility was key. We relocated some operations to other sites and set up external interfaces to ensure continuity. It was difficult, but because we had flexibility built into our processes, we managed.

Interviewer: It must have required a significant investment.

Interviewee D: Absolutely. Companies had to invest heavily, but there was no precedent for this. We were all navigating in the dark, unsure of how long it would last or what the true costs would be.

Interviewer: Thank you so much for answering all my questions. That was exactly what I needed.

Interviewee D: You're welcome.

ANNEX C – QUESTIONNAIRE

1. What is your age?
Please select an option:

- 18 – 24
- 25 – 34
- 35 – 44
- 45 – 54
- 55 – 65
- 65+

2. What is your gender?
Please select an option:

- Male
- Female
- Other

3. What is your level of education?
Please select an option:

- Primary education
- Secondary education
- Bachelor's degree
- Master's degree
- Doctorate

4. What type of food retail establishments do you usually shop at?
(You may select more than one option.)

- Supermarkets
- Local grocery stores
- Farmer's markets

- Online food retailers
- Other

5. If your previous answer was "Other," please specify:

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6. When you shop at food retail establishments, for how many people do you usually purchase food products?
Please select an option:

- Just for myself
- For myself and one other person
- For myself and two or three others
- For myself and four or more people

7. Evaluate the following aspects based on the importance you attribute to them when making your purchases, on a scale from 1 (Not Important) to 5 (Very Important).
Please select an option for each aspect:

Aspect	1 (Not Important)	2 (Slightly Important)	3 (Moderately Important)	4 (Important)	5 (Very Important)
Quality	☐	☐	☐	☐	☐
Price	☐	☐	☐	☐	☐
Flexibility	☐	☐	☐	☐	☐
Sustainability	☐	☐	☐	☐	☐
Availability	☐	☐	☐	☐	☐

8. During recent global disruptions such as the COVID-19 pandemic, international conflicts, cybersecurity vulnerabilities (external attacks), and economic instability, did you experience any change in the availability or significant shift in the purchase of agricultural products?
Please select an option:

- Yes
- No

9. If yes, what consequences did you experience due to disruptions?
(Select all that apply.)

- Higher prices
- Product shortages
- Lower quality of products
- Longer delivery times

- Difficulty finding specific products or preferred brands
- Lack of information or transparency regarding product availability
- Other

10. If your previous answer was "Other," please specify:

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11. Based on your experience or perception, how would you rate the importance of each of the following aspects for improving the resilience of the agricultural product supply chain? Please evaluate each aspect on a scale from 1 (Not Important) to 5 (Very Important).
Please select an option for each aspect:

Aspect	1 (Not Important)	2 (Slightly Important)	3 (Moderately Important)	4 (Important)	5 (Very Important)
Creating strategic alliances with other supply chain partners	☐	☐	☐	☐	☐
Partial automation of administrative tasks	☐	☐	☐	☐	☐
Centralizing logistics operations for better control	☐	☐	☐	☐	☐
Holding monthly meetings with suppliers	☐	☐	☐	☐	☐
Diversifying suppliers to reduce dependency on a single supplier	☐	☐	☐	☐	☐
Using advanced technology for accurate demand and stock forecasting	☐	☐	☐	☐	☐
Increasing cybersecurity in the workplace	☐	☐	☐	☐	☐
Creating a dedicated internal communication team for information sharing	☐	☐	☐	☐	☐
Using basic sensors to monitor inventory	☐	☐	☐	☐	☐

12. In your opinion, do companies and suppliers that invest in optimizing their supply chain and building a resilient environment become more competitive in the market?
Please select an option:

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

13. If yes, do you think this competitiveness can bring benefits not only to the customer but also to the industry in the long term?
Please select an option:

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

14. Would you be more likely to continue purchasing from a retailer that implements a strategy focused on flexibility, real-time monitoring, and collaborative planning to ensure the availability of agricultural products during unstable times?
Please select an option:

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

15. Do you have any additional comments or suggestions on how a strategy focused on supply chain resilience could be improved or implemented in the agricultural product retail sector?